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TRACE ELEMENT GEOCHEMISTRY AND PGE POTENTIAL OF NORITIC BODIES FROM UAUÁ BLOCK, BAHIA - BRAZIL

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Abstract: Preliminary field relationship and incompatible trace element geochemistry on two bodies of noritic rocks from Uauá area are discussed with the aim of evaluating their metallogenic potential. The rocks show primitive mantle normalized and chondrite normalized patterns very similar to chilled margins and parental magmas to the Bushveld and Insizwa complexes (RSA) which host major platinum group elements deposits. The data suggest the Uauá noritic bodies may be potential for ore mineralisation.

Resumo: Resultados geoquímicos preliminares e observações de campo são apresentadas para dois corpos noríticos da região de Uauá, objetivando a sua avaliação metalogenética. As rochas exibem padrões normalizados ao manto primitivo e aos condritos muito semelhantes a margens resfriadas ou magmas parentais dos Complexos de Bushveld e Insizwa (Africa do Sul) que reconhecidamente hospedam jazimentos de elementos do grupo da platina. O estudo sugere que os corpos noríticos de Uauá podem ser potenciais a mineralizações.

Introduction

The growing demand for platinum group elements (PGE) in Japan and western countries during the last six years and the expectation of further increases in future, especially from the car and electrical industries, jewellery and fuel cells (Coombes & Mathey 1991), ranks the PGE amongst the most strategic and valuable mineral resources.

Differentiated mafic-ultramafic bodies in continental settings may host important deposits of platinum group minerals, Ni-Cu sulphides, and oxides (chromite, ilmenite, magnetite). That is the situation in large Precambrian layered complexes such as the Bushveld (RSA) and Stillwater (USA), and the Great Dyke of Zimbabwe. Likewise, intrusive bodies (sills and dykes) associated with the outburst of Mesozoic continental flood basalts are potential targets for both base and precious metals deposits as reported from the Noril'sk-Talnakh region of Siberia (Naldrett 1989) and the Insizwa complex of South Africa (Cawthorn 1980).

The genesis of such complexes and of the associated mineral deposits has been a matter of much debate. It is generally accepted that the nature of the parental(s) magma(s), magma mixing, crustal contamination and fractional crystallization may play a decisive part in ore genesis. Interestingly, all major PGE deposits that occur in mafic to ultramafic intrusions are believed to have formed from high-MgO parent magmas (Davies et al. 1980, Cawthorn 1980, Sharpe 1982, Longhi et al. 1983, Davies & Tredoux 1985, Barnes 1990, Sun et al. 1991).

Recent geochemical work on mafic rocks of the Uauá Block (Oliveira 1989, 1990) unravelled the presence of differentiated siliceous high magnesian noritic bodies that may be potential for PGE deposits. These bodies are poorly known but the data presented here indicate they deserve further studies. Although no platinum group element analysis is available for such rocks a geochemical comparison with parental magmas or chill margins of PGE-bearing mafic-ultramafic complexes, using primitive mantle normalized diagrams, is attempted to assess their metallogenic potential. Further field work and PGE analysis are necessary to tell whether this approach is useful or not.

Outline of the Regional Geology

The Uauá Block is situated in the northeastern part of the São Francisco Craton. It is covered to the east by late Proterozoic metasediments of the Sergipano Belt and is bounded to the west by a shear zone that separates it from a few kilometre wide belt of gneisses, quartzite and mafic rocks usually referred to as Caldeirão Belt (Fig. 1). This belt is the northern extension of the early Proterozoic Rio Itapicuru greenstone belt terrain.

The Uauá Block is made up of (i) a gneiss terrain which is composed of banded gneisses, augen gneisses, migmatites, granitic rocks, and metamorphosed basic and ultrabasic rocks which were collectively called the Caraiba Series by Andritzky (1971), (ii) a swarm of mafic dykes, (iii) a metamorphosed volcanic-sedimentary sequence of the Rio Capim Group, and (iv) a complex of granulites to the east of the Rio Capim Group.

The mafic dyke swarm intrudes the gneiss terrain but not the Rio Capim Group nor the granulite complex which led Andritzky (1971) and Winge (1981) to suggest the dykes as feeders to the basic volcanics of the Rio Capim Group. On structural and metamorphic grounds, Sá et al. (1984) refuted the latter suggestion and put foward a model in which the lower grade Rio Capim sequence developed contemporaneous with the adjacent higher grade granulites. Yet, the basement to the Rio Capim Group lies to the west and is represented by the gneiss terrain.

Rb-Sr and K-Ar age dating indicate, respectively an Archaean age for the gneiss terrain (2.7 Ga. cf. Mascarenhas & Garcia 1989) and an early Proterozoic age for the mafic dyke swarm (2.0 - 1.9 Ga. cf. Gava et al. 1983, Sá et al. 1984).

The Mafic to Ultramafic Complexes

The noritic bodies crop out as lensoid intrusive complexes in the gneiss terrain. They are several hundred metres wide and a few kilometres long. Two bodies have been surveyed along the road from Caldeirão to Caratacá; one in the outskirts of Uauá city and the other about one kilometre to the east of Caratacá village (Fig. 1).

Several other mafic to ultramafic complexes do occur in the area but their geology remains to be unveilled. Some of them have been briefly commented by Andritzky (1971, p. 1056) and Winge (1981, p. 51). Others, such as the layered Lagoa da Vaca Complex (Fig.1), have already been explored for chromite.

The two noritic bodies of Uauá and Caratacá exhibit internal textural and mineralogical variation that may be ascribed to *in situ* differentiation. They show fine-grained chilled margin against the country-rock gneisses, and medium- to coarse-grained cumulus texture in the centre.

The chilled margins are apparently of two types: the first, at Uauá, is composed of a melanocratic olivine/orthopyroxene-rich rock with quenched ophitic groundmass of clouded plagioclase and prismatic pyroxene; olivine may show reaction rims of orthopyroxene or amphibole - phlogopite and opaque minerals are accessory phases; The second, near Caratacá, is mostly composed of ophitic intergrowths of plagioclase, opaque minerals and pyroxene, the latter altered to uralitic amphibole.

The coarse-grained centre shows poikilitic texture with euhedral to subhedral orthopyroxene primocrysts embedded in optically continuous postcumulus plagioclase, less commonly phlogopite groundmass; olivine is rare and occurs as inclusions in orthopyroxene. Very little opaque minerals are present in these samples.

The noritic complexes seem to have pyroxene-rich facies, as observed in the Uauá body, and have undergone local metamorphic requilibrium to low amphibolite facies grade, mostly due to fluid percolation.

Cross-cutting relationships between the noritic bodies and the 2.0 Ga. old mafic dyke swarm suggest the latter is much younger than the former.

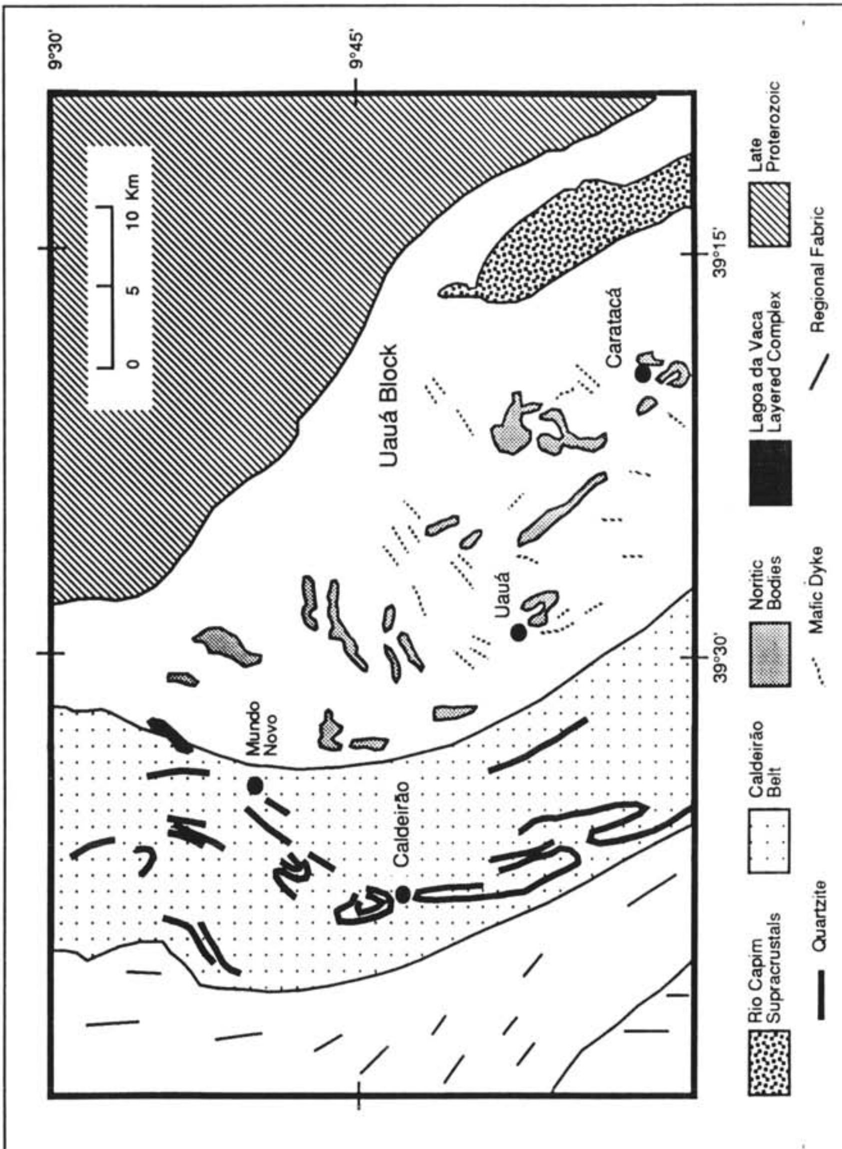

Fig. 1 - Geology of Uauá area.

Geochemistry

In this section the author attempts to highlight the geochemical similarity of the Uauá noritic bodies with the suggested parental magmas to the PGE-rich Bushveld and Insizwa complexes of South Africa. For this reconnaissance survey two noritic samples (1194-1 as chill margin from Uauá and 1284-89 as cumulate from Caratacá) have been analysed for major and trace elements, and one of these for rare-earth elements. The Analyses have been performed by X-ray fluorescence spectroscopy and inductively coupled plasma at Leicester University, UK. The results are shown in Table 1 along with data for the parental magma compositions to the Bushveld and Insizwa complexes for comparison.

The average of quench-textured micropyroxenite intrusions (BU) marginal to the Bushveld Complex was taken from Hall & Hughes (1990). This rock type is generally believed to represent one of the parental liquids (U-type) of the complex, and the carrier of platinum group elements. The other parental liquid has anorthositic composition (A-type) and is thought to have supplied sulphur for sulphide precipitation in response to mixing of the two parents (Irvine & Sharpe 1982, Irvine et al. 1983).

Although no unambiguous parental magma composition to the Mesozoic Insizwa Complex is available to date, samples INS 302 and INS 303 of a contact gabbro from the Lower Basal Zone at Waterfall Gorge (Lightfoot & Naldrett 1984) are used for this study. Sample INS 302 is a quenched plagioclase-bronzite rock with minor K-feldspar, biotite, ilmenite, spinel and quartz. The geochemistry of this sample may reflect minor interaction with footwall-derived granophyre from which quartz and K-feldspar have been incorporated. Sample INS 303, slightly away from the granophyre contact, contains grains of olivine set in a groundmass of plagioclase, bronzite, ilmenite, sulphide and biotite. Given the lack of mineral analysis for Uauá rocks, sample INS 303 is mineralogically very similar to that collected at Uauá city (1194-1 of Table 1).

The major and trace elements of the Uauá bodies differ mostly from the Bushveld and Insizwa rocks in terms of MgO, Al2O3, K2O, Rb, Ba and LREE abundances (Table 1). Their high MgO contents coupled with high chromium and low abundances of the above referred to elements suggest a strong mineral control of their whole-rock chemistry through fractionation of olivine and/or orthopyroxene. Despite the quench-textured groundmass observed in sample 1194-1, its chemistry shows that it is far from being close to a primitive liquid. The same holds for sample 1284-89 with its remarkable cumulus texture.

Nonetheless, the primitive mantle normalized patterns of the Uauá samples (Fig.2a) resemble very much those of Insizwa and Bushveld, especially the cumulate norite near Caratacá (1284-89).

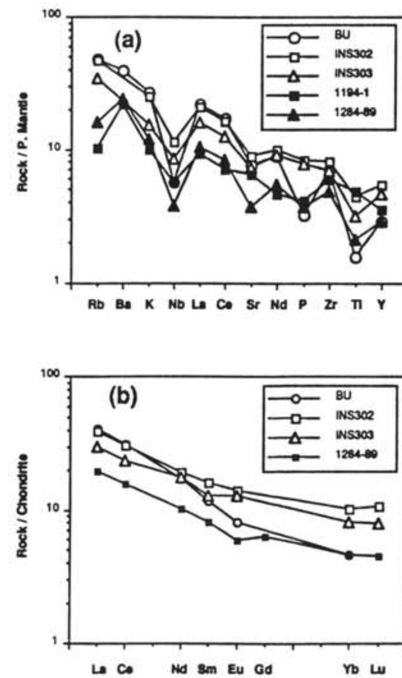

Fig. 2 : Primitive mantle (a) and chondrite (b) normalised diagrams of noritic rocks from Uauá area compared with rocks from Bushveld (BU) and Insizwa (INS). Normalising values after Sun & McDonough (1989) and Evensen **et al.** (1978)

Table 1

Major and trace element data for Bushveld (BU) and Insizwa (INS) Complexes and Uauá norites.

Rock No.	BU	INS 302	INS 303	1194-1	1284-89
SiO_2	56.07	53.72	49.16	46.00	51.70
TiO_2	0.34	0.96	0.68	1.05	0.46
Al_2O_3	11.47	13.36	14.07	8.00	8.40
Fe_2O_3	-	-	-	14.70	11.30
FeO	9.53	11.77	13.21	-	-
MnO	0.18	0.18	0.17	0.20	0.18
MgO	12.96	7.07	11.88	19.10	20.00
CaO	6.68	9.01	8.42	8.10	6.60
Na_2O	1.68	1.88	1.61	2.30	0.90
K_2O	0.80	0.75	0.46	0.30	0.36
P_2O_5	0.07	0.18	0.17	0.09	0.08
Total	99.78	98.88	99.83	99.84	99.98

Trace elements in ppm

V	-	-	-	260.2	170.5
Cr	1240	-	-	2222.2	2574
Ni	295	705	1972	1135.2	580.8
Zn	-	-	-	102	88.9
Cu	-	597	1525	-	-
Rb	30	29.5	21.5	6.4	10.1
Sr	158	188	153	136.2	78.4
Y	13	24.6	20.9	16.1	13.1
Zr	77	90	78	65.9	54.2
Nb	4	8	6	4	2.7
Ba	270	-	-	152.5	166.6
La	15	14.4	10.8	6.3	7.1
Ce	30	28.9	22	12.5	14.75
Nd	12	13.5	12.3	6.2	7.23
Sm	2.7	3.7	2.9	-	1.85
Eu	0.71	1.2	1.1	-	0.51
Gd	-	-	-	-	1.94
Tb	-	0.2	0.5	-	-
Ho	-	1	-	-	-
Yb	1.14	2.5	2	-	1.13
Lu	-	0.4	0.3	-	0.17

Their fractionated rare-earth element patterns are also very similar (Fig. 2b), suggesting a common, although not necessarily similar process in their petrogenesis.

The author believes therefore that such mineralogical and geochemical similarities suggest the Uauá bodies are potential for ore mineralisation. A careful geological mapping of some of those bodies and precise trace element analysis of samples representative as possible of the chill margins are needed for a better evaluation of their metallogenic potential. Emphasis should be given to trace element contents in olivine, especially nickel and chromium, and to element ratios in chilled margins such as Pd/Ir, Ni/Cu, Ni/Pd and Cu/Ir which may help distinguish the effects of olivine and chromite fractionation and sulphide segregation (cf. Barnes 1990). This sort of exercise is one of the subjects of an ongoing project on several mafic-ultramafic complexes of the Uauá Block, the results of which will be published elsewhere.

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