GEOCHEMISTRY AND PETROGENESIS OF THE CHARNOCKITOID ASSOCIATION IN THE UMARIZAL PLUTON, WEST OF RIO GRANDE DO NORTE STATE, BRAZIL

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INTRODUCTION The Umarizal batholith crops out over about 300 km^2, and is part of the Brasiliano-age granite complex (~1.500 km^2) in the Caraúbas-Umarizal region in western Rio Grande do Norte. The absence of a tectonic fabric and its Rb-Sr age of 545±7 Ma show that the Umarizal pluton is post-tectonic relative to the Brasiliano cycle (Galindo *et al.* 1995). Three texturally and petrographically different facies were identified: the Ação facies is predominantly biotite-amphibole-syenogranite, the Lagoa facies is mainly biotite-amphibole-monzogranite and the predominant facies, composing ~80% of the pluton, is an association which includes an early-formed charnockite mafic mineral assemblage.

THE CHARNOCKITOID ASSOCIATION Ferrohyperstene-bearing assemblages are not common in these rocks. Nevertheless, semi-quatitative P-T estimates show that this assemblage and the more common, fayalite-bearing assemblage crystallized under similar high P-T conditions. Hedenbergite is always present. The anhydrous minerals are partly substituted by amphiboles (fayalite → grunerite → Fe-edenitic hornblende; hedenbergite → Fe-edenitic hornblende). Fe-edenitic hornblende and Fe-rich biotite form separate crystals, the latter in symplectitic intergrowth with quartz. The felsic minerals are perthitic microcline, oligoclase and quartz. Accessory minerals include magnetite and ilmenite. The rocks are mainly quartz-monzonite (leuco-mangerites) or quartz-syenite and are accompanied by syenogranite (charnockite).

The rocks show geochemical affinities with both alkaline and sub-alkaline series. Multi-element patterns are similar to those found for A-type post-collisional granites (Galindo 1993).

PETROGENESIS The presence of the FMQ equilibrium mineral assemblage indicates that the crystallization of these rocks started under the relatively low fO_2 condition typical of this buffer. The presence of Opx-Cpx and Cpx-Fa equilibrium pairs leads to an estimate of the temperature range at the beginning of crystallization between 800 and 900 °C (Ormaasen 1977, Stepheson & Hensel 1978, Frost & Lindsley 1992). Based on the pairs Opx-Cpx and Fa-Cpx, Eboral (1976) estimate pressure of around 8-10 kb for the crystallization of the very similar bauchites of Nigeria. The Cpx-Hb pair and the presence of Fa together with Fe-biotite yield T estimates in the same range. Later, pH_2O and probably fO_2 must have increased as volatiles became concentrated in the magma, leading to the substitution of the anhydrous minerals and the stabilization of the hydrous assemblage.

The leucocratic felsic nature of the magmas and the anhydrous initial mineral assemblage, together with the high initial $^{87}Sr/^{86}Sr$ ratio of 0,71208±0,00021 point to an anhydrous or water-poor, intermediate or felsic crustal origin for the original magma. Although anhydrous mafic minerals were formed early and hydrous minerals, later, geochemical modelling of major and rare earth element differentiation, using XLFRAC (Stormer Jr. & Nicholls 1978) for the former, show that feldspar were also very important, but that accessory such as zircon and apatite had a large influence on REE behaviour. It was deduced that mangerites could be potential source rocks for the primary magma.

The genesis of magmas of this type in anorogenic environments could be linked to (i) presence of a hot-spot under thinned continental crust in an extensional environment causes partial melting (Sandiford & Powell 1986); (ii) large volumes of mafic magma are trapped under or intruded into the crust, causing partial melting (Clemens *et al.* 1986, Whalen *et al.* 1987). These situations are not exclusive to anorogenic or rift environments, and could also develope in post-collisional situations (Whalen *et al.* 1987).

The final intrusion as A-type magmas usually occurs into shallow crust, and magma ascent is facilitated by crustal fracturing. In the case of the Umarizal pluton, magma ascent was probably facilitated by the presence of deep faults associated with the Portalegre shear zone, an important geological feature in the region, which was active before the intrusion of the Umarizal pluton.

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