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GEOCHEMISTRY OF HIGH-GRADE COMPLEXES OF BAHIA STATE, BRAZIL

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ABSTRACT The high-grade terrains of Bahia State can be divided into the granulitic Jequié complex, probably of middle Archean age, surrounded by the younger (late Archean?) granulitic-gneissic-migmatitic Caraíba, Itabuna, and Paramirim complexes.

The Jequié granulites have essentially a granitic chemistry, presenting scattered enrichment (Rb, Y, Zr, Nb, Ba, REE, etc.) or non-depletion (Cs, U, etc.) of many trace elements which are normally highly depleted in high-grade metamorphic rocks. The Caraíba and Itabuna gneisses and granulites have a granodioritic-tonalitic composition, with subordinate mafic-ultramafic and carbonate-calc-silicate lenses. Most of the Caraíba rocks show signs of remobilization and reintroduction of LIL elements. The mafic-ultramafic rocks of the Caraíba complex can be separated into two groups: one has a composition intermediate between high-Mg basalts and tholeiites, while the other is essentially a LILE-enriched tholeiite. The Caraíba and Itabuna rocks are more heterogeneous than the Jequié granulites and have a substantial supracrustal component. Granitic gneisses, related to the early Proterozoic Jacobina Group, occur associated with the Caraíba rocks. The Piramirim complex is poorly known.

INTRODUCTION The major rock units of the state of Bahia, located within the São Francisco craton (Almeida, 1977), consist of high-grade metamorphic basement rocks overlain by a succession of younger mainly metasedimentary sequences. The high-grade rocks are divided into an older (3.1 to 2.7 Ga) nucleus (the granulitic Jequié complex) surrounded by younger (2.7 to 2.2 Ga) mobile belts (the granulitic-gneissic-migmatitic Caraíba, the granulitic Itabuna, and the gneissic-migmatitic Paramirim complexes).

The Jequié orogenic cycle (2.7 ± 0.2 Ga), a major isotopic homogenization episode, is associated with the formation and stabilization of almost all the high-grade terrains of Bahia State (Jardim de Sá *et al.*, 1976) and probably dates its main granulite facies metamorphic episode (Cordani and Iyer, 1979). Several age dates for these high-grade terrains are between 2.5 and 2.2 Ga and its geological significance is still obscure. The Transamazônico orogeny (2.0 ± 0.2 Ga) promoted a total or partial resetting of the Rb/Sr system in large parts of the high-grade terrains of Bahia. The reworking of these terrains during the Transamazônico cycle is indicated by several K/Ar age determinations (Tavora *et al.*, 1967; Figueiredo, 1976).

The predominant rock types in the Jequié complex are felsic granulites, migmatized granulites and augen gneisses, at times interleaved with pegmatites and amphibolites, with minor occurrences of metaquartzites and calc-silicate rocks (Sighinolfi *et al.*, 1981). The Caraíba and Itabuna complexes consist mainly of intermediate granulites, gneisses and migmatites, with subordinate layers and lenses of metasedimentary rocks and subconcordant mafic-ultramafic bodies (Sighinolfi, 1971; Figueiredo, 1980). A low-grade volcanic-sedimentary sequence (Rio Itapicuru greenstone belt, Kishida and Riccio, 1980) occurs associated with the Caraíba complex.

The late Archean Piramirim complex consists predominantly of felsic gneisses and migmatites (amphibolite facies) with a few intercalations of mafic-ultramafic bodies and metasedimentary rocks, with a NNW-SSE structural trend (Jardim de Sá *et al.*, 1976). The Paramirim rocks are poorly known in terms of lithogeochemistry.

JEQUIÉ COMPLEX The Jequié complex (Cordani, 1973) consists mainly of granulite facies rocks, folded and foliated in variable patterns NE-SW (Fig. 1). The predominant rock types are banded granulites, migmatized granulites and augen gneisses. Mafic granulites (two-pyroxene, amphibole and plagioclase) occur interbedded with the more abundant felsic types (Hypersthene-bearing quartz-feldspathic gneisses). Charnockitic rocks are recognizable in the field by their darker colours and typical xenoblastic textures. Small lenses of metasedimentary rocks, metamorphosed to granulite facies, occur mainly in the western part of the complex.

Rb/Sr isotopic investigations in the Mutuípe region (*e.g.* Cordani and Iyer, 1979) yielded three tentative reference isochron lines: 3.16 ± 0.06 Ga with initial $^{87}Sr/^{86}Sr$ ratio (R_0) of 0.711 ± 0.004; 2.73 ± 0.05 Ga with $R_0 =$ = 0.7065 ± 0.0015; and 2.44 ± 0.04 Ga with $R_0 =$ = 0.7066 ± 0.0008. The 3.16 Ga isochron was generated by data points of four samples from a single outcrop, while the other two (like most Rb/Sr isochrons of Bahia State) represent different rock types from very large areas. According to Cordani and Iyer (1979) the 2.7 Ga isochron indicates a regional Sr homogenization event probably related to the main granulite facies metamorphism, while the 3.1 Ga one reflects the presence of an older basement surviving through the 2.7 Ga granulitization. The 2.4 Ga isochron was obtained from rocks from the eastern margin of the Jequié complex (rocks from the western margin – Maracás area – yielded similar ages) and could represent a retrogression of older rocks.

In relation to chemical composition, the charnockitic rocks of the Jequié complex are quite distinct from the more abundant granulites (Tables 1 and 2). The granulites have essentially a granitic chemistry and are enriched or

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non-depleted in the large-ion lithophile elements (LILE), while the composition of the charnockites resembles average andesites, with a great scatter of LILE values (Sighinolfi *et al.*, 1981). The enrichment of LILE seen in most rocks of the Jequié complex also includes the rare earth elements (REE). The REE patterns of the Jequié granulites and charnockites (Fig. 2) are strongly enriched in total REE, particularly the light ones, and depleted in Eu, being considerably different from most Archean granulites and gray gneisses. The strong and consistent Eu negative anomaly of all Jequié rocks suggests that feldspar fractionation was involved in the parent material. This, together with the high initial $^{87}Sr/^{86}Sr$ ratio of 0.711, is consistent with a derivation of these rocks from older crustal material.

Granulite facies rocks have been observed (*e.g.* Sighinolfi, 1971; Lewis and Spooner, 1973; Heier, 1973; Tarney, 1976; Turner, 1980; Rollinson and Windley, 1980) to be usually depleted in LIL elements. On the other hand, some granulitic areas present normal or even enriched LILE values (*e.g.* Moine *et al.*, 1972; Gray, 1977; Weaver, 1980). Sighinolfi *et al.* (1981) discussed three processes for the explanation of the undepleted character of the Jequié rocks: retrograde metamorphism over wide areas was accompanied by the reintroduction of LIL elements; the rocks underwent dehydration to become granulite facies without partial melting and substantial loss of trace elements; and, the rocks were always dry and fluid loss (and partial melting) during metamorphism was slight.

The concept of LILE reintroduction by a later metasomatic event would alleviate the doubts about the general understanding of the distribution of heat-producing elements at depth, and Sighinolfi *et al.* (1981) suggested an attractive model of thrusting of high-grade rocks over younger, cooler and wetter low-grade rocks, producing retrograde metamorphism of the overthrust slab. However, this hypothesis is difficult to support since geochronological studies of the Jequié rocks (Cordani and Iyer, 1979) indicates that the Rb/Sr system was not altered after at least 2.4 Ga ago. If the chemical character of the Jequié rocks is due to metasomatic overprinting, the present isotopic data suggest an Archean age for such a process.

As shown by Brown and Fyfe (1970), partial melting of high-grade metamorphic rocks containing muscovite-biotite-hornblende is a typical process, leaving granulitic rocks as a residue. Another possibility for widespread granulitization is a dilution of the fluid phase with CO_2 or other volatiles (*e.g.* Touret, 1971, 1974, 1977; Hollister and Burruss, 1976; Newton *et al.*, 1980). However, it has been suggested (*e.g.* Collerson and Fryer, 1978; Weaver, 1980; Weaver and Tarney, 1980) that CO_2-rich fluids would also cause LILE depletion in high-grade rocks. Therefore, LILE depletion would be expected in any of the two processes discussed so far for fluid loss during granulitization (partial melting or dilution by CO_2).

The alternative that the Jequié rocks are granitic-andesitic and contained no water during metamorphism could explain their undepleted character and possibly even the suggestion of Cordani and Iyer (1979) that the Mutuípe granulites (3.1 Ga) could have survived through a 2.7 Ga granulitization. But it is difficult to admit such a large volume of water-free rocks, particularly considering the presence of supracrustal rocks.

Therefore, it appears that no definite conclusions can be drawn at this time, regarding the origin of the Jequié complex. Any attempt would have to consider the following points: a granitic-andesitic chemistry with scattered enrichment of LIL elements; the strong and consistent Eu negative anomaly, indicating feldspar fractionation, and the strong enrichment of total REE; the high initial $^{87}Sr/^{86}Sr$ ratio of 0,711; and the middle Archean age with a late Archean granulitization or isotopic rejuvenation.

ITABUNA COMPLEX The Itabuna complex is composed of felsic to mafic granulites, with regional structural trends mainly in a N-S direction, with tectonic and transitional contacts with the Jequié complex. The Itabuna and Caraíba complexes appear to be in structural continuity and accomodated around the older Jequié complex (Fig. 1). The characteristic mineralogical association of the Itabuna granulites is orthopyroxene-plagioclase, but garnet-clinopyroxene-quartz is occasionally found (Sighinolfi, 1970).

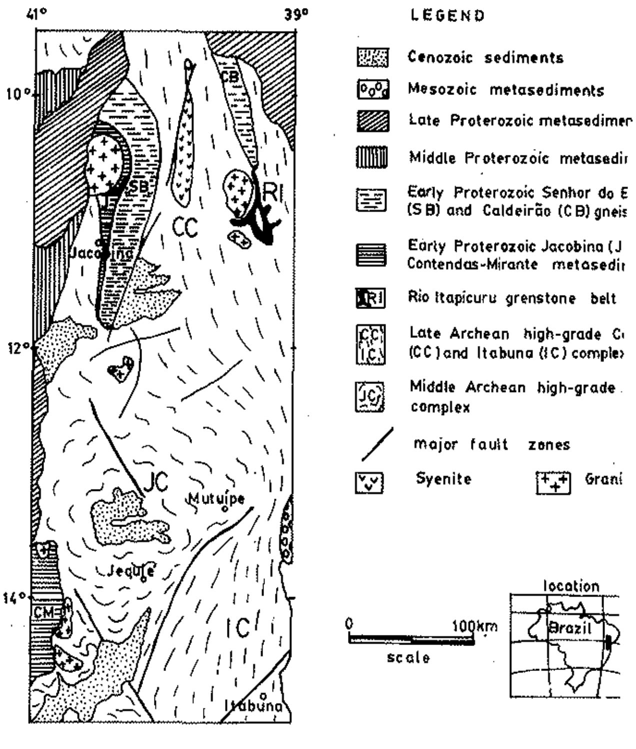

Figure 1 — Geological sketch map of eastern Bahia, after Inda and Barbosa (1978), modified

In the Salvador area occurs interbedded felsic and mafic granulites, distinguished by the presence of aluminous minerals, such as sillimanite, garnet, corundum, sapphirine, and cordierite, in the felsic rocks, while the mafic granulites typically contain the orthopyroxene-plagioclase assemblage (Fujimori, 1968). Stormer and Whitney (1977) indicated conditions of 750-800 °C and 4-8 kb during the metamorphism of the Salvador granulites.

Cordani and Iyer (1979) reported a Rb/Sr isochron, for ten samples of granulites from the Itabuna region, yielding 2.29 ± 0.09 Ga and 0.703 ± 0.001. In their opinion, this isochron represents an apparent age reflecting the formation of secondary biotite and K-feldspar. However, it must be noted that this isochron depends mainly on only one sample (with a high $^{87}Rb/^{86}Sr$ ratio) and the other nine points would yield an age of 2.55 Ga, making even more difficult the task of interpreting such a reference isochron. The Rb/Sr data for the Salvador area defined an isochron with 2.27 ± 0.04 Ga and 0.703 ± 0.001. This low initial $^{87}Sr/^{86}Sr$ ratio and the aluminous character of the Salvador granulites suggest that these granulites may in fact be Transamazônico.

The Itabuna granulites (Sighinolfi, 1970, 1971) have a composition (Table 1) slightly more basic than most Archean granulites and gray gneisses being, however, very similar in chemistry to the granulites of the Musgrave Range in Australia (Lambert and Heier, 1968). The average composition of eleven sub-acid granulites from the Itabuna complex (Sighinolfi, 1971) is fairly typical of Archean high-grade rocks, being particularly comparable to the granulites from Caraíba (Figueiredo, 1980) and New Quebec (Eade *et al.*, 1966), and with the gray gneisses from east Greenland and Scotland (Sheraton *et al.*, 1973). The heterogeneity of the Itabuna complex granulites, as well as the Salvador granulites, led to an idea (*e.g.* Fujimori, 1968; Sighinolfi, 1970) of a dominant sedimentary component for the original material.

Table 1 – Average compositions of the high-grade metamorphic rocks of eastern Bahia (oxides in wt%; trace elements in ppm; Fe_2O_3 = total iron as Fe_2O_3)

	1	2	3	4	5	6	7
SiO_2	68.77	60.95	60.70	65.65	71.48	48.51	47.82
TiO_2	0.50	0.79	0.95	0.54	0.34	1.22	0.86
Al_2O_3	14.36	17.37	15.83	16.25	13.97	14.61	12.61
Fe_2O_3	3.84	6.61	7.82	4.64	2.67	12.59	11.97
MnO	0.06	0.09	0.11	0.05	0.05	0.20	0.18
MgO	0.54	2.75	3.02	1.31	0.72	7.22	11.05
CaO	2.10	4.67	5.28	3.95	2.14	11.02	11.74
Na_2O	3.28	3.53	3.55	4.18	3.72	2.85	1.49
K_2O	4.90	1.85	2.28	2.44	3.59	0.97	0.66
P_2O_5	0.18	0.29		0.24	0.12	0.18	0.09
Cr	3	147	71	12	13	222	598
Ni	21	93		8	9	65	251
Zr	430	340	222	205	312	91	54
Rb	168	37	46	31	145	15	11
Sr	177	338	543	544	196	214	107
Ba	839	725	1217	943	768	564	328
Y	72	19		11	31	27	16
K/Rb	296	774	626	645	207	537	498
Rb/Sr	0.95	0.11	0.09	0.06	0.74	0.07	0.10

1. Jequié granulites (Sighinolfi *et al.*, 1981); **2.** Jequié charnockites (Sighinolfi *et al.*, 1981); **3.** Itabuna granulites (Sighinolfi, 1971); **4.** Non-remobilized Caraíba gneisses and granulites (Figueiredo, 1980); **5.** Jacobina gneisses (Figueiredo, 1980); **6.** Caraíba LILE--enriched mafic-ultramafic rocks (Figueiredo, 1980); **7.** Caraíba mafic-ultramafic rocks (Figueiredo, 1980)

CARAÍBA COMPLEX The Caraíba complex (Barbosa, 1970) is composed predominantly of banded, felsic to intermediate gneisses and granulites, with subordinate layers and lenses of carbonate-calc-silicate rocks, banded iron-formations, graphite-rich rocks and subconcordant mafic-ultramafic bodies. Disseminated copper sulfide deposits, hosted mainly in hypersthenitic and noritic bodies, and chromite--bearing ultramafic bodies, are found in the Curaçá and Jacurici valleys, respectively. With intrusive characteristics are found a large (over 1,000 km^2) syenitic orthogneiss and granitic bodies, ranging from small lenses to large plutons.

The Rio Itapicuru greenstone belt (Mascarenhas, 1976; Kishida and Riccio, 1980), composed of a sequence of mafic to felsic metavolcanic as well as metasedimentary units, with stratabound gold deposits, occurs associated with the Caraíba complex. There is a broad metamorphic zonation, with greenschist facies rocks in the greenstone belt area and granulite facies rocks in the Curaçá valley region, amphibolite facies rocks intervening between these two.

The metasediments of the Jacobina Group are also found in northeastern Bahia. The Jacobina Group consists of coarse-grained clastic (quartzites and subordinate conglomerates) and pelitic sediments, with gold and uranium mineralization, and mafic-ultramafic intrusions, metamorphosed to amphibolite facies conditions (Leo *et al.*, 1964; Cox, 1967; Sims, 1977). The contact relations between the Jacobina metasediments and the Caraíba complex, particularly along the east side of the Jacobina Ridge where a belt about 20 km wide of gneisses and migmatites, with subordinate lenses of quartzites and occasional conglomerates, occurs, have been a subject of controversy. This belt named the Senhor do Bonfim gneiss belt by Figueiredo (1980), has been described either as highly metamorphosed Jacobina sediments or as Caraíba complex basement rocks. Other similar gneiss belts, such as the Caldeirão belt, which could be related to the Jacobina Group, are found in northeastern Bahia (Jordan, 1972; Figueiredo, 1980).

The Senhor do Bonfim and Caldeirão gneiss belts are characterized by metamorphism of amphibolite to upper--amphibolite facies conditions, while the Caraíba complex shows a variation from upper-amphibolite facies in its southern parts towards granulite facies in the Curaçá valley. The equilibration temperature of these granulites, determined using two-pyroxene and clinopyroxene-garnet geothermometers, is estimated (Figueiredo, 1980) to have been of the order of 750-850 °C.

Archean ages were determined by Rb/Sr data for the Caraíba complex (Jardim de Sá *et al.*, 1976; Brito Neves *et al.*, 1980), but isotopic disequilibrium is fairly common. Recent unpublished data (Koji Kawashita, personal communication, 1982) defined Archean ages for many rocks of the Caraíba complex, but Transamazônico ages were indicated for over half of the samples analysed.

A Rb/Sr isochron for the Campo Formoso granite, which is intrusive into the Jacobina metasediments, yielded an age of 1.911 ± 0.013 Ga with $R_0 = 0.708$ (Torquato *et al.*, 1978), indicating an early Proterozoic age for the deposition of the Jacobina Group. A Rb/Sr mineral isochron for the Itiúba syenite (Figueiredo, 1976) defined an age (of biotite) of 1.8 Ga with $R_0 = 0.705$, reflecting the metamorphism of the syenite during the Transamazônico cycle. The Transamazônico reworking of the Caraíba complex is also shown by K/Ar ages (Távora *et al.*, 1967; Figueiredo, 1976).

Figueiredo (1980) demonstrated that over half of the Caraíba gneisses and granulites were subjected to strong remobilization of LIL elements. The non-remobilized rocks have a granodioritic-tonalitic chemistry (Tables 1 and 2) and are comparable to other Archean high-grade rocks, as discussed previously for the Itabuna granulites. Lindenmayer (1980) suggested that these granodioritic-tonalitic rocks formed a basement (of unknown origin) for the mainly sedimentary supracrustal rocks. On the other hand, Figueiredo (1976, 1980) suggested that the close association, and occasional gradation, of these gneisses and granulites with the sediments would favor a supracrustal origin for these granodioritic-tonalitic rocks. The chemistry of the granodioritic-tonalitic gneisses and granulites, including the REE (Fig. 2), is very similar to Archean dacitic-andesitic rocks and arkose-graywackes.

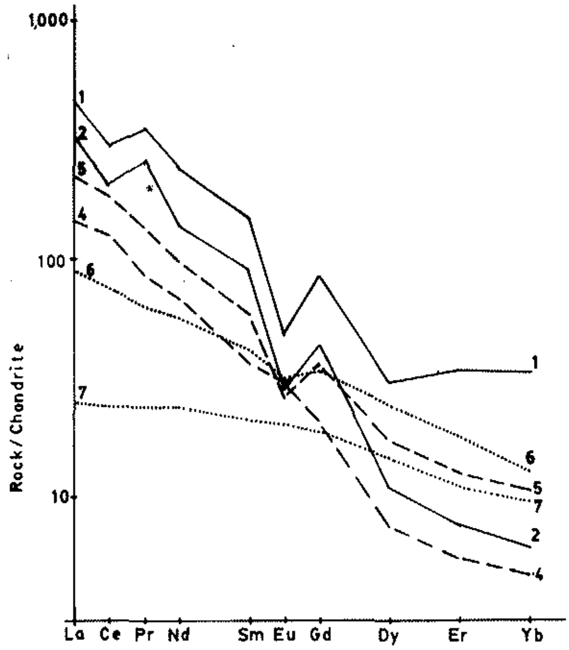

Figure 2 – Chondrite-normalized REE patterns for eastern Bahia high-grade rocks. Same legend as Table 1. Chondrite values used for normalization are Leedey chondrite data (Masuda et al., *1973) divided by 1.20*

Table 2 – Average rare earth element contents (in ppm) of high-grade metamorphic rocks of eastern Bahia (Ce_N/Yb_N = chondrite-normalized Ce/Yb ratio; Eu = interpolated value between Sm and Gd)*

	1	2	4	5	6	7
La	148	103	46	71	28.4	7.9
Ce	246	169	105	150	62	19.6
Pr	41	30	10	16	7.4	2.8
Nd	143	83	41	59	14.3	18.3
Sm	29	17.5	7.1	11.3	4.1	5.1
Eu	3.5	2.1	2.2	1.9	1.5	1.6
Gd	22.4	11.3	5.5	9.4	4.9	5.2
Dy	10.0	3.6	2.5	5.7	4.6	3.9
Er	7.3	1.6	1.2	2.7	2.4	1.5
Yb	7.0	1.3	1.0	2.2	2.0	0.8
Ce_N/Yb_N	9.0	33.3	28.0	17.6	5.8	2.5
Sm/Nd	0.20	0.21	0.17	0.19	0.29	0.28
Eu/Eu*	0.43	0.47	1.04	0.58	0.83	1.02

Same legend as Table 1 (no REE data available for the Itabuna granulites)

The mafic-ultramafic rocks of the Curaçá valley can be separated into two groups in terms of chemistry (Tables 1 and 2): one group (where the copper mineralization is found) has a composition intermediate between tholeiites and high-Mg basalts, and their REE patterns (Fig. 3) present a slight enrichment of light REE, resembling the enriched Archean tholeiites (Condie, 1976); the other group (identical to the melanocratic portions in outcrop scale) has a LILE-enriched character (Tables 1 and 2), and their REE patterns (Fig. 3) show considerably more light REE enrichment and a small negative Eu anomaly. According to some geologists (*e. g.* Lindenmayer, 1980; Townend *et al.*, 1980), these mafic-ultramafic rocks would correspond to layered intrusions (differentiated tholeiitic sills) of the Skaergaard type, with the copper mineralization being formed by separation of sulfide immiscible liquid, also involving assimilation of sulfur from the ubiquitous carbonate metasediments (sometimes with anhydrite, Leake *et al.*, 1979) and graphitic rocks. The intimate association of these mafic rocks with banded iron-formation (and other metasediments) and the direct relationship between copper sulfide and magnetite content, led Figueiredo (1976, 1980) to favour a submarine volcanic origin for these mafic rocks and copper mineralization.

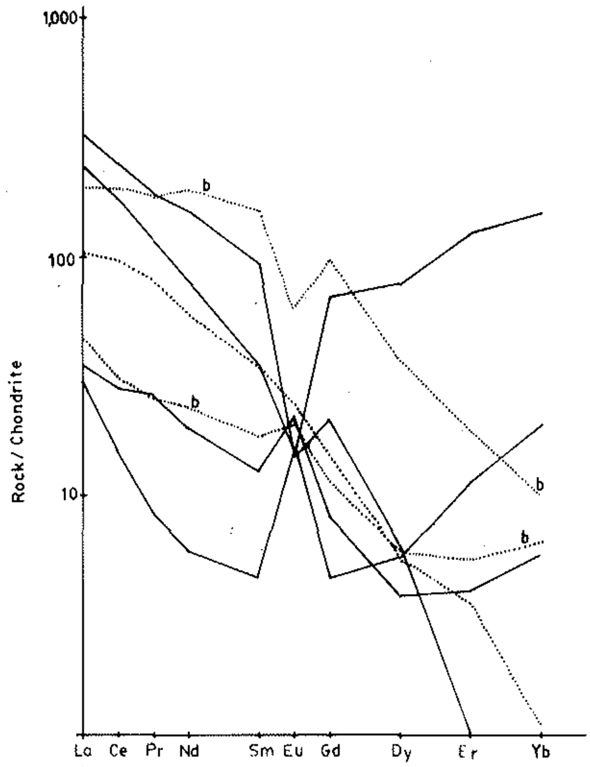

Figure 3 – Chondrite-normalized REE patterns for felsic to intermediate gneisses, granulites and augen gneisses (continuous lines), *and mafic-ultramafic rocks* (dotted lines) *from the Caraíba complex (b = biotitites). Chondrite values used for normalization are Leedey chondrite data (Masuda* et al., *1973) divided by 1.20*

Recent studies (Appel, 1980) indicated appreciable amounts (similar to the Caraíba Mine ones) of copper sulfides in the carbonate, silicate and sulfide facies iron-formation as well as in sulfide facies admixed with basaltic tuffs, of the Isua supracrustals from west Greenland, mainly within intercalated layers of basaltic lavas and tuffs, banded iron-formation, quartzites, carbonates and graphitic metasediments. One of the samples of Caraíba Cu ore analysed by Figueiredo (1980) had a very high iron content (55% Fe_2O_3) and its REE pattern is similar to those from the banded iron-formations, being typical (as the REE patterns of Caraíba marbles) of Archean chemical sediments (Fryer, 1977). This additional evidence, together with the impressive lithological and chemical similarity between the Caraíba rocks and the Isua supracrustals, suggests rather strongly that the Caraíba mafic-ultramafic rocks are basaltic volcanic rocks (lavas and tuffs) and that the copper mineralization is of submarine exhalative origin, from brines related to the basic volcanic rocks.

The gneisses of the Senhor do Bonfim and Caldeirão belts have a granitic chemistry (Tables 1 and 2) and their REE patterns (Fig. 2) are quite distinct from those of the Caraíba non-remobilized gneisses and granulites, showing a greater fractionation between light and heavy REE and strong negative Eu anomalies. The chemical differences between the Caraíba rocks and the Senhor do Bonfim and Caldeirão gneiss belts, from granodioritic-tonalitic to granitic, the latter being enriched in K/Na, light REE and depleted in Eu, seems to be related to the overall geochemical change that occurred in the Archean to early Proterozoic transition (*e.g.* Veizer and Jansen, 1979). This chemical distinction, together with the lithological (chemical sediments as opposed to coarse-grained clastics) and metamorphic (granulite *versus* amphibolite facies) differences between the Caraíba complex on one hand and the Senhor do Bonfim and Caldeirão belts on the other, indicates that these gneiss belts with subordinate quartzite and conglomerate layers and lenses are not related to the Caraíba Complex but to the early Proterozoic Jacobina Group.

Clear evidence of K-metasomatism in the Caraíba complex rocks is provided by biotitites replacing hypersthenites and norites and by augen gneisses in fracture zones. Based on K/Ar data in biotites, Rb/Sr mineral isochrons and Rb/Sr whole-rock isochrons for K-granites, it seems reliable to assume a Transamazônico age for the K-metasomatic event in the Caraíba complex. REE data for several of the gneisses, granulites and mafic-ultramafic rocks of the Caraíba complex (Fig. 3) provide clear evidence of strong remobilization of the REE during high-T (upper-amphibolite facies conditions) metasomatic processes. Other LIL elements, such as K, Rb, Ba, Pb and Y, also show signs of remobilization (Figueiredo, 1980).

Considering that over half of the felsic to intermediate gneisses and granulites, as well as the mafic-ultramafic rocks, of the Caraíba complex were subjected to strong remobilization of LIL elements, it is not surprising that over half of the Rb/Sr isotopic data for these rocks defined Transamazônico ages, obviously reflecting the remobilization process.

The REE have been generally considered to be immobile in most metamorphic conditions, but REE mobility has been detected during hydrothermal alteration, spilitisation, lower greenschist facies hydrous metamorphism, and weathering (*e.g.* Hellman and Henderson, 1977; Wood *et al.*, 1976; Hellman *et al.*, 1979; Nesbitt, 1979). The Caraíba complex rocks probably represent the clearest example of REE remobilization in high-grade conditions. On the other hand, some Caraíba rocks provide a remarkable example of immobility of the REE. A few kilometers north of Poço de Fora (Fazenda Capivara) gneisses and migmatites were strongly retrogressed to greenschist facies conditions (chlorite and epidote replacing almost totally the clinopyroxenes and amphiboles), but the REE patterns of the retrogressed rocks are virtually identical to the ones from the gneisses and migmatites (Figueiredo, 1976, 1980).

CONCLUSIONS The high-grade rocks of eastern Bahia are comprised at an older nucleus (the Jequié complex), surrounded by late Archean early Proterozoic mobile belts (the Caraíba and Itabuna complexes).

The Jequié granulites and charnockites have essentially a granitic-andesitic chemistry, with a LIL element undepleted character. The fairly homogeneous composition of these rocks, their LILE-undepleted character, the granitic-type REE patterns and strong Eu anomaly, and the high initial $^{87}Sr/^{86}Sr$ ratio of 0.711, suggest that the Jequié complex consists of an orthogneiss terrain of crustal derivation, possibly intruded into deep levels of the crust and metamorphosed to granulite facies, with a tectonic emplacement of the minor lenses of supracrustal rocks.

The Itabuna and Caraíba complexes have a composition considerably more heterogeneous, with a bimodal (granodioritic-tonalitic and basic rocks) distribution, and probably are dominated by supracrustal material. The chemistry of the granodioritic-tonalitic rocks of the Caraíba complex, including the REE patterns, is consistent with meta-dacites-andesites (or else, meta-granodiorites-tonalites) and/or meta-arkose-graywackes. The Caraíba basic rocks probably represent basic lavas and tuffs associated with the metasediments, and the copper sulfide mineralization found in them is considered as having a submarine exhalative origin, from brines related to the basic volcanics. Most Caraíba rocks show clear signs of remobilization of LIL elements (including the REE) during K-metasomatism of amphibolite-facies conditions. Such a remobilization of LILE is reflected by partial and total Transamazônico (2.0 ± 0.2 Ga) resetting of Rb/Sr and K/Ar isotopic systems, respectively.

Amphibolite facies gneiss belt, with subordinate quartzite and conglomerate lenses, of granitic composition, occurring in northeastern Bahia, are related to the early Proterozoic Jacobina metasediments. The chemical differences between these gneisses and the Caraíba complex rocks reflect the overall chemical change which occurred in the Archean-early Proterozoic transition.

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