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Petrological and Geochemical Characteristics of the Granulitic Terrain of Brejões, Bahia, Brazil

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Abstract

New petrological and geochemical characteristics of the Brejões region, situated in the south of Bahia, Brazil are discussed. The region forms a part of the most important and extensive granulite facies terrain in Brazil of Archean/Paleoproterozoic age. Five groups of rock types all equilibrated in the granulite facies are identified in this region. They are: i) supracrustal and related rocks, ii) undifferentiated granulites, iii) hornblende bearing enderbite-charnockites, iv) hornblende free enderbite-charnockites, v) charnockites. The first group appears to be the oldest in the region as they form enclaves in the 2.9 Ga old undifferentiated granulites. The third and fourth group are enderbite-charnockites, whose protoliths constitute two series of calc-alkaline rocks, one titanium poor (hornblende free) and another titanium rich (hornblende bearing). U/Pb zircon SHRIMP dates indicate ages of formation at 2.81 Ga (hornblende free) and 2.69 Ga (hornblende bearing) for the two groups. The fifth group of rocks have charnockitic affinity and are present in the center of the Brejões Dome. These rocks also have calc-alkaline affinity, but show petrographic and geochemical characteristics distinct from those of other groups. Preliminary geochronological investigations by zircon Pb-Pb evaporation method yielded 2.6 Ga and 2.0 Ga for the charnockites from the inner core of the Brejões Dome. These age data suggest that the circular structure was formed by the re-fusion of the 2.6 Ga old deep crustal material generating younger charnockites at 2.0 Ga.

Key words: Brejões Dome, granulite facies rocks, geochemistry, geochronology

Introduction

The high grade metamorphic terrain of South Bahia, Brazil represents an important metamorphic province in the world and is composed of amphibolite and granulite facies rocks (Fig. 1). Geological study of this terrain was initiated in the beginning of the seventies. Detailed investigations did not start until 1985, when petrochemical and mineralogical studies were undertaken with a view to trace the metallogenetic evolution in the region. Important studies over the last twelve years include Barbosa (1986, 1988, 1990, 1991, 1992, 1996), Barbosa and Fonteilles (1989), Barbosa et al. (1992, 1996), Iyer et al. (1995), Wilson (1987), Figueiredo (1989), Figueiredo and Barbosa (1993), Cruz (1989), Marinho et al. (1992), Aillon (1992), Arcanjo et al. (1992), Alibert and Barbosa (1992), Fornari and Barbosa (1992), Fornari (1992), Ledru et al. (1994) and Alves da Silva et al. (1996). These studies have tentatively characterized the composition of the metamorphic products and helped to decipher the nature of the protoliths, their ages and the geothermo-barometric conditions that prevailed during the metamorphism. In addition, the metallogenetic evolution of the terrain, more in accord with the regional geology of the crustal segment, could be better modeled .

The western part of this terrain is made of Jequié Block and the eastern part is called the Itabuna Belt (Barbosa and Domingues, 1996; Fig. 1). The Jequié Block is reequilibrated to the granulite facies and contains charnockite-enderbites that intrude ortho-derived rocks (charnockites, tonalites intercalated with mafic and felsic granulitic bands), granulatized supracrustals (metabasalts/andesitic metabasalts, quartzites, iron formations, graphites and partially migmatized aluminous gneisses) and occasional anatectic granites with garnet and cordierite.

The rocks in the Itabuna Belt are also in the granulite facies, whose protoliths are volcanics and/or plutonic rocks of

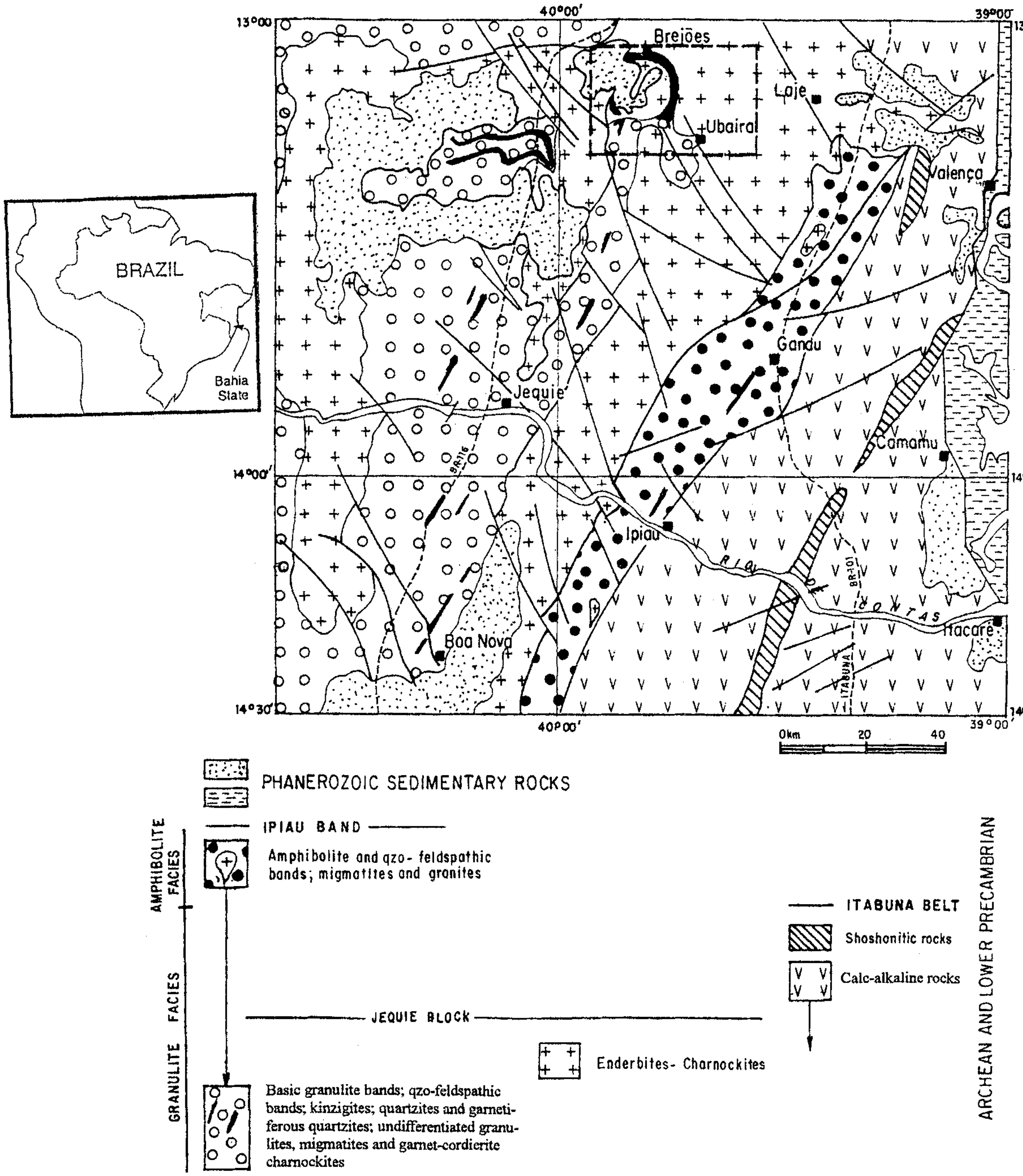

Fig.1. High grade metamorphic rocks of South Bahia, Brazil

shoshinitic affinity, low K calc-alkaline and tholeiitic. The tectonic setting and the geochemical characteristics of these rocks are similar to the rocks of recent volcanic arc like that of Japan or the active continental marginal arc of Chile (Figueiredo, 1989; Barbosa, 1990).

The region between the Jequié Block and the Itabuna Belt is known as Ipiau Band (Barbosa, 1986, 1990; Fig. 1) where gabbros intercalated with quartz-feldspathic layers, aluminous gneisses , iron formations and garnetiferous quartzites are the major rock formations.

All the three regions were subjected to a minimum of three phases of deformation. The Jequié Block and Itabuna Belt are equilibrated to an intermediate pressure (5-7 Kb) and high temperature (850-870°C) granulite facies metamorphism (Barbosa, 1990). The rocks of Ipiau Band are in the amphibolite facies.

The geotectonic model proposed for this area suggests that the Itabuna Belt on the east corresponded to an island arc related to a subduction zone. The existence of a back-arc basin between the Itabuna Belt and the Jequié Block, farther to the west, could be recognized. The Jequié Block may be considered a probable micro-continent. The rocks of the back-arc basin and the major part of the region that forms the arc appear to have obducted over the micro-continent during the period of arc-continent collision (Figueiredo, 1989; Barbosa, 1990). It should be pointed out, however, that recent detailed geological mapping, as well as geochemical and isotopic data, suggest the need for a major revision of this tectonic model (Barbosa, *in prep.*).

Previous investigations carried out in the Brejões area were isolated and invariably dealt with some specific local aspects of the geology without considering its relation to the regional rock formations. The present study, with the help of new data, attempts to integrate the geological, petrologic and geochemical aspects of the area and provides a revised interpretation.

Geological Setting and Petrology

Geological mapping of the area is hampered by lack of good exposures, resulting from thick soil and recent sedimentary cover, which could reach up to 30 meters in the west. Despite such difficulty, the study of some major outcrops suggests five rock types, four of which may be grouped into what is known as the country rocks of the Brejões Dome, while the last group that forms the internal part of the Dome has a distinct lithology (Fig. 2). The lithological characteristics of the five groups are discussed briefly below:

Supracrustal and related rocks

The supracrustal rock types include aluminous kinzigite gneisses, metabasalts/andesitic metabasalts, (Fig. 3) iron formations, quartzites and garnet bearing quartzites, graphites, quartz feldspathic bands (Fig. 4), intrusive metagabbros and charnockites with garnet and cordierite (Fig. 5). These rocks form parallel intercalated bands of varying thickness of 20-50 cm to 1-5 m. The total thickness of these rocks is less than 100 metres. Major outcrops of these rocks is well exposed in the valleys that encompass the Brejões Dome (Fig. 2).

Fig. 3. Fold in the andesitic metabasalts (north of Brejões Dome).

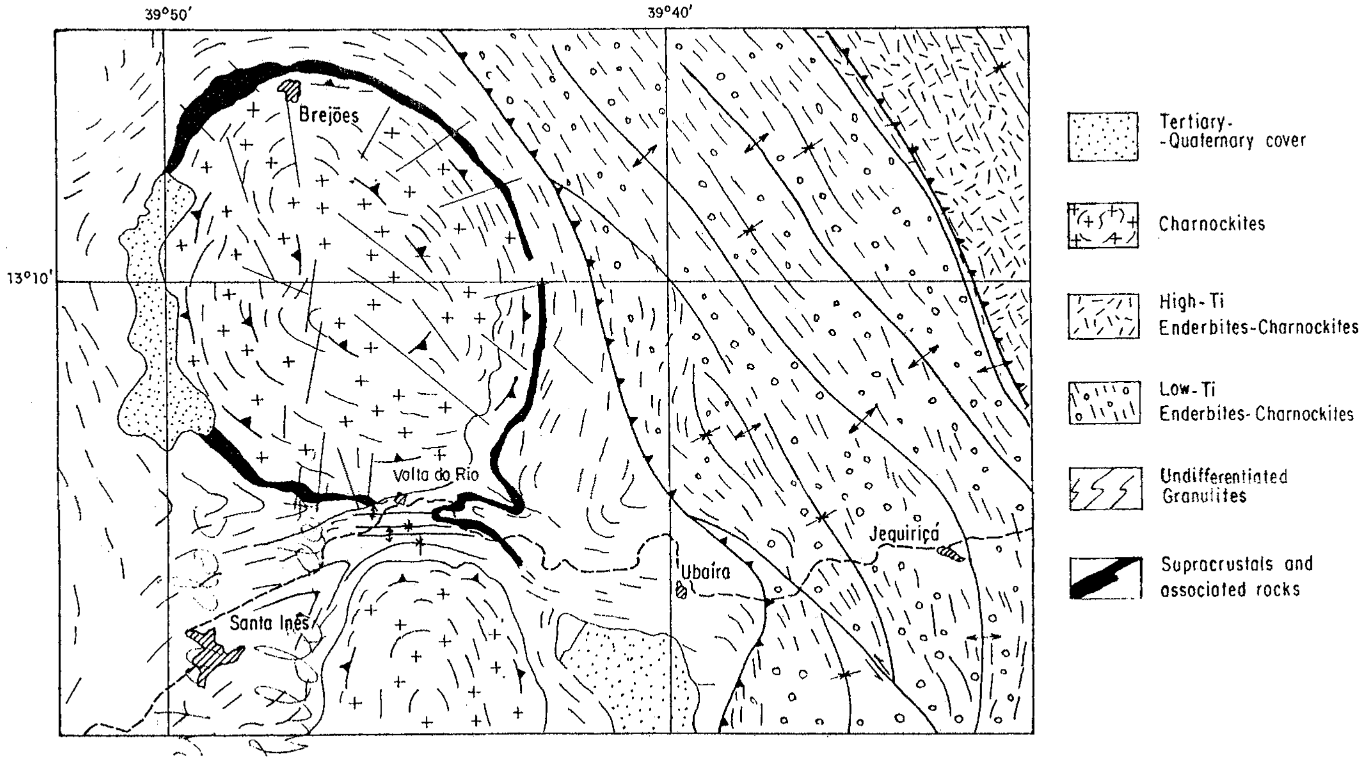

Fig. 2. Geological map of the Brejões area showing the Brejões Dome

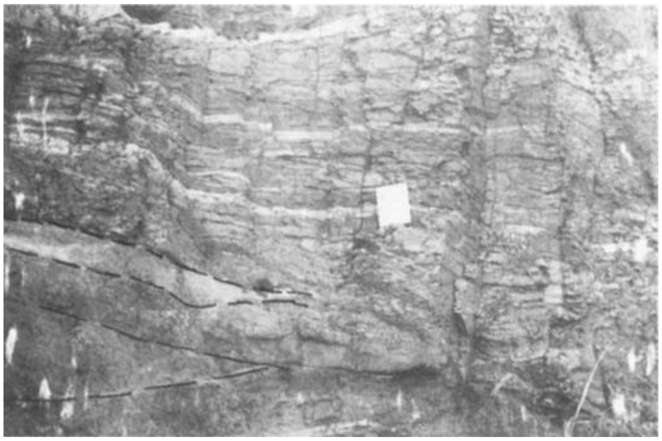

Fig. 4. Photograph of garnet-bearing quartzite (gray) intercalated with quartz-feldspathic bands (white). In the bottom left of the photo "boudinaged" metabasalts/andesitic metabasalts are visible. Location: northern part of the Brejões Dome.

Fig. 5. Photograph showing garnet and cordierite bearing gneisses penetrating the kinzigite gneisses . Outcrop in the north of the Brejões Dome

Better exposures of the medium grained *aluminous kinzigites-gneisses* may be found along the eastern border in the northern part of the Dome and are associated with quartzites, *metabasalts/andesitic metabasalts*. These rocks occur as bands of thickness ranging from 20 cm to 1 metre and are rich in garnet (35%) and cordierite (10%) giving them a reddish tint (Tables 1, 2). These bands alternate with garnet bearing quartz feldspathic bands of similar thickness, the amount of garnet being much smaller. Petrographic studies reveal the presence of spinel plus quartz in some of the samples, indicating a possible high temperature (>1000°C) of formation (Ellis, 1987; Ellis et al., 1980). The estimated temperature is much higher than the average value calculated for the aluminous gneisses present in the Jequié Block (to be discussed later). In some localities the kinzigite gneisses are cut by centimetre thick quartz feldspathic and pegmatitic veins, formed probably during the peak of granulite facies metamorphism (Fig. 5).

The *metabasalts/ andesitic metabasalts* are found in the vicinity of the city of Brejões (Fig. 2), as bands exhibiting close folding (Fig. 3) or as enclaves within the undifferentiated granulites (Fig. 6), discussed in a later section. The rocks when fresh are dark green, exhibiting well defined foliation and are fine grained granoblastic in texture. The *andesitic metabasalts*, when present as bands are composed of plagioclase (40%), clinopyroxene (25%), orthopyroxene (20%), hornblende (10%), quartz (6%) and opaques (3%). *Andesitic metabasalts* show traces of secondary biotite and apatite (Table 1). The *metabasalts/andesite metabasalts*, when present as enclaves exhibit large quantities of biotite and hornblende (abnormally high)

The *iron formations* occur mainly in the northern part of the Brejões Dome (Fig. 2). Most occurrences are found as isolated blocks surrounded by soil, a few of them are associated with aluminous gneisses and metabasalts. The main constituents are haematite/magnetite (70-90%) and quartz (5-10%),(Table 1). These rocks invariably exhibit granoblastic texture with the mineral orientation parallel to the banding in the rock.

The *quartzites and garnet bearing quartzites* (Fig. 4) form parallel bands due to deformation and occur both in sub-horizontal (near the city of Brejões, Fig. 2) and sub-vertical (near the city of Ubaira, Fig. 2) positions. The slightly altered quartzites are light gray and medium to coarse grained. They show penetrating foliation, which is clearly seen due to the alignment of the reddish garnet and dark green orthopyroxene. The metamorphic paragenesis and accessory minerals in these quartzites are given in Table 1. The chemical compositions of the coexisting minerals are given in Table 2.

The *quartz feldspathic bands* are medium grained with a graphic texture showing irregular contacts between the mineral grains. These bands are essentially composed of either (i) quartz, antiperthitic plagioclase, and mesoperthite (rare) or (ii) quartz, mesoperthite, microcline perthite and plagioclase. Orthopyroxene, opaques, biotite and garnet are the major accessory minerals (Table 1). Generally, the hand specimens show a recrystallized mylonitic texture with the quartz crystals elongated parallel to the foliation, but in some cases they exhibit pegmatoid texture. These felsic granulite bands have varying thickness, ranging from a few centimetres to metres and occur intercalated not only with metagabbro bands, but also with quartzites (Fig. 4), graphites, kinzigites and banded iron formations.

The *metagabbros* are found either as enclaves (Fig. 7) within the undifferentiated granulites (discussed in a later section) or

Table 1 Mineralogical composition of the rocks from Brejões, Bahia, Brazil

ROCKS	MAJOR METAMORPHIC MINERALS (Modal Composition)	ACCESSORY MINERALS	RETROGRADE METAMORPHIC MINERALS
FIRST GROUP			
Kinzigites	Gt(35%); Qz(30%); Plag(15%); Cd(10%); Bi(5%); Sill; Mp	Op; Ap; Zr; Gf Sp	
Andesitic Metabasalts	Plag(40%); Cpx(25%);Opx(20%);Hb(10%) Qz(4%)	Op; Ap, Bi	
Banded Iron Formation	He/Mt(70-90%);Qz(30-10%)		
Quartzites/Garnetiferous Quartzites	Qz(70-90%); Gt(5-10%); Plag(1-5%);Opx; Bi	Op	Bi;Clr
Quartz-Feldspathic Band	Qz(50%);Mp(40%);Plag(8-10%)	Op	Se
Metagabbros	Plag(40-50%)(An 30-35); Hb(30-35%) Opx-Cpx(25-30%)	Op; Ap; Zr; Qz	Hb; Bi
Garnet/Cordierite Charnockites	Mp(50-60%); Qz(10-20%); Plag(10-20%) Cd(5%); Gt(5%); Opx; Bi:	Op; Zr	Se; Mir
SECOND GROUP			
Undifferentiated Granulites	Mp(40-50%); Qz(30%); Plag antp(10%) (An 23); Opx(10%); Cpx(2-7%); Hb;Bi	Op; Zr;Ap	Hb; Bi; Mic; Plag; Clr; Bt Mir
Quartz-Feldspathic Veins	Mp(50-60%); Qz(20-30%); Plag antp(5%) (An 25-30); Opx; Cpx; Hb;Bi	Op; Zr	Hb; Bi; Clr
THIRD GROUP			
Hornblende Free Enderbites	Plag antp(60%)(An 30); Qz(7-11%); Opx(2-5%); Cpx(5-10%), Mp; Bi	Op; Zr;Ap	Plag; Mu; Se; Bt; Mir
Hornblende Free Charnockites	Mp(40-50%); Qz(30%); Plag antp(10%) (An 23); Opx(10%); Cpx(2%); Bi	Op; Zr;Ap	Mic; Plag; Clr; Bt; Mir
FOURTH GROUP			
Hornblende Bearing Enderbites	Plag antp(50%)(An 40); Hb(10-20%); Qz(10-15%);Opx(1-6%); Cpx(3-4%); Mp(3-5%)	Op; Zr;Ap	Plag; Mu; Se; Bt; Mir
Hornblende Bearing Charnockites	Mp(30-40%); Hb(10-20%); Qz(30%); Plag antp(10-20%)(An 27); Opx(5%); Cpx(2%); Bi	Op; Zr;Ap	Mic; Plag; Clr; Bt; Mir
FIFTH GROUP			
Charnockites	Mp(30-40%); Plag antp(30%)(An 25); Opx(5-10%); Cpx(2-5%); Hb(10%); Qz	Op; Zr;Ap	Bi; Se; Clr; Bt

ABBREVIATIONS : Opx - orthopyroxene; Cpx - clinopyroxene; Plag antp - antiperthitic plagioclase; Mp-mesoperthite; Hb - hornblende; Bi - biotite; Qz - quartz; Gt - garnet; Cd - cordierite; Sill - sillimanite; Mic - microcline; Op - opaque minerals; Zr - zircon; Ap - apatite; Gf - graphite; Clr- chlorite; Mu - muscovite; Se - Sericite; Bt - bastite; Mir - mirmekite; Epi - epidote; Tr - Tremolite; Sp - spinel; He/Mt - hematite/magnetite; An (anorthite percentage)

as bands intercalated with the quartz-feldspathic band described earlier . In the latter case the metagabbros are 1 to 5 metres thick, fine to medium grained and have an occasional polygonal texture. The main minerals are plagioclase (40-50%), green-brown hornblende (30-35%) and orthopyroxene-clinopyroxene (25-30%). Titaniferous brown biotite, quartz and opaques are present in small quantities (Tables 1 , 2).

The *garnet and cordierite bearing charnockites* are always associated with the aluminous kinzigite-gneisses (Fig. 5). They are light gray, medium grained and less deformed compared to the other plutonic rocks in the region (Fig. 5). Some samples show vestiges of a basic material almost consumed by the parental magma. The major minerals of these rocks are mesoperthite, quartz and plagioclase, while garnet, cordierite, biotite, hornblende, and orthopyroxene are present in small proportions (Table 1). Petrological and geochemical data indicate that the protolith of the garnet/cordierite bearing charnockite may be a "S" type granite (Hine et al., 1978). These charnockites probably had an anatectic origin during peak granulite metamorphic conditions, as they are undeformed and in the majority of the cases are associated with or cutting the kinzigite gneisses (Barbosa, 1990)

Undifferentiated Granulites

A second group of rocks is made of relatively heterogeneous dark green granulites of medium to large grained, with charnockitic characteristics (Figs. 2, 6, 7). In these ortho-derived granulite facies rocks are found enclaves , not only of metabasalts (Fig. 6), andesitic metabasalts and metagabbros (Fig. 7), but also quartz-feldspathic bands and other supracrustal

Table 2. Representative mineral chemical analyses of the rocks from Brejões, Bahia, Brazil

	Quartzites with Garnet			Metagabbro					Undifferentiated Granulites					
	Opx (169)	Bi (173)	Gt (176)	Opx (100)	Cpx (106)	Hb (110)	Bi (102)	Plag (103)	Opx (64)	Cpx (63)	Hb (68)	Bi 332	Plag (65)	Plag (73)
SiO_2	48,77	37,,24	39,58	51,43	51,71	42,67	36,79	58,45	49,71	50,98	52,09	37,74	60,41	61,20
Al_2O_3	6,04	15,65	22,39	0,73	2,00	11,70	13,83	25,76	0,63	0,99	0,77	13,84	24,57	24,29
CaO	0,10	0,04	1,06	0,52	21,82	11,39	0,06	7,71	2,10	21,03	11,40	0,01	6,09	5,79
MgO	18,52	13,57	9,57	16,18	11,31	9,38	11,00	0,01	10,13	8,54	6,85	13,37	-	-
MnO	0,43	0,02	1,28	0,74	0,31	0,14	0,08	-	0,71	0,31	0,16	0,10	0,02	0,08
FeO	26,17	14,35	22,63	31,09	12,55	18,04	19,03	0,10	37,41	18,44	26,89	17,07	0,07	0,02
TiO_2	0,15	5,91	0,04	0,07	0,25	2,07	5,91	0,01	0,14	0,16	0,05	4,60	-	8,18
Na_2O	0,01	0,12	0,002	-	0,52	1,49	0,04	7,03	0,03	0,42	0,16	0,04	8,06	0,33
K_2O	-	9,35	0,01	-	0,01	1,83	9,85	0,36	-	0,01	0,07	9,85	0,33	-
Cr_2O_3	0,26	0,51	0,21	-	0,02	0,01	0,03	0,03	-	0,01	-	-	0,02	-
Cl	-	-	-	0,01	-	0,10	0,04	-	-	-	0,01	-	0,01	-
OH						1,99	3,97	-		-	1,96	4,02	-	-
TOTAL	100,45	100,85	100,78	100,77	100,5	100,8	100,6	99,47	100,84	100,8	100,4	100,6	100,1	99,90

Structural Formulas

Si	1,837	5,460	6,018	1,983	1,947	6,375	5,555	2,628	1,982	1,957	7,912	5,628	2,708	2,723
Al	0,269	2,705	4,012	0,033	0,089	2,005	2,462	1,365	0,030	0,045	0,138	2,433	1,288	1,274
AL^{IV}	0,163	2,540		0,017	0,053	1,539	2,445		0,018	0,043	0,088	2,372	-	-
Al^{VI}	0,106	0,165		0,016	0,036	0,466	0,017		0,012	0,002	0,050	0,061	-	-
Ca	0,004	0,007	0,172	0,021	0,882	1,823	0,010	0,372	0,090	0,872	1,855	0,002	0,290	0,276
Mg	1,043	2,965	2,168	0,930	0,636	2,090	2,476	0,001	0,604	0,493	1,550	2,971	-	-
Mn	0,013	0,003	0,164	0,024	0,010	0,017	0,006	-	0,029	0,010	0,020	0,012	0,001	-
Fe	0,827	1,760	3,386	1,003	0,396	2,254	2,403	0,004	1,251	0,596	3,416	2,129	0,003	0,003
Fe^{2+}	0,784		3,386	0,999	0,356	2,024	0,003		1,251	0,539	3,251			
Fe^{3+}	0,043		-	0,004	0,040	2,230	2,000		-	0,061	0,165			
Ti	0,004	0,651	0,005	0,002	0,007	0,232	0,671	0,001	0,004	0,005	0,005	0,516	-	0,001
Na	0,001	0,035	0,006	-	0,038	0,431	0,010	0,613	0,002	0,031	0,045	0,011	0,695	0,706
K	-	1,749	0,001	-	0,001	0,349	1,897	0,021	-	0,001	0,013	1,874	0,019	0,019
Cr	0,007	0,058	0,025	-	0,001	0,001	-	0,001	-	0,001	-	-	0,001	-
Cl	-	-	-	0,001	-	0,024	0,011	-	0,001	-	0,002	-	0,001	-
OH	-	2,00	-			1,000	-	-	-	-	1,000	2,000	-	-
TOTAL	4,005	17,393	15,957	3,997	4,007	16,655	17,504	5,006	3,993	4,001	15,956	17,576	5,006	5,002

FM	44,64	37,29	62,09	52,47	38,96	52,09	40,80	79,67	6,787	55,20	68,91	41,89	100,0	93,91
WO	0,20			1,08	45,84				4,57	44,23				
EN	55,25			47,02	33,06				30,66	24,99				
FS	44,54			51,90	21,10				64,77	30,79				
AB								60,96					69,23	70,54
OR								2,08					1,86	1,89
AN								36,96					28,91	27,58

rocks described earlier. The major mineralogy of this rock type is mesoperthite (40-50%), quartz (30%), antiperthitic plagioclase (10%) (An 23 in the matrix), orthopyroxene (10%) and clinopyroxene (2-7%). (Tables 1, 2). These granulites with basic enclaves are penetrated by charnockite-enderbite with or without hornblende (discussed in a later section). It is not easy to differentiate between the three plutonic rock types (undifferentiated granulites and charnockite-enderbite with or without hornblende) in the field and in the thin section. However, geochemical data (to be discussed later) permit a clear distinction of the three rock types. In some cases these granulites with basic enclaves are migmatized, where the neosomes contain orthopyroxenes. In some outcrops clear, large grained, relatively homogeneous quartz-feldspathic veins appear to cut the rocks (see Table 1 for mineralogy). Though there are various enclaves in these rocks, that of basic granulites are the most common. The enclaves and the basic granulite "boudins" contained in these ortho-derived granulites are of various sizes (few centimetres to few metres), dark in color and medium grained. The mineralogy of these rocks are similar to that of metabasalts/andesitic metabasalts and metagabbros described earlier, except for the higher abundance of biotite and hornblende, especially near the borders. This is due to the influx of alkalis in these basic granulites resulting in the

Table 2 contd...

	Hornblende Bearing Enderbites-Charnockites									Hornblende Free Enderbites-Charnockites					
	Opx (254)	**Cpx (253)**	**Hb (260)**	**Bi (255)**	**Plag (257)**	**Opx (319)**	**Cpx (320)**	**Hb (318)**	**Mp (312)**	**Opx (307)**	**Cpx (308)**	**Bi (261)**	**Plag (313)**	**Mp (328)**	**Mp (322)**
SiO_2	49,81	49,21	41,91	37,20	60,63	47,94	48,74	40,89	64,66	50,85	50,43	36,53	60,85	64,54	64,51
Al_2O_3	0,71	1,87	10,53	14,59	24,78	0,22	0,94	9,82	18,89	0,61	2,03	12,89	24,90	18,42	18,76
CaO	1,34	19,35	11,13	0,02	6,38	0,74	13,82	10,96	0,16	0,92	20,11	0,02	6,24	0,20	0,19
MgO	11,56	8,54	7,00	10,01	-	6,49	5,75	6,06	-	12,04	9,24	8,31	-	-	-
MnO	0,81	0,42	0,12	0,02	-	1,21	0,77	0,30	0,01	0,97	0,40	0,07	0,01	-	-
FeO	36,67	19,35	21,73	23,21	0,08	42,33	29,45	23,80	0,03	36,28	17,70	23,51	0,06	0,13	0,02
TiO_2	0,18	0,32	2,02	2,99	0,02	0,10	0,18	2,31	0,04	0,11	0,24	5,27	0,03	0,02	0,04
Na_2O	0,01	0,48	1,65	0,02	8,08	-	0,29	2,19	2,00	0,02	0,45	0,05	8,35	2,35	1,44
K_2O	-	-	1,65	8,20	0,25	0,02	0,01	1,70	13,89	-	0,03	9,33	0,24	13,03	14,51
Cr_2O_3	0,05	0,03	-	-	0,04	0,01	-	0,02	-	-	0,02	0,02	-	0,01	-
Cl	-	-	-	-	-	-	-	-	-	-	-	-	-		-
OH	-		1,94	3,93	-	-		1,91	-			3,87	-		-
TOTAL	101,16	99,57	99,68	100,21	100,26	99,06	99,95	99,96	99,68	101,80	100,65	99,88	100,69	98,70	99,47
Structural Formulas															
Si	1,976	1,933	6,459	5,670	2,694	1,992	1,971	6,406	2,976	1,962	1,942	5,661	2,262	2,991	2,981
Al	0,033	0,086	1,911	2,620	1,297	0,011	0,045	1,812	1,024	0,028	0,092	2,355	1,298	1,006	1,021
AL^{IV}	0,024	0,080	1,540	2,330		-	0,034	1,593		0,016	0,067	2,339		-	-
Al^{VI}	0,009	0,003	0,371	0,290		0,011	0,011	0,219		0,012	0,025	0,016		-	-
Ca	0,057	0,814	1,837	0,003	0,303	0,033	0,599	1,840	0,007	0,038	0,830	0,003	0,296	0,010	0,009
Mg	0,683	0,499	1,608	2,274	-	0,405	0,346	1,415	-	0,703	0,530	1,920	-	-	-
Mn	0,027	0,014	0,016	0,003	-	0,043	0,026	0,039	0,001	0,032	0,013	0,008	0,001	-	-
Fe	1,217	0,635	2,800	-	0,003	1,481	0,996	3,108	0,001	1,189	0,570	-	0,002	0,005	0,001
Fe^{2+}	1,212	0,568	2,660	2,959		1,481	0,961	2,968		1,189	0,508	3,047		-	-
Fe^{3+}	0,005	0,067	0,140			-	0,035	0,140		-	0,062			-	-
Ti	0,005	0,009	0,242	0,392	0,001	0,003	0,005	0,271	0,001	0,003	0,006	0,619	0,001	0,001	0,001
Na	0,001	0,036	0,492	0,006	0,696	-	0,022	0,665	0,179	0,001	0,033	0,016	0,716	0,211	0,128
K	-	-	0,324	1,595	0,014	0,001	0,001	0,339	0,815	-	0,001	1,845	0,013	0,770	0,855
Cr	0,001	-	-	-	0,001	0,001	-	0,002	-	-	0,001	0,002	-	0,001	-
Cl	-	-	-	-	-	-	-	-		-	-		-		-
OH	-		1,000	2,000	-	-		1,000				2,000	-		-
TOTAL	4,000	4,027	16,689	17,472	5,0107	3,970	4,010	16,897	5,006	3,956	4,018	17,471	5,021	4,994	4,998
FM	64,54	56,53	63,65	56,57	96,54	79,01	74,70	69,05	100,00	63,46	52,39	61,41	96,32	95,73	100,00
WO	2,87	41,47				1,69	30,44			1,96	42,70				
EN	34,44	25,45				20,64	17,60			35,82	27,28				
FS	62,69	33,08				77,67	51,96			62,22	30,02				
AB					68,65				17,85				69,83	21,28	12,96
OR					1,41				81,37				1,31	77,71	86,08
AN					29,93				0,78				28,87	1,01	0,96

transformation of pyroxenes to red biotite and green hornblende. The plagioclase appears to be unaltered. Small grains of perthitic microcline and some myrmekite (certainly metasomatic) are at times present in the basic enclaves. In some outcrops, where basic "boudins" are found enclosed within migmatitic granulites along their borders, centimetre thick aureoles rich in orthopyroxenes may be found. This may be interpreted as a consequence of the progressive granulite facies metamorphism that affected the region (Fig. 7).

Hornblende Free -Enderbite-Charnockite

This third group of rocks present in the eastern part of the area under study (Barbosa, 1986; Fornari and Barbosa, 1992; Fornari, 1992) include enderbites, charno-enderbites and charnockites. Though the rocks are highly deformed in most of the region (Costa and Mascarenhas, 1982; Barbosa, 1986), there are some areas where they are deformed to a lesser extent. In the latter case the rocks preserve a large grained texture, with phenoclastic mesoperthite (1 to 3 cm) in the case of charnockite (Fig. 8) and antiperthitic plagioclase in the case of enderbite, submerged in a medium grained granoblastic matrix. The matrix contains quartz, orthopyroxene, clinopyroxene and biotite (Tables 1, 2). Studies on the textural relations among the mineral grains in these plutonic rocks indicate that the rocks have been subjected to differing stages of retrometamorphism. The Table 1 lists the retrograde minerals.

Hornblende-Bearing Enderbite-Charnockite

Macroscopic and microscopic characteristics of the enderbites, charno-enderbites and charnockites discussed here

Fig. 6. Photograph showing the outcrop of undifferentiated granulite of charnockitic type showing an enclave of metabasalt. Locality : south of Brejões Dome close to the village of Volta do Rio.

are very similar to those discussed earlier, the only difference being the presence of brown-green hornblende belonging to the granulite facies (Tables 1, 2). In many outcrops the lithologies exhibit banding , in some cases folded (Fig. 9) characterized by intercalation of light and dark green bands. The light bands are dominated by feldspar, whereas ferromagnesium minerals predominate in the dark bands. These rocks contain mafic enclaves about 2 metres wide and 20 cm long, deformed and oriented parallel to the banding (Fornari and Barbosa, 1992). Pegmatoid veins with orthopyroxene and milky quartz veins are present either parallel to or crisscrossing the banding. Fluid inclusions in quartz samples from the pegmatites suggest that synmetamorphic fluids rich in low density (0.85 g/cm^3) CO_2 percolated through the rocks of the region during peak metamorphism (Xavier et al., 1989). The pressure and temperature estimates from the fluid density data are concordant with the thermo-barometric data calculated from coexisting mineral compositions (Barbosa, 1986).

Charnockites

The fifth group of rocks investigated form the inner part of the Dome and is composed of charnockites which are generally well deformed. In some outcrops the rocks appear undeformed and are in contact with the undifferentiated granulites discussed

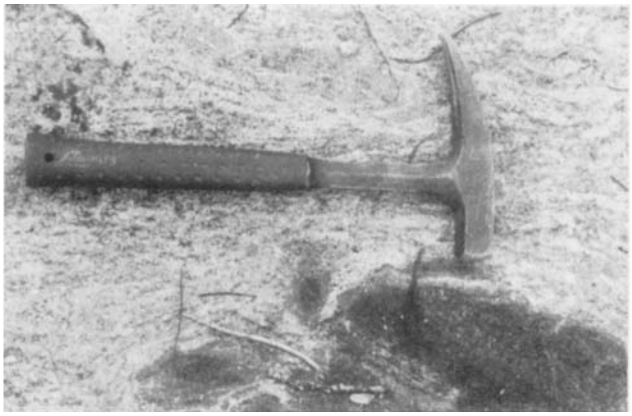

Fig. 7. Outcrop of undifferentiated granulites with basic enclaves, near the city of Santa Ines. On the periphery enrichment of orthopyroxene (formed due to the regional metamorphism) can be observed. The center of the enclave is richer in hornblende.

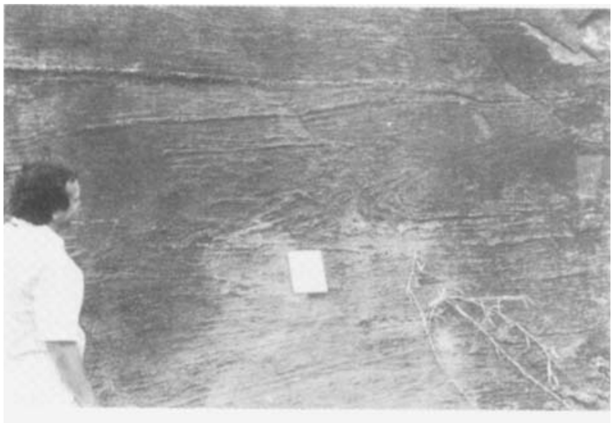

Fig. 8. Hornblende free enderbite-charnockite (low Ti) showing large crystals of deformed mesoperthite. The sinistral displacement can be observed.

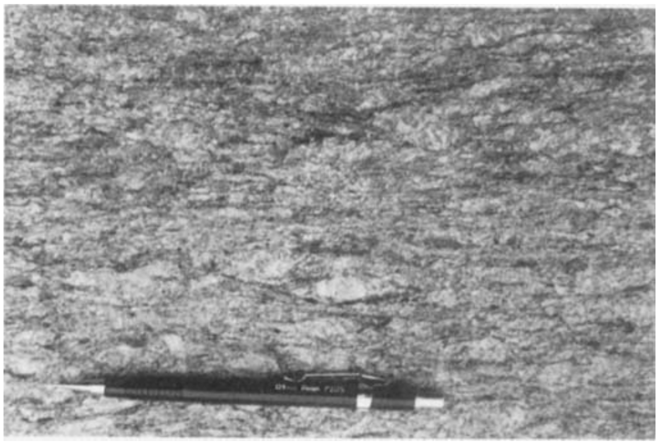

Fig. 9. Outcrop of hornblende bearing enderbite-charnockite (high Ti) situated in the western part of the area under investigation. The fold seen in the photo belongs to the first phase of deformation and vergence towards west.

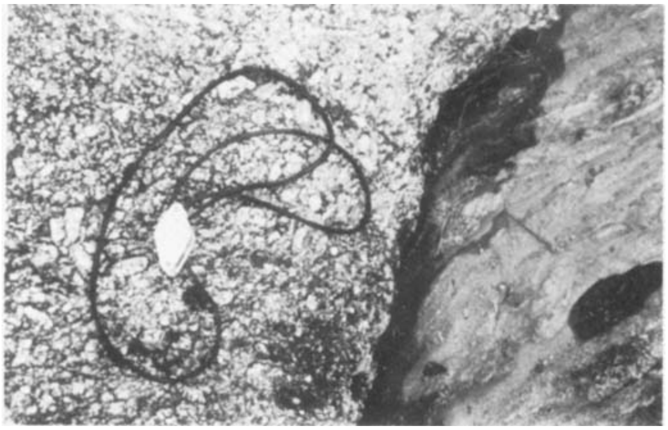

Fig. 10. Outcrop showing the contact between the deformed undifferentiated granulite and the intruding undeformed charnockite (center part of the Brejões Dome).

earlier (Fig. 10). They are greenish, large grained with big crystals (5 cms) of antiperthite (30%) containing approximately 20% anorthite in the matrix of the lamellae, orthopyroxene (5-10%), clinopyroxene (2-5%) and quartz (5%) (Table 1). The accessory minerals are opaques, apatite and zircon. Due to their relatively larger size the brown hornblende and mesoperthite stand out in the rock giving it a characteristic colorful appearance. The hornblende frequently contains inclusions of pyroxene and at times borders the crystals of opaques, indicating signs of retrogression. The orthopyroxenes show thin exsolution lamellae of clinopyroxene attesting to the lowering of temperature. Occasional internal growth of myrmekites occur in the boundary regions of large crystals of mesoperthite. Pegmatitic and milky quartz veins are common in these charnockites and they are either concordant or discordant to the banding in the rocks. Some charnockites contain garnet which is interpreted as a contaminant derived from supracrustal rocks in the parental magma.

Geochemistry

The chemical analysis presented in this study were carried out using wet chemical, X-ray fluorescence and inductively coupled plasma spectrometric methods. The geochemical data of the rock samples reflect the large lithological variation observed in the field as well in the petrography. The chemical characteristics of each rock group are discussed below.

Supracrustal and associated rocks

The chemical composition of the kinzigite gneisses containing the alumino-silicate minerals cordierite and sillimanite (Fig. 2), when plotted in the geochemical discrimination diagram of Garrels and Mackenzie (1971), falls in the field of sedimentary rocks (Barbosa, 1986; Barbosa and Fonteilles, 1989). Thus, these rocks are considered to have originated from pelites that were subjected to granulite facies metamorphism. The data for these rocks are plotted in Fig. 11, which show that they plot apart when compared to other rock types from the area, thus reflecting their aluminous nature.

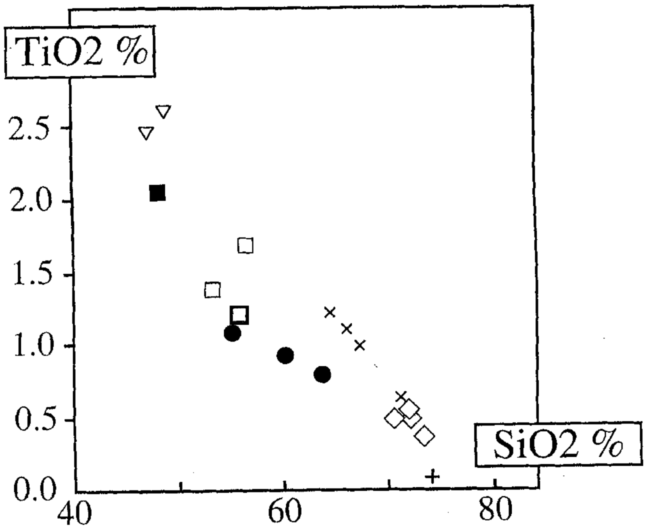

Fig. 11. SiO$_2$ (%) Vs TiO$_2$ (%) diagram for the first and second group of rocks (Table 1) from the Brejões area. The scatter of the data plot indicates the chemical heterogeneity . (•) supracrustal kinzigites; (∇) Metabasalts [enclaves; (◊) Andesitic metabasalts: (■) Metagabbro; (♦)] Quartz feldspathic bands; (+) Charnockite with garnet-cordierite; (x) Undifferentiated granulite.

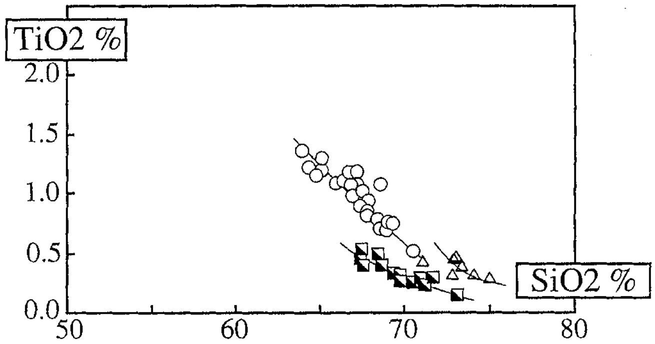

Fig. 12. SiO$_2$ (%) Vs TiO$_2$ (%) diagram for the third, fourth and fifth group of rocks (Table 1) from the Brejtes area. (o) Hornblende bearing enderbite-charnockite; (◪) Hornblende free enderbite-charnockite; (Δ) Charnockites

The metabasalts/andesitic metabasalts are of tholeiitic affiliation and display flat rare earth element pattern with Y/Nb ratios of about 3. These rocks in general possess high concentrations of Ti, Fe, Cr and are low in Al, P, K and Na (Figs. 11, 12). However some metabasalts/enclaves (BJ 188b, BJ 210-A) show high concentrations of K and Na due to metasomatism during the plutonic or metamorphic event (Barbosa, 1986).

It is not easy to ascertain the nature of the protolith of the quartz-feldspathic bands. When the concentration of the mesoperthite is high the chemical composition appears to be similar to aplitic granites. The higher concentration of antiperthitic plagioclase would imply dacite or tonalite which were tectonically compressed along with metabasalts/andesitic metabasalts and supracrustals during a period of intense

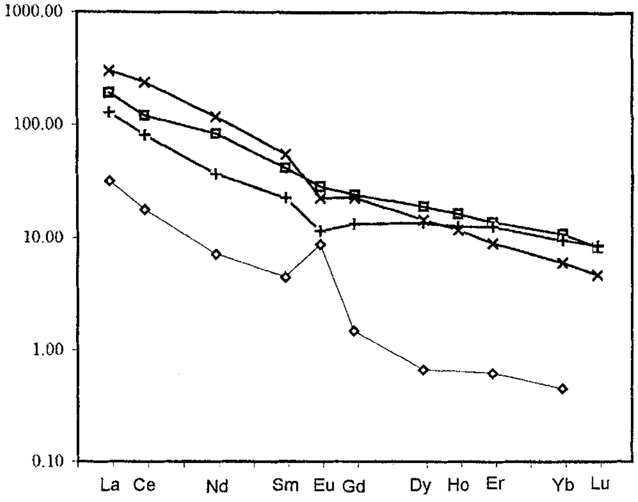

Fig. 13. Chondrite normalised rare earth element distribution pattern for the first and second group of rocks (Table 1) from the Brejões area. Chondrite values are from Sun (1988). Symbols are the same as in Figure 11.

deformation contemporaneous with the granulite metamorphism. In the geochemical plot the data for these rocks (Table 3) are relatively scattered, but situated in a different field of the diagram as compared to other rocks (Fig. 11). The rare earth element distribution of the quartz-feldspathic rocks are shown in Figure 13.

The chemical characteristics of the metagabbros are similar to the andesite metabasalts and metabasalts enclaves with high concentrations of Ti, Fe and Cr, (with the exception of metabasalts enclaves) and low K, Al and P (Table 3). The chemical compositions seem to imply that these basic granulites are derived from tholeiitic magmas (Barbosa, 1990, 1991).

The garnet/cordierite bearing charnockites (Table 3) are always associated with the kinzigites/aluminous gneisses and are subalkaline with average $Na_2O/K_2O < 1$, characteristics of anatectic "S" type granites.

The quartzites, garnet bearing quartzites and banded iron formations were not analyzed. Their field occurrence and association with the supracrustal rocks suggest that these rocks were formed by granulite facies metamorphism of impure cherts and ferruginous sediments.

Undifferentiated Granulites

In the geochemical discrimination figures (Figs. 11 and 13, Table 3) the data points for the undifferentiated granulites are well dispersed making it difficult to suggest a magmatic trend. This dispersion may probably be due either to different protoliths or to contamination from the enclaves of basic granulites and supracrustals. Except for the concentrations of K and Na the enclaves and the basic granulite "boudins" have similar chemical compositions to the granulite bands formed by granulite metamorphism of metabasalts/andesitic metabasalts and metagabbros, which are intercalated with supracrustals (Fig. 13; Table 3). This suggests that these enclaves originated from the granulitic bands (Barbosa et al., 1996).

Hornblende Free Enderbite-Charnockite

The geochemical data for these rocks suggest that they were derived from the calc-alkaline magmatic series (Fig. 14) with low concentrations of titanium (Fig. 12; Table 3) concordant with the petrologic data (absence of hornblende and low abundance of biotite and opaques, Table 1). Thus in this domain of plutonics (Fig. 2) two sequences of enderbites, charno-enderbites and charnockites are defined, one with low concentrations of titanium and another group (to be described later) with high concentrations of titanium.

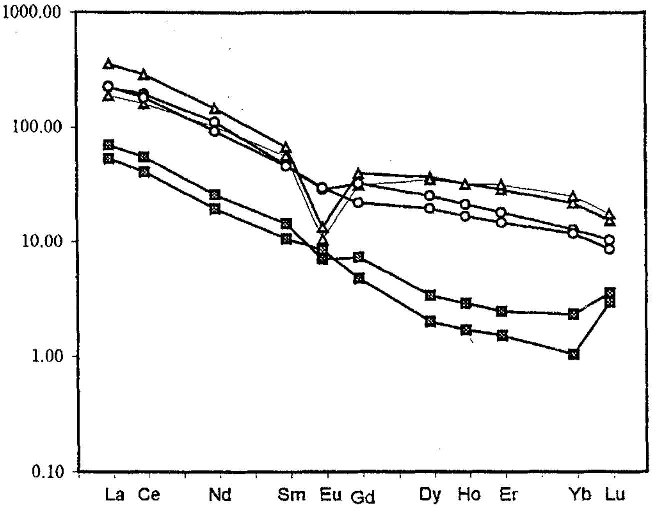

Fig. 14. Chondrite rare earth element distribution pattern for the third, fourth and fifth group of rocks (Table 1) from the Brejões area. Chondrite values are from Sun (1988). Symbols are the same as in Figure 12.

Hornblende Bearing Enderbite-Charnockite

These rocks are characterized by higher concentrations of titanium and greater abundance of hornblende, biotite and opaques. than the hornblende free enderbite charnockites (Fig. 12; Table 3). The two rock types (with and without hornblende) cannot be separately identified in the field and separate identification is possible only through chemical data. The geochemical data indicate that the sequence with low Ti is generally found near the contact with the Brejões Dome, whereas the other group (high Ti) is situated more to the east (Fig. 2). The rock type with higher titanium has higher concentrations of rare earth elements. The rare earth element distribution patterns for both groups (Fig. 14; Table 3) attest to calc-alkaline affinities, agreeing with the suggestion of Fornari (1992), Fornari and Barbosa (1992), who used the concentration data of CaO, Na_2O, K_2O, SiO_2.

Charnockites

These rocks occur in the inner part of the Brejões Dome and are chemically distinct from all other rock types, especially

Table 3. Representative chemical analyses of rocks from Brejões, Bahia, Brazil.

LITHOLOGY	SpKz	SpKz	SpKz	Metabas.	Metabas.	Metaba. A	Metagab.	NQF	ChGt	Und. Gra	Und. Gra	Und. Gra	Und. Gra
SAMPLE	TN-001	TN-003	TN-004	BJ-188-B	210-A	IJ-14-B	BJ-258-A	BJ-258-B	BJ-131-A	8	ZI-01	ZI-04	BJ-131-E
Si02	60.2	63.5	54.8	48.82	47.07	55.6	48.27	73.61	74.2	71.49	66.3	67.5	64.5
Al203	14.9	14.1	16.4	12.39	15.08	16.1	14.42	15.71	13.2	12.58	13.1	12.8	13.1
Ca0	1.4	1.4	1.4	6.95	7.18	6.9	10.26	0.6	1	2.21	3.3	2.9	3.8
Mg0	5.7	5.2	6.7	6.58	6.33	6.2	9.08	0.13	0.15	0.42	1	1.3	2.3
Mn0	0.13	0.1	0.18	0.18	0.17	0.18	0.13	0.03	0.03	0.05	0.15	0.14	0.12
Fe203	2.4	3.5	3.9	1.52	2.38	2.2	2.27	0.01	0.14	0.93	1.9	1.8	1.7
Fe0	11.1	7.8	11.7	10.42	8.31	9	12.02	1.48	0.86	2.46	5.2	4.9	5.76
Ti02	0.95	0.81	1.1	2.6	2.45	1.2	2.05	0.37	0.1	0.64	1.1	0.98	1.2
P205	0.05	0.05	0.05	0.95	0.98	0.38	0.11	0.22	0.05	0.23	0.38	0.29	0.37
Na20	0.73	0.88	0.67	2.43	2.67	0.96	1.9	2.91	3.8	3.14	2.7	2.6	4.1
K20	0.64	0.71	1.2	4.6	4.3	0.5	0.33	5.16	6	4.15	3.8	3.8	2
C02	-	-	-	-	-	0.23	-	-	0.16	-	0.29	0.24	-
Total	98.2	98.11	98.1	97.44	96.92	99.22	100.84	100.23	99.53	98.3	98.93	99.01	98.95
V	230	192	220	174	209	190	178	-	50	-	49	46	160
Ni	148	134	210	117	161	207	630	-	10	2	12	37	38
Co	89	192	147	41	40	58	139	-	2	31	10	10	11
Cu	20	42	42	31	82	38	20	-	2	-	15	14	18
Cr	-	-	-	210	167	255	472	-	5	27	43	86	46
Rb	25	27	30	161	163	23	10	161	130	100	97	97	31
Sr	110	100	97	229	467	450	88	10	180	190	308	269	240
Zr	220	210	220	298	340	206	108	496	53	341	434	551	320
Ba	310	350	440	1118	1375	562	207	530	900	1270	1364	1143	1040
Y	38	20	44	-	-	29	12	-	10	-	59	65	42
Nb	28	22	22	-	-	16	30	-	20	-	23	27	20
Th						5	-	-	-	-	5	6	-
Ta						5	-	-	-	-	5	10	-
Hf				-	-	8	-	-	-	-	10	13	-
	-	-	-	-	-								
	-	-	-	-	-								
La	-	-	-	-	-	62.62	-	10.5	41.82	-	78.22	98.55	-
Ce	-	-	-	-	-	103.6	-	15.4	69.75	-	179.7	204.6	-
Nd	-	-	-	-	-	52.1	-	4.49	23.13	-	80.09	73.95	-
Sm	-	-	-	-	-	8.4	-	0.91	4.57	-	13.26	11.17	-
Eu	-	-	-	-	-	2.19	-	0.67	0.88	-	2.36	1.73	-
Gd	-	-	-	-	-	6.6	-	0.41	3.64	-	8.59	6.25	-
Dy	-	-	-	-	-	6.51	-	0.23	4.66	-	7.68	4.94	-
Ho	-	-	-	-	-	1.25	*	-	0.97	*	1.43	0.91	*
Er	-	-	-	-	-	3.09	-	0.14	2.82	-	3.2	2.02	-
Yb	-	-	-	-	-	2.4	-	0.1	2.1	-	2.42	1.33	-
Lu	-	-	-	-	-	0.28	-	-	0.29	-	0.27	0.16	-

SpKz- Supracrustals Kinzigites; Metabas. - Metabasalts (enclaves); Metaba. A - Andesitic Metabasalt; Metagab - Metagabbro; NQF - Quartz -feldspathic band; ChGt - Charnockite with garnet-cordierite; Und. Gra - Undiferentiated granulite

with respect to the calc-alkaline enderbite-charnoenderbite-charnockite sequence with high and low titanium. These charnockites contain medium level concentrations of Ti, higher Si in relation to calc-alkaline enderbite-charnoenderbite-charnockite sequence with low and high Ti (Fig. 12; Table 3). The charnockites are enriched in total and light rare earth elements and show more pronounced Eu anomaly as compared to the charnockite-enderbite with low and high concentrations of titanium (Fig. 14).

Structural Geology

Despite the fact that circular or oval structures are frequently observed in Archean (more common) and Paleoproterozoic terrains, the few studies carried out in the Brejões area, have paid little attention to its structure. Miranda (1983) and Barbosa (1986, 1990) were the only authors to discuss the structural aspect of the Dome. According to Barbosa (1986, 1990) the circular structure, earlier known as the Mutuipe Dome, later renamed as Brejões Dome (Alves da Silva et al., 1996, Fig. 2), would represent a typical dome- basin interference pattern (F_2F_3/F_4 phase). We are carrying out detailed structural and geochronological studies to substantiate or modify this hypothesis (Alves da Silva and Barbosa, *in prep.*).

Though called a Dome this structure does not possess a dome shape in strict sense. In the northern, eastern and western part of the Dome the foliation dip outside, whereas in the south it is inverted and has an inclination, for the major part, inwards.

Table 3 contd...

LITOLOGY	CH c/ Hb	CH c/ Hb	CH c/ Hb	CH c/ Hb	CH c/ Hb	CH s/ Hb	CH s/ Hb	CH s/ Hb	CH s/ Hb	CH	CH	CH	CH
SAMPLE	IJ-28	IJ-17	ZI-06-B	ZI-10	71	SM-13	JA-38-A	JA-46-A	JA-49-A	IJ-22	IJ-20	IJ-07-A	ZI-08-C
Si02	71	67.4	70	72.9	69.25	71.24	71.8	73.3	73.9	72.4	71.2	76	77.4
Al203	13.4	13.1	12.1	13	12.64	14.98	14.4	14.3	13.9	12.6	13	11.6	10.6
Ca0	1.4	2.9	2.2	1.2	2.46	2.21	1.5	1.8	1.2	1.3	1.4	0.45	1.1
Mg0	0.35	0.89	0.3	0.33	0.78	0.74	0.66	0.64	0.34	0.37	0.38	0.1	0.22
Mn0	0.17	0.12	0.15	0.1	0.07	0.03	0.03	0.04	0.01	0.11	0.1	0.07	0.06
Fe203	1.6	2.2	1.8	0.85	0.8	1.72	0.45	0.27	0.1	1.9	1.9	2	1
Fe0	2.6	4	4.5	2.5	3.45	1.55	1.4	1.2	0.79	2.1	2.3	0.71	1.5
Ti02	0.43	1	0.38	0.33	0.77	0.23	0.32	0.14	0.11	0.48	0.49	0.28	0.21
P205	0.08	0.32	0.06	0.06	0.27	0.06	0.12	0.05	0.08	0.07	0.06	0.05	0.05
Na20	2.4	2.6	3.7	2.5	2.9	4.82	3	4.6	3.5	2.4	2.4	2.5	2.3
K20	5.8	4.4	4	5.3	4.76	2.57	5.8	3.3	5.5	5.6	5.9	5.6	4.7
C02	0.37	-	0.37	0.33	-	-	-	-	-	0.19	0.29	0.19	0.33
Total	99.22	98.93	99.19	99.07	98.15	100.15	99.48	99.64	99.43	99.33	99.14	99.36	99.14
V	10	48	10	10	-	-	-	-	-	19	30	10	104
Ni	27	48	14	18	-	-	-	-	-	52	43	41	18
Co	21	23	10	10	-	-	-	-	-	21	24	13	10
Cu	15	26	12	10	4	-	-	-	-	26	57	27	101
Cr	67	93	30	25	-	-	-	-	-	76	73	62	29
Rb	208	117	5	5	125	79	170	98	210	222	310	275	258
Sr	77	248	127	110	170	375	320	350	440	76	79	49	45
Zr	470	439	669	346	365	91	290	120	93	541	467	388	257
Ba	730	1080	872	770	1048	597	2180	660	1520	672	570	356	365
Y	68	62	93	48	-	5	18	12	12	94	91	100	104
Nb	29	22	24	17	-	-	-	-	-	33	43	26	25
Ti	2578	5995	-	-	4616	1379	1918	839	659	2878	2938	1679	1259
K	48148	36536	-	-	39514	21334	48148	27394	45657	46487	48978	46487	39015
Th	5	5	13	14	-	-	-	-	-	29	49	38	24
Ta	5	5	9	5	-	-	-	-	-	5	5	5	9
Hf	11	10	15	8	-	-	-	-	-	13	11	9	8
La	70.46	72.56	76.09	74.15	-	-	-	22.72	17.24	118.2	108.4	116.7	61.95
Ce	155.2	165.9	156.9	155.7	-	-	-	46.58	34.63	281.2	230	247.5	137.8
Nd	54.63	70.11	72.85	57.93	-	-	-	15.97	12.05	111.6	87.47	91.4	63.44
Sm	10.59	9.43	12.88	9.24	-	-	-	2.9	2.15	18.04	12.5	13.5	11.25
Eu	1.34	2.18	2.25	1.28	-	-	-	0.54	0.65	1.66	1.68	1.02	0.81
Gd	6.89	8.85	10.12	5.99	-	-	-	2	1.32	12.66	11.37	10.77	8.49
Dy	6.55	8.46	11.56	6.57	*	-	-	1.15	0.68	14.57	11.22	12.37	11.8
Ho	1.25	1.62	2.27	1.28	-	-	-	0.22	0.13	2.99	12.18	2.43	2.44
Er	3.09	4.03	5.89	3.3	-	-	-	0.55	0.34	8.44	5.54	6.36	6.99
Yb	2.29	2.83	4.54	2.6	-	-	-	0.51	0.23	6.57	13.86	4.79	5.51
Lu	0.28	0.35	0.54	0.29	-	-		0.12	0.1	0.8	0.46	0.52	0.59

Ch c/Hb-Hornblende Bearing Enderbites -Charnockites; CH s/Hb - Hornblende Free Enderbites - charnockites; CH - Charnockites

Furthermore in the southern part the supracrustal rocks appear compressed between the Dome and another oval structure known as Santa Ines (Fig. 2), showing a synform and antiform sequence with a west-east direction.

The Brejões Dome was subjected to a heterogeneous deformation, presenting both higher and lower strain components. Well developed vertical structural zones of the S/C and other types can be seen in the central part, where the foliation is sub-horizontal. This monotony is broken only by the presence of open folds and occasional quartz veins.

Geochronology

Geochronological data on the undifferentiated granulites, which at times show incipient migmatization, was obtained by Wilson (1987) in the region of Jequié just south of the study area. In the outskirts of the town of Jequie the author obtained a Pb-Pb isochron age of 1.9 Ga on ten samples, two of which yielded Sm/Nd model ages of 2.9 and 2.6 Ga. In the southern portion of the Brejões Dome Sm/Nd model ages of ~3.2 Ga were obtained for samples from the enclaves (Marinho et al., 1992).

Wilson (1987) dated hornblende bearing enderbite-charnockite by the Rb-Sr method. Samples from a single outcrop yielded a Rb-Sr isochron age of 2.69 Ga, while a Sm/Nd (T_{DM}) age of 3.0 Ga was obtained for a single sample. Later Alibert and Barbosa (1992), using SHRIMP, defined with greater precision a crystallization age of 2.689 +/-0.007 Ga for hornblende-bearing enderbite-charnockites (U/Pb in the zircon). For the hornblende-free enderbite-charnockites Alibert and Barbosa (1992) obtained an age of 2.81 Ga (using SHRIMP). The charnockites from the center of the Brejões Dome are being investigated using zircon Pb-Pb evaporation method. Preliminary results indicate the presence of zircons with two age values, one having an age of 2.7 Ga (age of formation of the rock) and another ~2.1 Ga (age of granulite metamorphism). The age value of 2.1 Ga was also obtained for charnockites with garnet and cordierite associated with kinzigite gneisses, which are considered to have formed during the peak granulite facies metamorphic episode (Barbosa et al., *in prep.*).

^{39}Ar/^{40}Ar dates were obtained for hornblendes (2.0 and 2.1 Ga) and biotites (1.9 Ga) from hornblende bearing enderbite-charnockites (Ledru et al., *in prep.*). These age values represent the closure of the system and probably corresponds to age of the metamorphism.

Sm/Nd mineral isochrons were obtained from supracrustal granulites (clinopyroxene, plagioclase, biotite and garnet) from the southern part of the Brejões Dome and hornblende free enderbite-charnockites (plagioclase, clinopyroxene and whole rock) from the eastern part of the area of study. The ages obtained were 2.023+/-0.009 Ga and 1.9988+/-0.0043 Ga respectively, corresponding to the age of the granulite facies metamorphism (Alibert and Barbosa, *in prep.*).

Discussion and Conclusion

The first group of granulites discussed in this paper, consisting of supracrustal and associated rocks appear to be the oldest rocks in the area, as they form enclaves in undifferentiated granulites (the second group of rocks) . Preliminary geochronological data for the undifferentiated granulites indicated an age around 2.9 Ga. The scattered nature of the chemical data for the two groups (supracrustals and undifferentiated granulites) in the discrimination diagram suggests the derivation of each group from multiple protolith materials.

The enderbite-charnockites with or without hornblende (the third and fourth groups of samples) constitute two series of normal calc-alkaline protolith rocks, one titanium rich and another titanium poor. U/Pb zircon SHRIMP dates indicate ages of formation of 2.81 Ga and 2.69 Ga for the two groups respectively. Field relationships and geochronological data may be interpreted to suggest that the two groups of enderbite-charnockites intruded the other groups discussed earlier.

The fifth group of rocks of charnockitic affinity is found in the center of the Brejões Dome. These rocks are also calc-alkaline and show petrographic and chemical characteristics (major, trace and rare earth elements) distinct from those of the other groups of enderbite-charnockite rocks. Preliminary geochronological data indicate an age of formation of 2.6 Ga for these rocks, whose isotopic system appeared to have been reequilibrated during the regional metamorphic episode at 2.0 Ga.

It may be mentioned that whereas the hornblende bearing and hornblende free enderbite-charnockites and the charnockites define a trend in the geochemical discrimination diagram, the data points for the undifferentiated granulites and the supracrustals are well scattered. This is due to the co-magmatic character of the former and the multiple non co-magmatic sources for the latter group of rocks. Although the presence of the enclaves of basic granulites in the undifferentiated granulites may have altered their chemical character of the latter it is considered that such changes do not alter the previous conclusion of multiple non co-magmatic sources for the undifferentiated granulites.

The geochronological data using different isotopic clocks (whole rock Pb-Pb, Pb-Pb in zircon by evaporation, ^{39}Ar/^{40}Ar and Sm/Nd in minerals) on different rock types indicate an age of 2.0 Ga for the intermediate pressure (5-7 Kb, 850-870°C) granulite metamorphism that affected the whole area (Barbosa, 1990).

Though the genesis of the Brejões Dome is still being investigated by two of the authors of this paper (Alves da Silva and Barbosa, *in prep.*) preliminary observations indicate that the regional foliation/banding depicts asymmetric triple points both in the north and in the south. This contradicts the hypothesis of the Dome being formed by the interference of transverse deformation (Miranda et. al., 1983; Barbosa, 1986, 1990). Two new hypotheses may be put forward to explain the origin of the Brejões Dome. The first one suggests that the circular structure represents a primary igneous feature related to the intrusion of the pluton and the original geometry is still preserved. In such a case the foliation within the Dome, which generally dips outwards of the Dome (except in the southern part, where it dips in towards the pluton) suggests an extrusion of the mass from the north towards south. The second hypothesis suggests that the Dome represents an expression on the surface of a thermal anomaly over the intruded rocks, caused probably by the vertical movement that did not result in the intrusion of a pluton.

The distinct nature of the charnockites from the internal part of the Dome and the two ages values of 2.6 Ga and 2.0 Ga obtained for the zircons, imply that the circular structure was formed by the re-melting of the old deep crustal segment at 2.6 Ga in Bahia (Barbosa et al., *in prep.*) generating younger charnockitic plutons at 2.0 Ga. This interpretation of the age data lends support to the first hypothesis (primary igneous structure related to plutonic intrusion) for the generation of the Brejões Dome and explains the presence of spinel + quartz in the nearby kinzigites that suggests temperatures above 1000°C . Thus, plutonic intrusion may have provided the necessary additional thermal source to that of the regional granulite facies metamorphism in this region, with temperatures of 850 - 870° C.

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