GEOCHEMISTRY OF PITINGA BAUXITE DEPOSIT – AMAZONIAN REGION - BRAZIL

Adriana Maria Coimbra Horbe[1, 2] & Sanclever Freire Peixoto[2]

[1]Current address CRC-LEME/visitor c/o CSIRO Exploration and Mining, 26 Dick Perry Avenue, Kingstone, WA 6152.;
[2]Departamento de Geociências – Universidade Federal do Amazonas, Av. Gal. Rodrigo O. J. Ramos 3000, Japiim, 69077-000, Manaus, Brazil – AM ahorbe@ufam.edu.br

INTRODUCTION

The Amazonian region, located in the north of South America has been modified by weathering processes since the late Cretaceous. During this time, the climate has changed from seasonally humid to tropically humid with rainforest vegetation, with shorter periods of drier conditions and savannah vegetation. These events promote kaolinization, development of deep weathered profiles, duricrusts and soils on a variety of parent rocks (e.g. Costa 1991; Truckenbrodt *et al.* 1991; Angélica & Costa 1991 and 1993; Costa & Araújo 1996; Costa 1997; Lucas 1997; Horbe & Costa 1999). Two widespread episodes of duricrust development occurred during the Upper Cretaceous/Eocene and Pleistocene which developed two main landscapes. The older landscape, with bauxite duricrust, was developed on all pre-Cretaceous regions, and forms higher residual plateaus and incised valleys belonging to the Sul-American Pediplain. The younger landscape, developed on sedimentary rocks, is characterized by lower plateaus and flat hills belonging to the Velhas Pediplain (Costa 1997).

The Pitinga mine, situated approximately 300 km from Manaus city (Figure 1), hosts the main Sn, REE minerals (Zr, Nb, Th, Ta, Y and REE) and cryolite deposits of Brazil (Horbe *et al*. 1991; Horbe *et al*. 1999; Costi *et al*. 2002; Lenharo *et al.* 2003). In the Pitinga region, Sn deposits are associated with bauxite (Costa *et al*. 1988). Recently new pits were dug to investigate the effects of the parent rock on weathering and the bauxite.

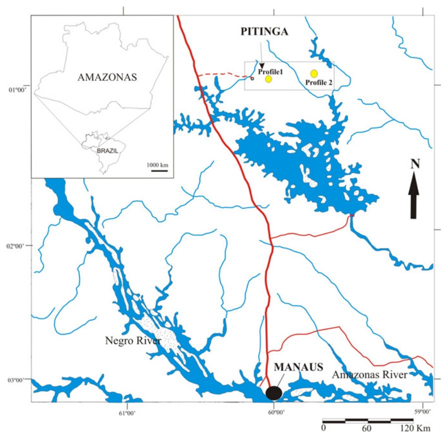

Figure 1: Location of the studied profiles in Pitinga mine.

THE WEATHERING PROFILE

The bauxitic profiles are developed on volcanic and granitic terrains of the Guiana Shield. The profiles on both rocks are similar, 10 m thick, and comprise, from the base to the top by three horizons: mottled, bauxite and loose material (Figure 2). The profiles (1 and 2) occurred in broad uplands, on the summit of regional plateaux at 240 - 320 m elevation. The vegetation is rain forest and the climate is tropical with a mean annual temperature of 26°C and a mean annual rainfall of 2000 mm. Seasonal rainfall is greatest from December to May.

The mottled horizon is dominated by red to whitish clay to silty clay materials and quartz grains. Quartz grains are more abundant on the granitic profile. The bauxite horizons are 6 m thick on the volcanic profiles and 5 m thick on the granitic profiles, are brown to red, having massive textures, as well as ferruginous and aluminous nodules (Figure 2). The middle horizon contains ferruginous nodules and pisoliths, some with goethite cutans. The loose ferruginous and aluminous pisoliths and nodules (< 4 cm diameter) as well as fragments of massive bauxite, are embedded in a yellow clayey matrix. The profiles are covered by 2 to 5 m of yellowish Oxisols.

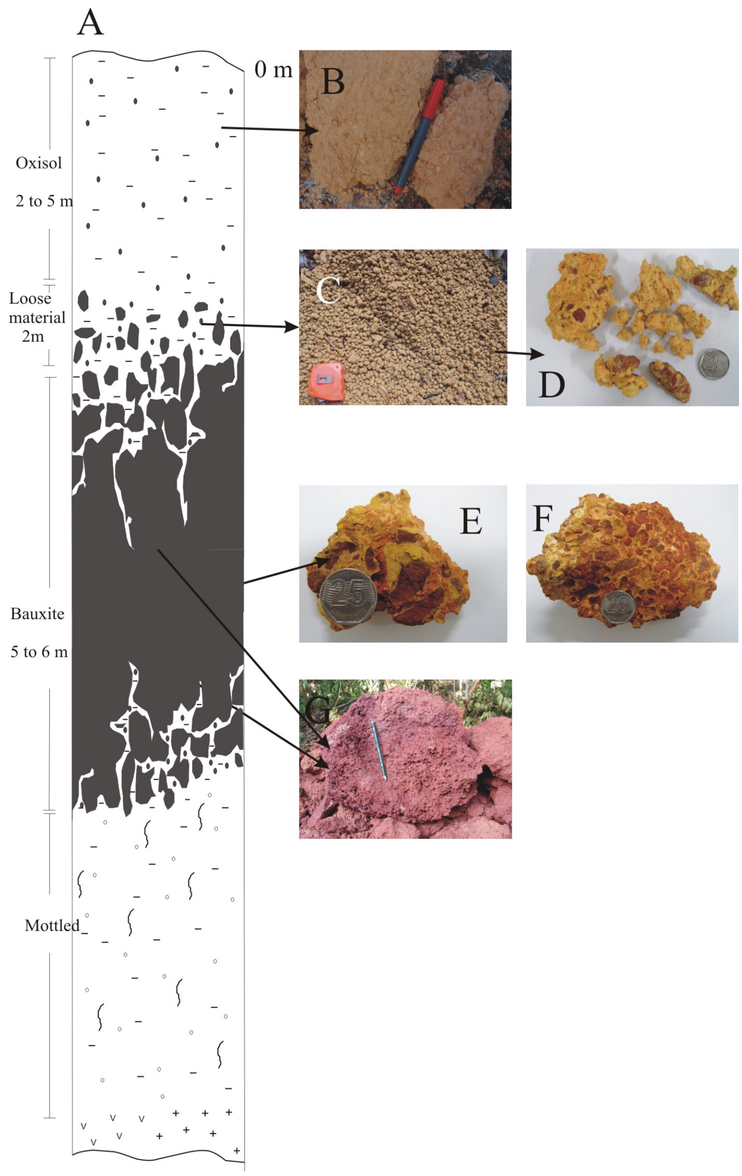

Figure 2: A- Bauxite profile of Pitinga region, field photograph of B- Oxisol, C- Loose material, D- detail of the nodules and pisoliths, E and F - portions with ferruginous nodules and pisolith, G- massive bauxite.

CHEMICAL COMPOSITION

The main minerals are gibbsite, kaolinite and hematite with smaller amounts of goethite, quartz and anatase. Major element chemical analysis showed Al_2O_3, Fe_2O_3 and SiO_2 to be the most abundant, while TiO_2 and P_2O_5 are subordinate (< 3%). Aluminium reaches 57% (Al_2O_3) in the bauxite on volcanic rocks and 50% in the bauxite of granitic rocks, indicating both are of industrial quality.

Trace element analysis showed Zr, Ba, V, Sr, Y, Hf, Mn, Pb, Sc, Zn, Cu and Co are more abundant in the profile developed on volcanic rocks while Nb, Th, Ga, Sn, W, Ta, As, Mo and Hg are more abundant in the granitic rock profile. Weathering profiles formed on volcanic rocks contain high concentrations of Zr, Th, Nb, Ga, Hf, Y, Sn, Sc, W, Pb, Ta and U in the yellow clayey matrix of loose horizon and in the Oxisols; Mn and Zn were higher in the saprolite; V, As, Mo, Cu, and Hg are highest in the Fe-Al portion of the bauxite. Weathering profiles formed on granitic rocks showed similar patterns of trace elements distribution except for Mn which is slightly higher in the bauxite and Oxisol, and higher Zn in the yellow clayey matrix of the loose horizon. The REE's (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Er and Lu) also showed the highest contents in the profile formed on volcanic rocks profile with upward, concave, sub-parallel curves. The higher fractionation and negative anomaly for Eu was sharper in the granitic rock profile.

The geochemical characteristics of each profile are directly related to the parent rock since they were formed under similar weathering and good drainage conditions that promote the leaching of Si, Ca, Na, K, and Mg, and alteration of kaolinite to gibbsite. The trace elements (Zr, Th, Nb, Ga, Hf, Y, Sn, Sc, W, Pb, Ta, U and REE) associated with resistant minerals increase towards the Oxisol surface. Vanadium, As, Mo, Cu and Hg increase in the ferruginous nodules and pisoliths of the bauxite horizon.

The process of enrichment of these trace elements is similar to that developed over the high grade tin deposits of the Pitinga mine (Horbe & Costa 1999). The bauxite on volcanic and granitic rocks in the Pitinga region highlights a new prospective opportunity in the north region of Amazonas River on the Guiana Shield, since previous exploration only targeted the Upper Cretaceous sedimentary rocks (Paragominas and Juruti regions) in Brazil.

REFERENCES

ANGÉLICA, R. S. & COSTA, M. L. 1991. Associações geoquímicas nos lateritos superficiais do Complexo de Maicuru, Estado do Pará. *Geochimical Brasiliensis* **5**:101-115.

ANGÉLICA, R. S. & COSTA, M. L. 1993. Geochemistry of rare-earth elements in surface lateritic rocks and soils from the Maicuru Complex, Pará, Brazil. *Journal of Geochemical Exploration* **47**:165-182.

COSTA, M.L. 1991. Aspectos geológicos dos lateritos da Amazônia. *Revista Brasileira Geologia* **21**:146-160.

COSTA, M.L. & ARAÚJO, E.S. 1996. Application of multi-element geochemistry in Au-phosphate-bearing lateritic crust for identification of their parent rocks. *Journal of Geochemical Exploration* **57**:257-272.

COSTA, M.L. 1997. Lateritization as major process of ore deposit formation in the Amazon Region. *Exploration Mining Geology* **6**:79-104.

COSTA, M.L., HORBE, M.A., HORBE, A.M.C., TEIXEIRA, J.T. & COSTA, W.A.M. 1988. A região laterítica bauxítica do Pitinga-AM. *In*: Proceeding of the Brazilian Congress of Geology 35, Belém, Brazil, v.1, p.22-26.

COSTI, H.T., DALL'AGNOL, R., BORGES, R. M. K., MINUZZI, O.R.R. & TEIXEIRA, J.T. 2002. Tin-Bearing sodic episyenites associated with the Proterozoic, A-type Água Boa Granite, Pitinga Mine, Amazonian Craton, Brazil. *Gondwana Reserarch* **5**: 435-451.

HORBE, M.A., HORBE, A.M.C., COSTI, H.T. & TEIXEIRA, J.T. 1991. Geochemical characteristics of cryolite-tin-bearing granites from the Pitinga Mine, northwestern Brazil- a review. *Journal of Geochemical Exploration* **40**: 227-249.

HORBE, A.M.C. & COSTA, M.L. 1999. Geochemical evolution of a lateritic Sn-Zr-Th-Nb-Y-REE-bearing ore body derived from apogranite: the case of Pitinga, Amazonas – Brasil. *Journal of Geochemical Exploration* **66**: 339-351.

LENHARO, S.R.L.; POLLARD, P.J. & BORN, H. 2003. Petrology and textural evolution of granites associated with tin and rare-metals mineralization at the Pitinga mine, Amazonas, Brazil. *Lithos* **66**: 37-61.

LUCAS, Y. 1997. The bauxite of Juriti. In: Carvalho, A., Boulangé, B., Melfi, A. J. & Lucas, Y. Brazilian bauxites, USP/FAPESP/ORSTOM, Brazil. 107-136.

TRUCKENBRODT, W.; KOTSCHOUBEY, B. & SCHELLMANN, W. 1991. Composition and origin of the clay cover on north brazilian laterites. *Geologische Rundschau* **80**:591-610.