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MAFIC MAGMATISM IN THE CARAJÁS REGION: A PETROLOGICAL RECONNAISSANCE

G.Rivalenti - Istituto di Mineralogia e Petrologia, Universitá di Modena, Italia., **V.A.V.Girardi** - Instituto de Geociências, Universidade de São Paulo, Brasil., **M.Mazzucchelli** - Istituto di Mineralogia e Petrologia, Universitá di Modena, Italia., **C.T. Correia** - Instituto de Geociências, Universidade de São Paulo, Brasil., **M.Molesini** - Istituto di Mineralogia e Petrologia, Universitá di Modena, Italia., **M.C.Finatti** - Istituto di Mineralogia e Petrologia, Universitá di Modena, Italia.

The Carajás region is affected by abundant manifestations of basaltic and acid magmatism, probably covering a long time span. The main are:

1) the Grão Pará basalts (GP) and intercalated rhyolites and dacites;
2) NE to NNE dyke swarm (NED);
3) NW to NNW dyke swarm (NWD);

Other, more rare occurrences of N-S trending dykes (NSD) have been found. Basaltic sills (SB) have been found at the Salobo mine in drill holes. Rhyolitic dykes are common, and at one locality they have been found to cut the dykes of the NED. Age determinations are available only for the GP basalts (2.7 Ga, zircon age in the intercalated rhyolites) and for the SB (~600 Ma, K/Ar whole rock determination). For all the others the age is unknown and field conditions do not allow to check for mutual intersections. The variability of the compositional and geochemical characteristics, however, suggest that not only the NED and NWD belong to different magma generations, but that, even within a single swarm, dykes may have heterogeneous characteristics requiring different parental magmas.

Petrographically, the GP basalts are metamorphic. All the others have suffered amphibolitizaton not accompanied by deformation, affecting mainly the contacts. Their primary mineralogy consists of dominant plagioclase and augite, with minor amounts of orthopyroxene in the NSD and of olivine in the NED.

If only the samples not affected (or least affected) by amphibolization are considered, the NED and SB are constituted by tholeiitic basalts and andesitic basalts, the NWD and NSD dominantly by transitional basalts, the GP rocks are latibasalts and andesitic basalts with calc-alkaline affinity (exhibited in an AFC plot). Two dykes of the NWD plot in the trachyandesite field (Fig. 1).

As a whole, the dykes define a wide compositional range of mg (= MgO/(MgO+FeO) in moles) from 0.63 to 0.36. The most evolved are the NWD (mg 0.43 - 0.36). The variation trends (Fig. 2) of the NED, NSD and SB dykes indicate fractionation of olivine and clinopyroxene, with plagioclase becoming an important phase at mg = 0.48). The NWD do not follow the variation trends of the other dykes and are enriched in Al_2O_3 and CaO, indicating higher amount of normative plagioclase. The GP basalts have lower CaO and higher Al_2O_3 and SiO_2, in agreement with their calc-alkaline character. At a given mg, the NWD are depleted in LILE, LREE, P, Ti, Sc, Y, Nb and Zr, in spite of being more evolved. The NSD and SB behave as evolved NED. The GP basalts have extremely high Ba contents.

Trace element characteristics are summarized in the spidergram of Fig. 3. All the dykes have highly fractionated patterns, characterized, in general, by negative Nb and Sr peaks and positive Ba. The patterns from Nd to Sc of the NED and NWD are essentially parallel, but the NED are relatively enriched in the elements from Rb to Sr and depleted in the others. The NSD have a pattern similar to that of the NED from Rb to Sr, but their pattern from Nd to Sc is much more flat and similar to that of the GP basalts which are however, extremely enriched in LILE. The patterns of the alkaline NWD are much steeper than those of the dykes of the same swarm.

Plots of the incompatible trace elements vs Zr (shown for some elements in Fig. 4), show that the NED basalts, with the exception of three, are enriched in Sc., Y, REE, LILE and depleted in Ti and P. This indicates that, while the NED swarm is compatible with a derivation from higher degree melting of a garnet peridotite source (decreasing Zr/Sc, Zr/Yb and Zr/Y and increasing Zr/P and Zr/Ti at increasing melting) with respect to the NWD, this contrasts with the enrichment in LILE and LREE. A complementary process is required, consisting either in enrichment of the mantle source or in crustal contamination of the melts.

The impossibility of deriving the NED and NWD from the same parent magma is supported by the extremely different Rb/Sr ratio, which cannot be explained by fractionation (0.04+0.02 in the NWD, 0.19+0.02 in the NED, 0.27+0.04 in the NSD and 0.1+0.02 in SB).

The lack of isotope determinations does not allow to reach a definite conclusion on this point, but considerations on the variation that crustal contamination would have induced on various element ratios (e.g. Fig. 5), indicates that this process, except for the GP basalts, have probably played a minor role, or would have required several, "ad hoc" contaminants.

Fig. 4 compares also the geochemical characteristics of the present dykes with those of other precambrian dyke swarms from Brazil. At the exception of the GP basalts, all the others (markedly the NED and NWD) are similar for most element characteristics to the 1 Ga old Olivença-Ilhéus dykes, for which Bellieni et al. have proposed a derivation by variable melting degrees from a depleted mantle source, variably metasomatized during, or slightly before melting. An ensialic anorogenic environment may be proposed also for the present dykes.

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Figura 1 - R1-R2 classification plot. Symbols: dots = NED; circles = NWD; asterisk = NW trachyandesites; X = Grão Pará; + = NSD; triangles = Salobo mine (SB); squares = rhyolites.

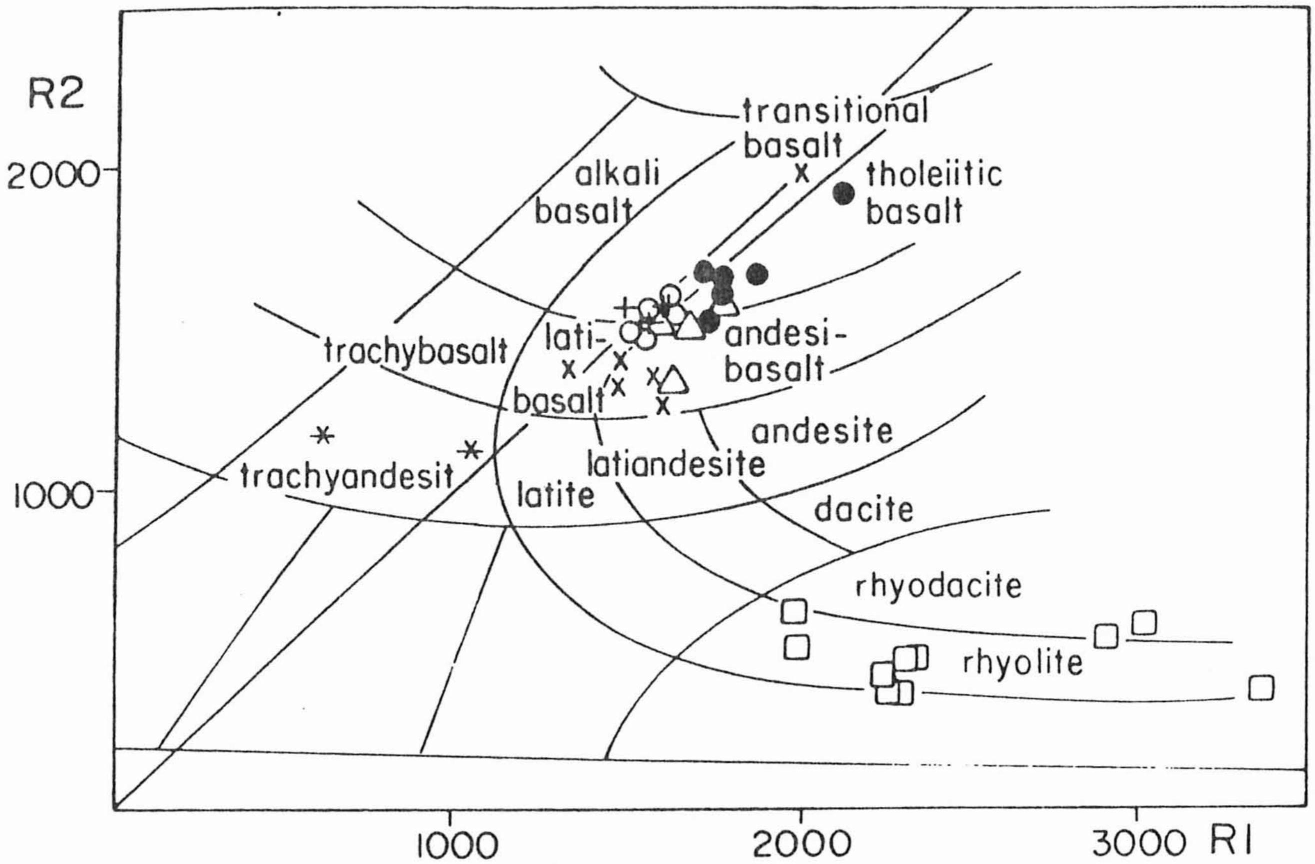

Figura 2 - plot of major (a) %Wt and trace elements ppm

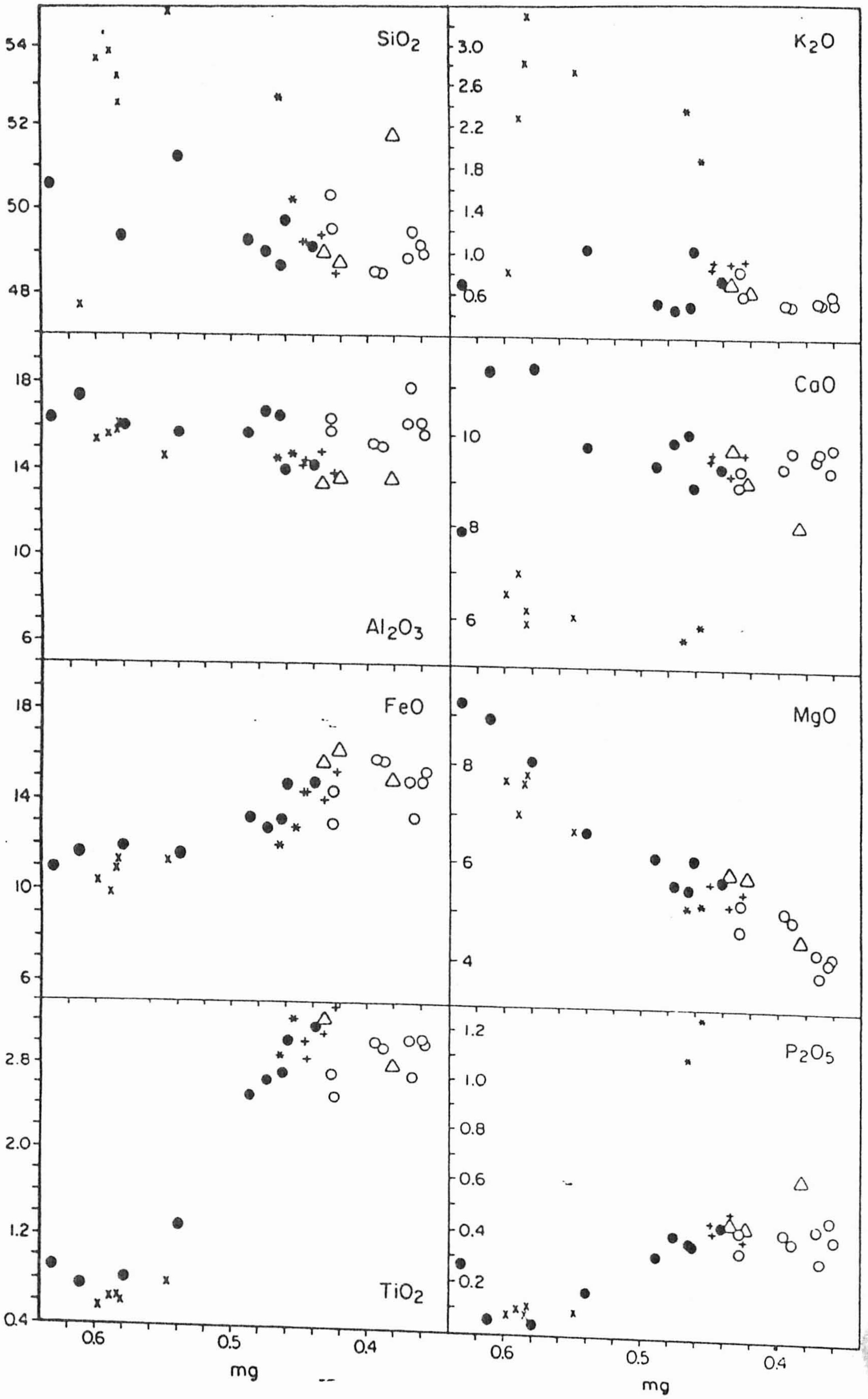

Figura 2 - (b) elements vs mg (MgO/MgO+FeO). Symbols as in Fig. 1.

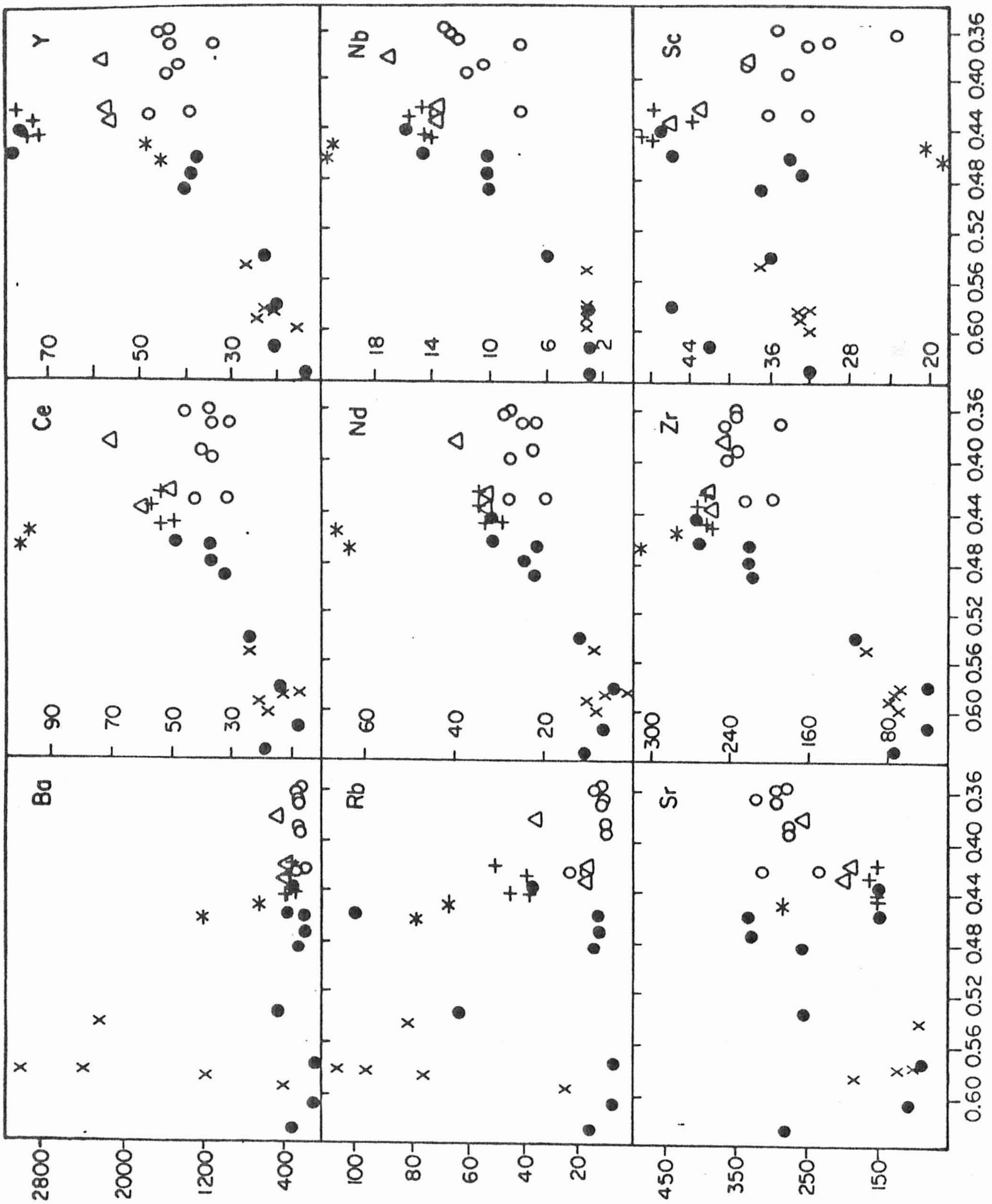

Figura 3 - "Spidergram" of various swarms normalized to primitive mantle. Fields: vertically dashed = NWD; obliquely dashed = NED; horizontally dashed = Grão Pará; dotted = NSD: contoured by a dashed line = NW trachyandesites.

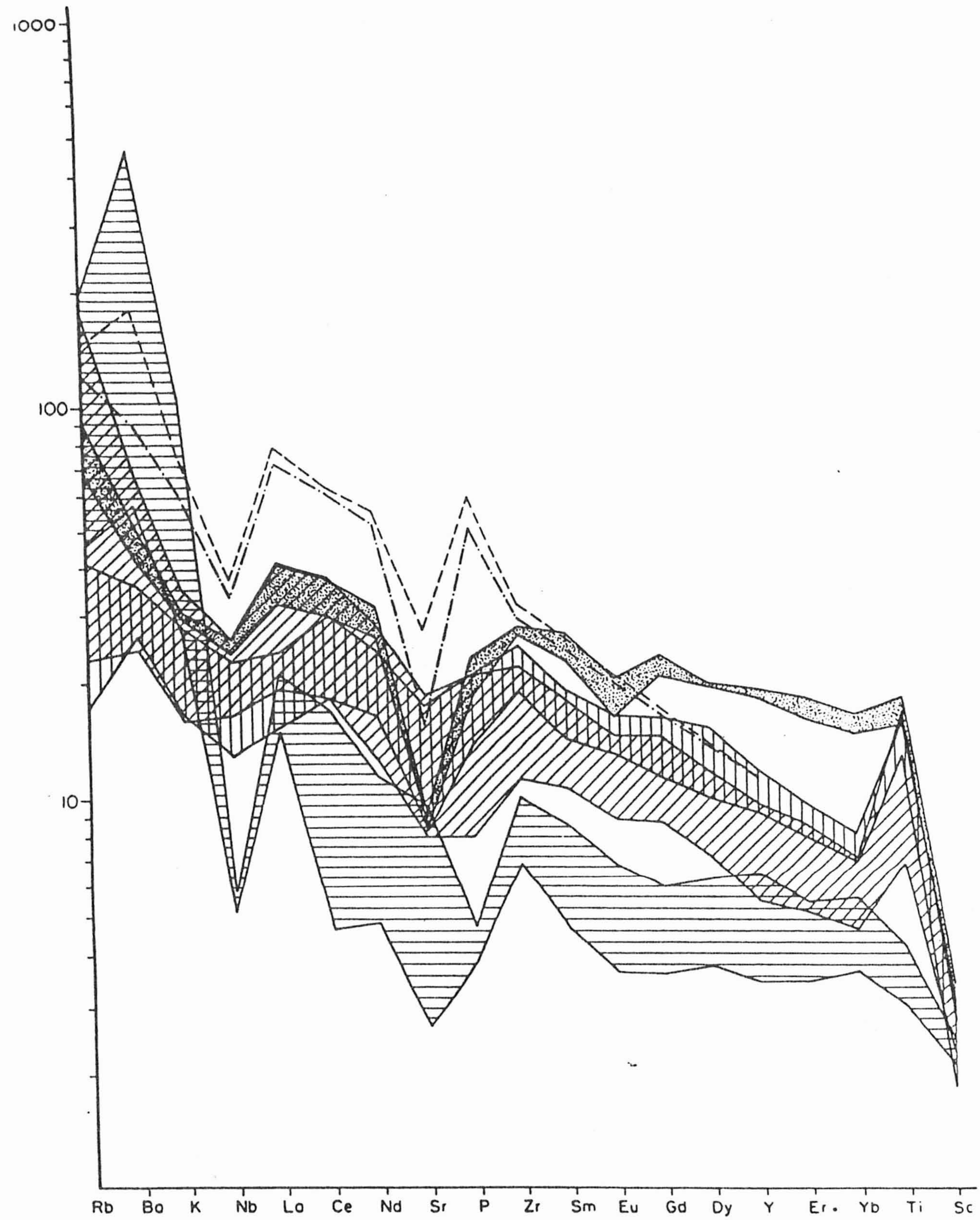

Figura 4 - Plots of incompatible elements vs Zr. Trace elements (ppm) and TiO_2 (Wt%). Fields: contoured by a continuous line = Olivença-Ilhés dykes; dash-dot = Salvador dykes; dash-two dots = UaUá dykes. Symbols as in Fig. 1.

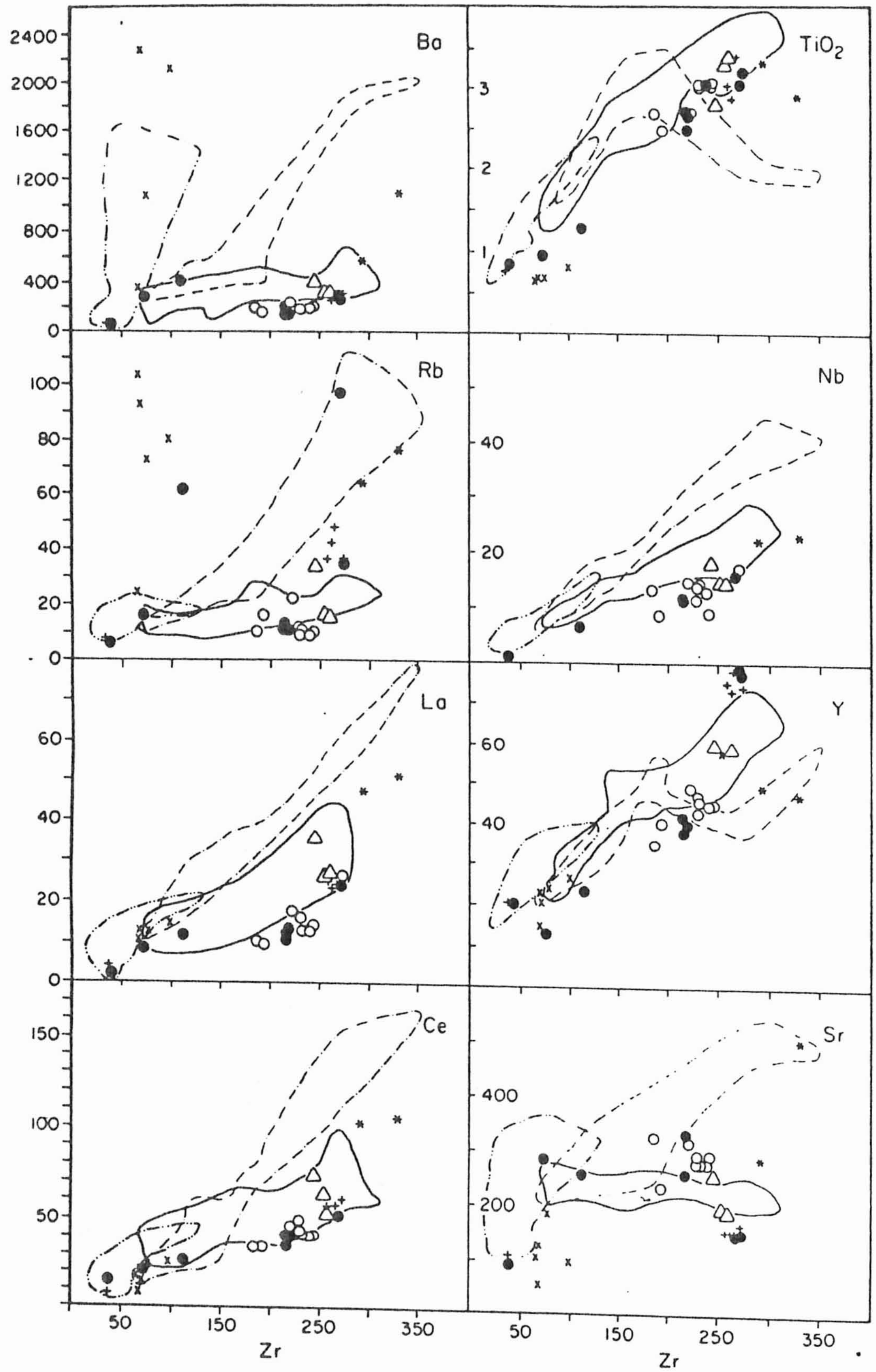

Figura 5 - La/Nb (normalized to primitive mantle) vs Zr/Nb and Ba/Nb. AFC lines are shown in the insert and partially in the figure. AFC parameters: End members: N-Morb (La=3.9 ppm; Nb=3.5 ppm; Ba 13.87 ppm; Zr 104.2 ppm) and rhyolite Cj52 (square; La 360 ppm; Nb 28 ppm; Ba 1060 ppm; Zr 565 ppm); Bulk D: La=0.13; Nb=0.05; Ba=0.2; Zr=0.007. R=0.2. Symbols as in Fig. 1.