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GEOCHEMISTRY OF DIFFERENTIATED MAFIC BODIES FROM THE HIGH-GRADE TERRAIN OF THE GUAXUPÉ MASSIF - EVALUATION OF CRUSTAL CONTAMINATION OF BASALTIC MAGMA

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One of the characteristic features of granulite facies rocks frequently cited in literature is their depletion in large ion lithophile elements (LILE) such as K, Rb, Cs, Th and U compared to amphibolite facies rocks (Tarney and Windley, 1977; Weaver and Tarney, 1983). Such a depletion is accounted for by the passage of fluids through deep crustal rocks during pro-grade metamorphism transitional from the amphibolite to granulite facies. The geochemical signature of the resulting crust is therefore an important factor that may or may not influence the composition of magmas which pass through or intrude this crust. In evaluating the presence or absence of crustal contamination in mafic magmas, Weaver and Tarney (1983) have examined the geochemical features of mafic dykes that intrude high-grade Archaean terrain in Scotland and have made comparisons of other continental mafic magmas from the Phanerozoic time. The influence of crustal contamination on basaltic magma has also been reported by Gibbs et al. (1988) for the Grão Pará volcanics. Here we examine some of the differentiated mafic bodies from the Guaxupé Massif and assess the degree of contamination of their magmas by the high-grade crust in which they occur.

GEOLOGY

Mafic bodies of various dimensions occur at many places in basement gneisses of Southern Minas Gerais as well as in granite-greenstone terrains - an evidence for recurrent basic magmatism in the process of consolidation of the crust in this region. A general account of the geology of a part of Southern Minas Gerais where the bodies occur can be found in Fernandes et al. (1987), while Choudhuri and Szabó (1982) give a more detailed account of differentiated mafic bodies which are dealt with here. These bodies occur scattered in the gneisses of the Guaxupé Massif and were probably sill-like intrusions, as suggested by their coarse grain (1-7 mm), later disrupted and separated during regional deformation and metamorphism. They are generally associated with tonalitic gneisses or metadiorites sometimes with garnet-biotite gneisses, all of them with parageneses compatible with granulite facies metamorphism. Later migmatization in the Brazilian Cycle (~ 600 Ma) has engulfed these rocks in masses of pink potassic granites, augen gneisses and migmatites with superimposed effects of intense regional shearing in a zone extending from WNW to ESE.

With rare exceptions, where a semblance of fine-scale layering remains and pale patches of feldspar aggregates can be seen on the outcrop scale, there is no clear evidence of the mafic bodies having resulted from differentiation in situ. Petrographic examination of the different rock types, however, show clearly that this has occurred, as can be seen by relict cumulus & intercumnlus textures, although these have been later overprinted by metamorphism. That these rocks are products of differentiation is also clear from the variation in plagioclase and mafic minerals, pyroxenes and hornblendes, which gives rise to types grading from cumulate hornblende pyroxenites with interstitial plagioclase, to gabbros and anorthositic gabbros, their present parageneses corresponding to granulite and amphibolite facies. The main minerals, olive-green hornblende, pink enstatite and pale green diopside* ± plagioclase (An_{34} to An_{48}), are accompanied by much apatite, ilmenite, magnetite, zircon ± carbonate and secondary biotite; texturally they are all annealed, polygonal and granoblastic.

MAJOR AND TRACE ELEMENTS

Major element chemistry of the mafic bodies shows them to belong to the tholeiitic series in an FeO_t-MgO-(Na_2O + K_2O) diagram, although observably a slight alkali enrichment in some of the samples, due no doubt to later migmatization effects, shifts them towards the calc-alkaline field. Plots of TiO_2, MgO, Ni, Cr and Zr (Fig. 1) among others, clearly bring out the differentiated nature of these rocks. their strong iron-enrichment, and accompanying high V contents, suggest an already evolved tholeiitic magma as the source of these rocks.

Crucial to the question of magma generation and source composition is the distribution of trace elements and REE in mafic-ultramafic rocks. The characteristic pattern obtained in a Wood et al. (1979) type "spidergram" aids in analysing and comparing their geochemical features with other rocks. An important facet of such spidergrams is the indication of possible contamination if any, of basaltic magma by the crust through which they have passed. Thus, Weaver and Tarney (1983) examined the patterns of Scourie dykes in Scotland comparing them with that of the granulite terrain in which these dykes intrude. In analogy we treat the incompatible element trend of the gneisses from the amphibolite and granulite facies terrain of the Guaxupé massif to assess the spidergrams of the basic bodies in Fig. 2. First of all, the pattern of the high grade terrain of the Guaxupé massif turns out to be distinct (enriched in LILE) compared to the crust in Scotland, so that the former has to be our line of reference. Therefore a chosen middle term sample of the mafic bodies is compared with those patterns. Now since the mafic compositions are evolved with respect to differentiation, their Th and Nb "dips" or anomalies are too pronounced to have resulted from mixing with or contamination by crustal components. On the other hand,

* Pyroxene names are adopted from the IMA nomenclature given by Morimoto et al. (1988).

enrichment of Rb and K is likely to be due to effects of a later migmatization mentioned earlier on. Surprisingly, the trend of the incompatible elements of the mafic rocks matches continental margin high-Al basalts, but as yet we have no explanation for this similarity. Continental basalts have in contrast much higher LILE and LREE. For the time being, we suggest that there appears to have been no significant crustal contamination of the basaltic magma and their composition probably reflects the nature of their source. Further work should provide a clearer understanding of such processes.

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FIGURE CAPTIONS

Fig. 1 - Harker diagrams for mafic bodies showing differentiation trends.

Fig. 2 - Spidergrams with elements normalized to primitive mantle in order of decreasing incompatibility after Wood et al. (1971). A = amphibolite facies gneisses, G = granulite facies gneisses from Guaxupé Massif, L = Lewisian granulites from Weaver and Tarney (1983), M = middle term of mafic bodies of this study.

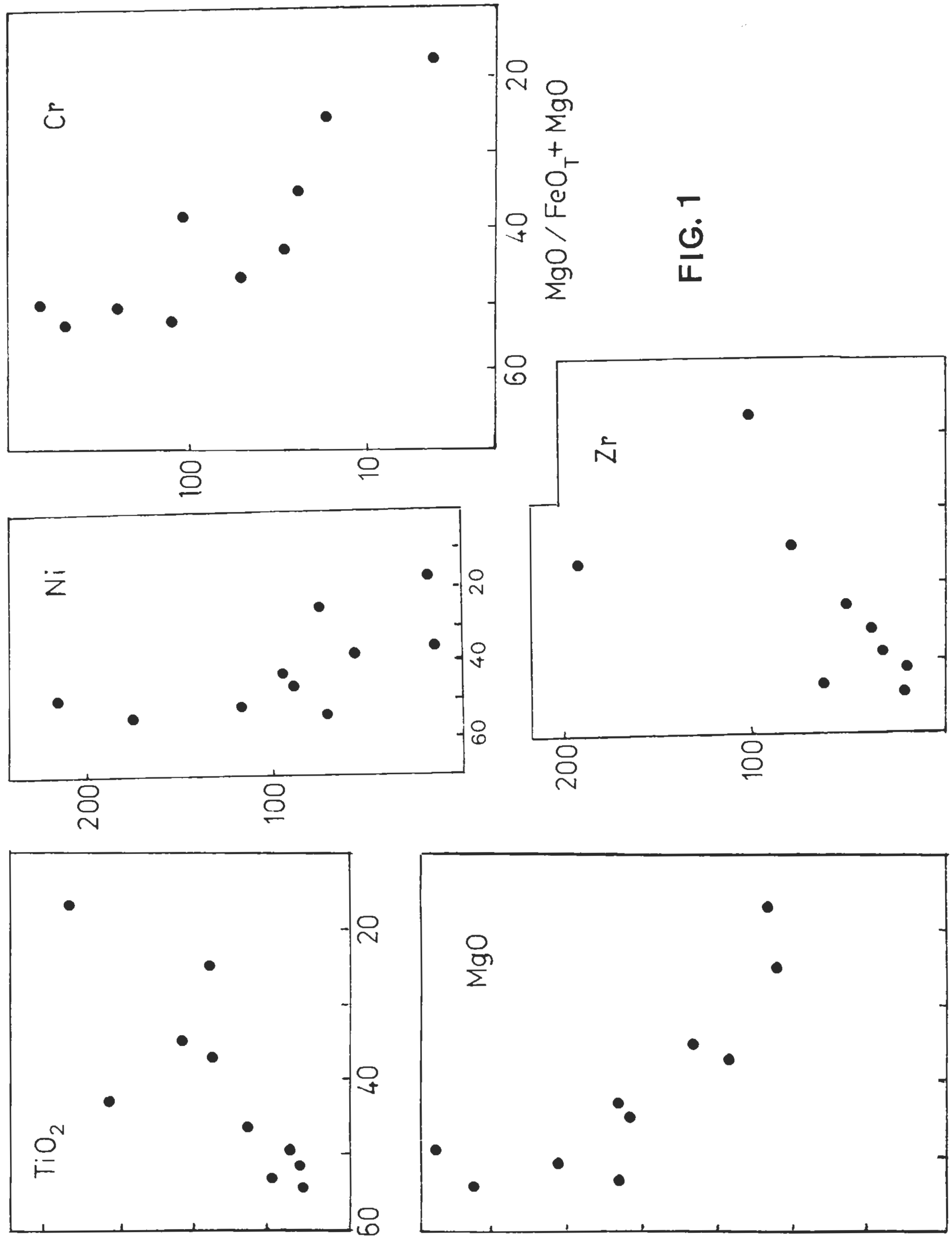

FIG. 1

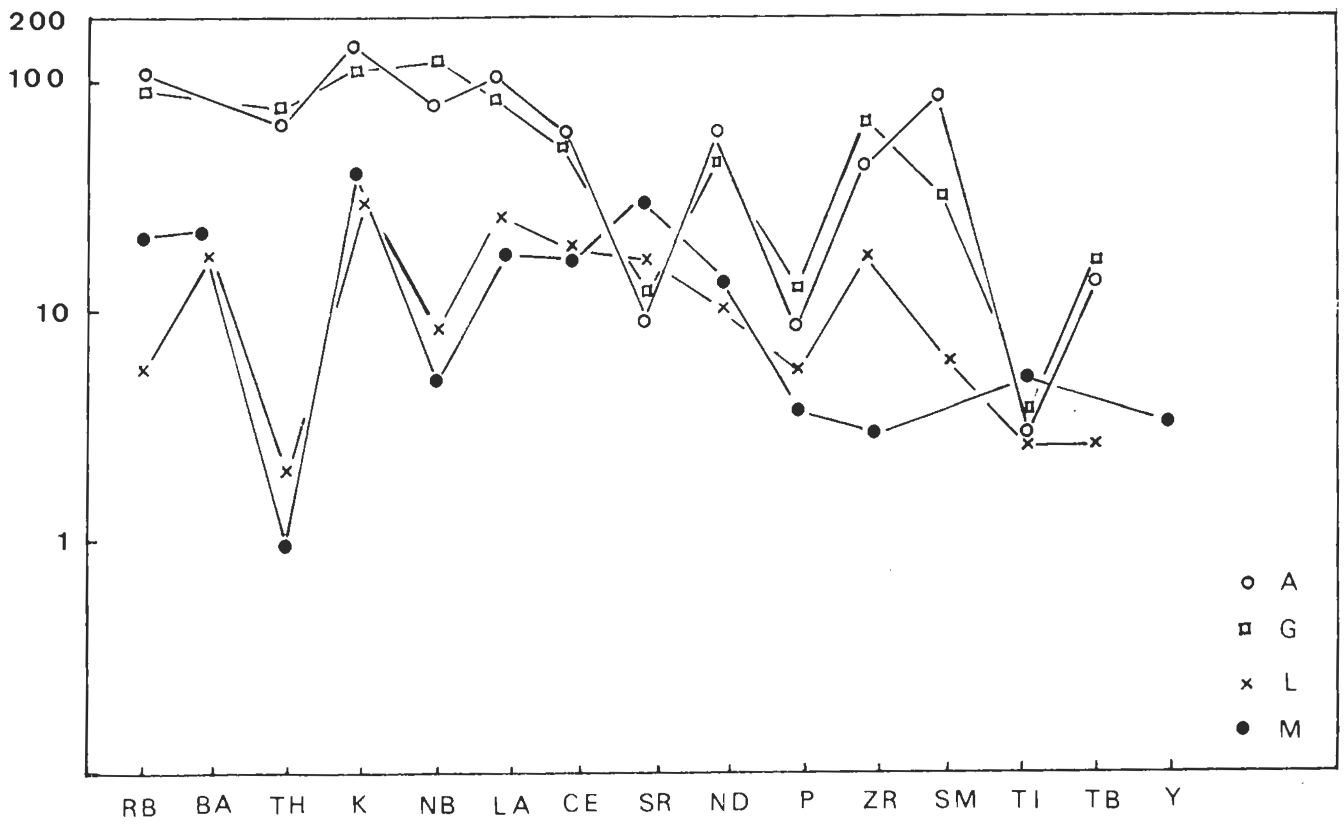

FIG. 2