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MINERALOGY OF SOME SOILS FROM THE AMAZONIA SEDIMENTARY BASIN

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ABSTRACT

The Amazonia Forest is an important biome that possesses great diversity of fauna and flora, which can play a significant role in several science areas, specially, the gene reserve for the future of humankind. Nevertheless, it is a very poorly understood environment, particularly the basis of this ecosystem, its soils. This study was conducted to gain insight in the mineralogy of important soils classes of the Amazonia sedimentary basin. The soils in the upland position in the landscape are developed from tertiary sediments belonging to the Alter do Chão series and those in the floodplain position are derived from quaternary, more specifically, Holocene´s sediments.

Sand, silt and clay fractions were separated and X-ray diffraction analysis was conducted. Very simple mineralogy composed basically of quartz in the coarser fractions and kaolinite, goethite and anatase for the finer fraction was found for the Oxisol, the Ultisol and the Entisol from an upland toposequence but differences in kaolinite crystallography could be noticed among them. Gibbsite was virtually absent, in spite of the advanced degree of development of most of these soils.

More distinctive mineralogy was revealed for the soils developed in the more recent sediments with quartz and feldspars in the sand and silt fractions and a suite of 2:1 minerals also appearing in their clay fraction, besides kaolinite and goethite. In one upland soil petroplinthite is the main feature and its mineralogy reflected its environment of formation which is usually associated with level to gently sloping areas with fluctuating water table.

KEY WORDS

Clay mineralogy; upland soils; floodplain soils

INTRODUCTION

A few research groups have studied the mineralogy of soils in the Amazon. Most studies were concerned with the determination of mineral species existing in these soils as well as trying to indicate which of these minerals are predominating in each of the soils (Lima , 2001; Lima et al ., 2006; Orrutea et al., 2012; Silva et al. 2012). Lima (2001) identified differences in the mineralogical composition of soils, finding greater diversity of minerals in soils subjected to flooding and/or deficiency of natural drainage. The same author observed a lower diversity when determinations were made in materials better drained and therefore more weathered, as is the case of soils from the upland parts of the Amazon. To Lima et al. (2006) the advanced degree of development of some soils of the Amazon region is strongly associated with the source material, weather conditions, vegetation and topography . These same factors affect these soils with low mineral reserves, high nutrient cycling and deep soils in comparison to other regions. Orrutea et al. (2012) studying the Amazon Inceptsols verified the predominance of kaolinite in the clay fraction and high mineral reserve of K associated with the occurrence of mica in the clay fractions, silt and sand . These authors offer a contribution to the understanding of the transformation processes related to mineralogy of soils against different soil managements, and found that these did not affect the levels of Fe associated with clay minerals. Silva et al. (2012) studied the mineralogy of Terra Preta Arqueológica (TPA)(Archaeological Black Earth or Indian Black Earth) among others. These authors identified the minerals quartz, kaolinite, goethite, hematite, anatase and illite. Pessoa Junior et al. (2012) define the TPA as spots of soil, rich in nutrients, found in large extensions of the Amazon basin and the origin of this soil is strongly related to the deposition of material remains of pre-Columbian populations. In relation to the behavior of iron oxides, Demattê et al. (1993) found that the degree of crystallinity decreased as the hydromorphic conditions intensified. Campos et al. (2011) characterized mineralogically Oxisols and Ultisols of the Amazon region and detected for all studied profiles similarity in mineralogical composition between the sand, silt and clay, registering the presence of the following minerals: kaolinite, gibbsite, quartz and traces of mica. The authors emphasized that the clay fraction showed most significant peaks for kaolinite and gibbsite, thus expressing its high degree of development. Marques et al. (2010) determined the mineralogical composition of six Oxisols of the Amazon region, in different portions of the landscape and found that there were no differences with respect to composition taking into account the location of the profiles in the landscape. The clay mineralogy analysis performed indicated predominant presence of kaolinite and gibbsite, goethite, quartz and anatase. Braz (2011) did not observe large variations between the soils of the Amazon region, in relation to mineralogical composition and several soils presented in the clay fraction predominantly kaolinite. The author reports that the soils that are influenced by groundwater showed peaks of chlorite. In this context, the present study aimed to characterize the mineralogy of soils from the Amazonia sedimentary basin.

MATERIAL AND METHODS

Soils of different classes of upland and lowland parts of the landscape were collected. In air dried soil samples it was performed separation of the clay and silt fractions by sedimentation and sand fractions by wet sieving (Jackson, 1979; EMBRAPA, 1997). The slides of natural and treated clays were mounted as powder and smear samples. The sand and silt fractions were analyzed as powder samples. The samples, in which there was the presence of 2:1 silicate minerals, were treated for differentiation through magnesium saturation and solvation with glycerol.

The qualitative identification of minerals of sand, silt and clay was carried out by X-ray diffraction (XRD), with an X'Pert PRO instrument using CoKα radiation in the range of 4 to 50° 2θ in steps of 0.01° 2θ per second with at 40 kV and 40 mA.

RESULTS AND DISCUSSION

The soils showed differences in their mineralogical compositions, as the different soil classes to which they belong (Table 1). For these soils, it can be seen a clear differentiation as far as the drainage conditions are concerned. Soils without drainage problem showed their composition with predominance of kaolinite and quartz only. On the other hand, soils subjected to flooding regimes and insufficient drainage conditions have a different mineralogy and the presence of the 2:1 type clay minerals such as smectite and chlorite are clearly seen. In general there was some similarity in terms of the mineralogical composition of the various horizons within each soils.

Table 1. Mineralogical composition of sand, silt and clay fractions

Sample	Horizon	Depth	Sand	Silt	Clay[1]
		cm			
			Yellow Latosol (Oxisol)		
1	A1	0-10	Ct, Qz, An	Ct, Qz, Gt, An	Ct, Gt, An, Pg
3	Bw	~100	Ct, Qz, An	Ct, Qz, Gt, An	Ct, Gt, An, Pg
			Yellow Argisol (Ultisol)		
4	A1	0-10	Qz, Ct	Ct, An, Gt, Qz	Ct, Gt, An
6	Bt	~100	Qz, Ct	Ct, An, Gt, Qz	Ct, Gt, An
			Quartzipsamments Neosol (Entisol)		
7	A1	0-10	Fd, Mc, Pg, Ct	Cl, Il, Ct, Qz, Pg, An, Es	Ct, Il, An
9	C	50+	Fd, Mc, Pg, Ct	Cl, Il, Ct, Qz, Pg, An, Es	Ct, Il, An
			Gleisol (Entisol)		
10	A1	0-10	Es, Il, Ct, Qz, Fd	Il, Ct, Qz, Fd	Es, Ct, Il, Qz
13	C	80+	Es, Il, Ct, Qz, Fd	Il, Ct, Qz, Fd	Es, Ct, Il, Qz
			Fluvic Neosol (Entisol)		
14	A1	0-10	Es, Qz, Pg, Mc, Fd	Es, Il, Ct, Qz, Fd	Es, Cl, Il, Ct, Qz
17	C	100+	Es, Qz, Pg, Mc, Fd	Es, Il, Ct, Qz, Fd	Es, Cl, Il, Ct, Qz
			Archaeological Black Earth (Terra Preta de Índio)		
18	A1	0-10	Qz	Ct, Qz, An, Fd	Ct, Gt, Fd, An
21	Bt	100+	Qz	Ct, Qz, An, Fd	Ct, Gt, Fd, An
			Plintosol (plinthic soil)		
22	A1	0-10	Ct, Hm, Qz, Gt	Ct, Hm, Gt, An, Qz	Ct, An, Qz, Gt, Hm
26	C	120+	Ct, Hm, Qz, Gt	Ct, Hm, Gt, An, Qz	Ct, An, Qz, Gt, Hm
			Quartzipsamments Neosol (Entisol)		
27	A1	0-10	Qz, Ct, Il	Ct, Qz	NO[2]
29	C	50+	Qz, Ct, Il	Ct, Qz	NO[2]
			Spodosol (Spodic soil)		
30	A1	0-10	Qz, Mc	Ct, Qz, Il	Ct, Qz, An, Hm, Gt

33	Bs	50-60	Qz, Mc	Ct, Qz, Il	Ct, Qz, An, Hm, Gt

[1]Natural clay non oriented; [2]Not obtained; Ct-kaolinite; Gt-Goethite; Il-ilite; Qz-quartz; An-anatase; Mc-mica; Fd-Feldspar; Hm-Hematite; Es-esmectite; Cl-chlorite.

CONCLUSION

The soils have different mineralogical compositions according to their position in the landscape. Lowland soils showed a mineralogy of 2:1 clay minerals in greater quantities than those found on upland soils. Smectites, chlorites and illites were found in appreciable amounts in the lowland soils, whereas kaolinite, goethite, hematite and anatase were predominat in the upland soils. Gibbsite was virtually absent in all soils, even in the more developed ones such as the Oxisols and Ultisols.

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