

BEHAVIOUR OF THE RARE EARTH ELEMENTS IN
A LATERITIC BAUXITE FROM SYENITE (BRESIL)

BOULANGE B.*, MULLER J.P.** and SIGOLO J.B.***

* ORSTOM, UR1G, Laboratoire de Géosciences de l'Environnement. URA CNRS 132.
Université d'Aix-Marseille III. 13397 Marseille Cedex 13, France.** ORSTOM, UR 1G, Laboratoire de Minéralogie et Cristallographie. Université Pierre et Marie Curie.
4, Place Jussieu, 75252 Paris Cedex 05, France.

*** Instituto de Geociências, Universidade de São Paulo, CP 20899, 01498 São Paulo, Brazil.

Distribution and mobility of Rare Earth Elements (REE) during weathering processes have been documented by several authors (Balashov *et al.*, 1964; Ronov, 1967; Roaldset, 1973; Steinberg et Courtois, 1976; Nesbitt, 1979; Duddy, 1980; Alderton *et al.*, 1980; Bonnot-Courtois, 1981). But, generally in these studies, the weathering products are clays in which the REE may accumulate by adsorption. In bauxites, such studies are most often limited to "karstic bauxites" and are very rare on lateritic bauxites. The aim of this work concerns REE distribution along a lateritic bauxite profile developed on nefelinic syenite of Passa Quatro intrusive block (Minas Gerais) in southern Brazil.

The studied profile occurs at the top of a topographic sequence in a place named Alto dos Posses (altitude of 2190 m). Weathering extends to a depth of 9 m. The profile presents a vertical sequence of four zones from the bottom to the top (Sigolo, 1988):

- an alkaline rock, nefeline syenite, divided into rounded shape decimetric blocks surrounded by a weathering cortex,
- a massive saprolitic bauxite in continuity with the cortex,
- a fragmentary saprolitic bauxite showing at the transition with the previous zone an increase of Al and Fe concentrations,
- a fragmentary aluminous crust.

Samples of the saprolitic bauxite and of the matrix were taken each meter from the rock to the crust. The petrologic studies show that the texture and structure are preserved at different scales, thus it is possible to apply an isovolumetric mass balance. We have applied this calculation to the REE concentrations (La, Ce, Nd, Sm, Eu, Gd, Dy, Er, Yb and Lu).

a) In the nefelinic syenite the range of REE

concentrations is 700-800 ppm. The distribution pattern, normalized to chondrite exhibits a strong LREE enrichment with a negative anomaly in Eu. There are not REE data of this Passa Quatro alkaline rock, but the REE content and their distribution, with $(La/Lu)_{ch}=25$ and $Eu/Sm=0.09$, are conformed to the syenite granite group (Cullers and Graaf, 1984).

b) The REE depletion begins in the weathering cortex and increases toward the massive saprolitic bauxite, principally Nd, Sm (fig.1). Nevertheless the range of REE concentration is more important in the massive bauxite (560 ppm) than in the cortex (480 ppm) on account of the big positive anomaly in Ce.

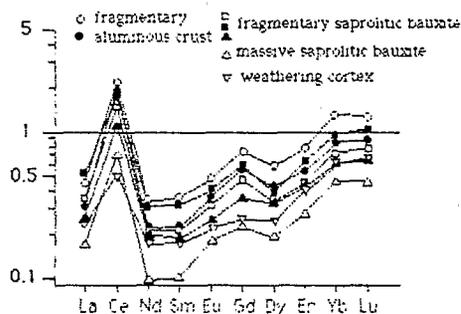


Figure 1 : The syenite normalized patterns of the bauxitic fragments with respect to the isovolumetric mass balance.

c) In the fragmentary saprolitic bauxite the range of REE concentration follows increasing: 850 ppm to 1050 ppm. The Ce positive anomaly is very important, and the concentration is getting up over the syenite concentration. This enrichment is greater not only for Ce, but also for Yb and Lu. The REE are more concentrated in the matrix than in the fragments. Furthermore, at the bottom of this zone, Ce and Gd reach the most strong concentration.

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d) In the fragmentary aluminous crust, the range of REE concentration increases to about 1350 ppm, nearly twice the concentration in the aluminous rock. But, the distribution pattern normalized to the aluminous rock, with respect to mass balance, shows that only Ce, Yb and Lu have a concentration coefficient superior to 1. On the other hand, at the bottom of this crust, the REE appear more leached than in the upper part. On the contrary in the matrix the REE are more concentrated. So it seems that a surficial removal (except for Ce) occurs principally at the bottom of the fragmentary aluminous crust.

Most studies on the behaviour of Rare Earth Elements during the weathering have been made from the profiles with clayey secondary products. In this environment, the authors agree to conclude to a weak removal of REE (Nesbitt, 1979; Decarreau *et al.*, 1979; Bonnot Courtois, 1981), or even sometimes to a whole lack of mobility (Piper, 1974). In comparison, the results obtained in bauxitization environment of the Passa Quatro aluminous massif, show a greatest fractionation and an important leaching at the weathering front. Nd and Sm are the most leached LREE, Ce and HREE (Er, Yb, Lu) are the most stable. The decreasing of the (La/Lu) ratio indicates, as in kaolinitic environment (Alderton and *al.*, 1970), that the LREE are quite strongly depleted and the HREE slightly depleted.

In the lateritic bauxitic profile, there is an important accumulation horizon where are deposited argilo-ferruginous, aluminous-ferruginous or aluminous secondary products. Linked to these Fe-Al accumulations, there is an important enrichment of all the REE, principally at the bottom of this accumulation horizon. The products constituting these deposits can come from the upper part of the profile, particularly from the bottom of the surficial aluminous crust where leaching is more intensive. Then :

i) on the one hand, in this bauxitic profile, the REE seem linked to the Fe-Al deposits in the accumulation horizon,

ii) on the other hand, when the iron is removed again, the REE are partially removed and leached toward the lower part of the profile.

In spite of the fact that the REE are depletive, a strong positive Ce-anomaly is always noticeable. The Ce anomaly agree completely with the results in clayey environment, it is a consequence of the weathering (Steinberg et Courtois, 1976). The immobilization of Ce occurs in form of Ce^{4+} , adsorbed on kaolinites as a monomeric species or as a polymeric hidroxication (Roaldset, 1973; Decarreau and *al.*, 1979; Laufer and *al.*, 1984). But

here in the absence of kaolinite, we have no indication concerning the eventual mineral phase which contributes to Ce immobilization. It is possible that phosphate minerals, apatite or florencite play this role.

In a lateritic bauxitic profile developed from nefelinic syenite the fractionation and the removal of REE are important at the weathering front. The LREE are more mobile than the HREE. As Fe and Al, all the REE are concentrated in the accumulation horizon. On the contrary, there is a tendency to the depletion in the upper part of the profile.

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