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Study of Clay Minerals in Venezuelan Plains Soils

V.S. SHRIVASTAVA*, J.A. ALFONSO†, Z. BENZO†, S. FLORES‡ and J.E. PAOLINI‡
Centre for P.G. Research in Chemistry, G.T.P. College, Nandurbar-425 412, India
E-mail: drvinod_shrivastava@yahoo.com

Clay minerals from soil samples were collected at different horizons from Savanna vegetation areas of Venezuela, which are known as Orinoco Llanos. The samples were settled and concentrated by the centrifuge method, for the extraction of clay. X-ray diffraction and scan electron microscopy analyses have been carried out for the samples. The analysis indicate that the clay samples contain mainly quartz (silica), illite and kaolinite minerals, while smectite was found in trace amount.

Key Words: Clay, Minerals, Venezuelan plains, Soils.

INTRODUCTION

Venezuela is characterized by the presence of vast plains covered by savanna vegetation, which are known as Orinoco Llanos[1]. The Venezuelan plains or lianos are among the most extensive fluvial plains in the world. Generally the plains are thought to consist of older and younger alluvia. The older alluvium marked by higher degree of pedogenesis[2] has been usually assigned to a lower pleistocene age[3] or minimum age of 120,000 years[4].

X-ray diffraction (XRD) is the best technique for the identification and quantification of all minerals present. Quantitative minerals analysis is important in petrologic studies, engineering and industrial applications of rocks that contain clay minerals. This technique[5] permits reproducible and accurate calculation of the mineral content of rocks including the major clay mineral families, Fe rich chlorides + berthierine, Mg rich chlorides, Fe rich dioctahedral 2:1 clay and micas, Al rich octahedral 2:1 clays and micas and kaolinites.

In the recent years, there has been improvement to facilitate quantification by XRD methods such as Mudmaster[6], Decompxr[7], Winfit[8], Macfit[9] and MacDiff[10] 4.1.2. All these, increase the ability to reduce overlapping peak interference and analyze peaks shape to obtain more reliable intensity estimates. Details of the general decomposition approach was described by Lanson[11]. It can be applied to improve XRD results from a variety of

†Chemistry Center, IVIC, Caracas, Venezuela.
‡Ecology Center, IVIC, Caracas, Venezuela.

samples. Other computer programs, such as NEWMOD[12]. Interstrat[13], MULCALC[14], the multispecimen method[15] or expert system[16] have been developed to stimulate XRD pattern or assist in the qualitative and quantitative analysis of clay minerals assemblages.

The formation of clay minerals during pedogenesis is the most fundamental process and temperature and drainage are the principle controls of clay minerals formation; these factors reflect climate and relief[17].

This study presents the XRD, SEM characterization and the interpretation of clay minerals assemblages in the Venezuelan plains soils of the Savanna region near the Orinoco river.

EXPERIMENTAL

A Siemens D 5005 X-ray diffractometer with a CuK_α radfiation tube was used. Philips XL 20 scanning electron microscope equipped with energy dispersive analysis system was used for SEM analysis.

Different soil profile samples were collected at different locations from the Venezuelan savanna plains near Orinoco river in polythene bags and brought to the laboratory. Samples were air dried, grinned and sieved through 63 μm, stored in glass bottles for further study.

50 g of fine powdered soil sample was weighed and diluted to 1 L with distilled water, shaked for 0.5 h and the supernatant was separated by gravity sedimentation. Samples for X-ray diffraction analysis were prepared following the Millipore filter transfer method[18].

RESULTS AND DISCUSSION

The results obtained during the course of this study are given in Table-1 and XRD diffractogram and SEM analysis are being presented in Figs. 1-4.

X-ray diffraction: X-ray diffraction is one of the most versatile techniques for materials characterization. The XRD results indicate that the main constituents of these clays samples quartz, kaolinite, illite and very small amount of the smectite and other minerals are present. The scans of the clay from all the samples are more or less similar and shown in Figs. 1-3. All the scan show a broad quartz peak centered from 3.3-3.5 Å. A sharpen asymmetric peak at about 9.7 Å and a slightly asymmetric kaolinite peak was observed at 6.9-7.1 Å. A symmetry of the peak result from a combination of changing LP factors and the presence of interstratified illite/smectite. Using the diffrac-plus software were fitted to the pattern, one is for quartz and kaolinite and two in the region of the illite reflection. The comparison used a pseudo-Voigt shape algorithm with splitful width at half maximum parameters each pattern was filled in the illite 001 region with a slightly asymmetric, peak spacing at 9.7 Å and much more symmetric peak, with its maximum range of a spacing from 8.44-8.70 Å. Comparison with calculated pattern for interstratified illite/smectite using Newmode[19] indicates that both the observed asymmetry and peak maximum for the illite/quartz components match reasonable well with the calculated pattern for the illite 80-90 %, quartz 20-10 % in the interstratified face by comparing the integrated peak intensities to calculate profiles was possible to estimate the proportion of each clay type.

TABLE-1
GENERAL CHARACTERISTICS AND MINERALS OBSERVED BY X-RAY DIFFRACTION ANALYSIS

S. No.	Sites of sample collection	General characteristics	Main minerals observed
1	High plains, Gaurico state	Depth : (99-125) cm Vegetation: Forest	Quartz kaolinite
2	High plains, Calabozo Gaurico state	Depth : (96-120) cm Vegetation: Trachypogon, Axonopos	Quartz kaolinite
3	High plains, Calabozo Gaurico state	Depth : (7-24) cm Vegetation: Trachypogon, Axonopos	Quartz kaolinite
4	High plains, Calabozo Gaurico state	Depth : (63-101) cm Vegetation: Trachypogon, Axonopos	Quartz kaolinite
5	Near Apure river (low plains, Apure river)	Depth : (0-20) cm Vegetation: flooded Savanna	Quartz kaolinite illite
6	Near Apure river (low plains, Apure river)	Depth : (0-20) cm	Quartz kaolinite illite
7	Near Apure river (low plains, Apure river)	Depth : (0-20) cm	Quartz kaolinite illite

Even through, further work is needed to substantiate these associations between position in the landscape and clay mineralogy. Present results indicate that soils in different locations must be managed differently in terms of the type and amount of ameliorate required to overcome problems of hardsettings.

Scan electron microscopy (SEM): The scanning electron microscopy is the first analytical instrument used for quick observations[20]. The optical microscope can be used for imaging the surface but it has limitations of resolution and depth of the field at higher magnification. The SEM can be used for high resolution imaging of the surface, with a large depth of field. Out of the XRD analysis of the samples, we have scanned four clay samples by scanning electron microscopy analysis.

The arrangement of particles size average of the obtained liquid phase was investigated by SEM. Fig. 4 shows the microscopy typical clay particle size from the different soil profiles. These are different (corresponding different clay minerals), in the same crystal, confirming the presence of

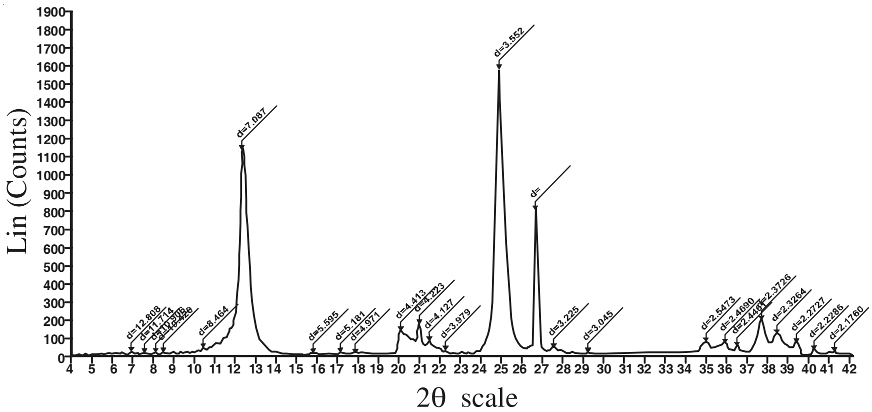

Fig. 1. Representative XRD diagram of the < 2 μm fraction of high plain soil under forest vegetation, horizont 96-120 cm

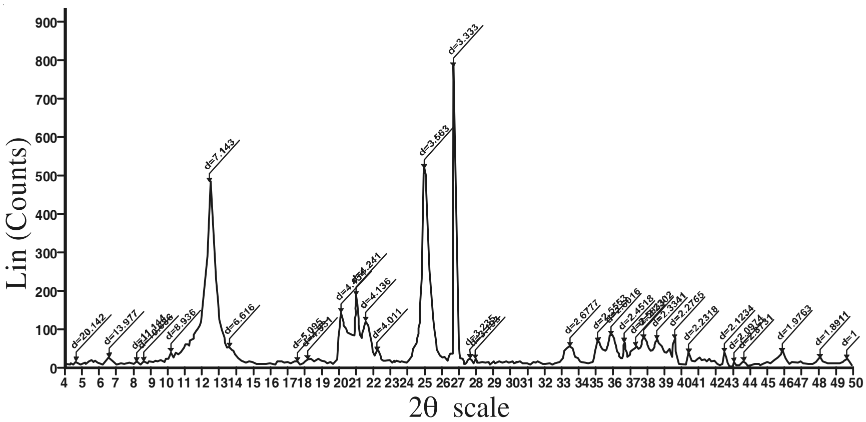

Fig. 2 Representative XRD diagram of the < 2 μm fraction of high plain soil under Savanna vegetation, horizont 7-24 cm

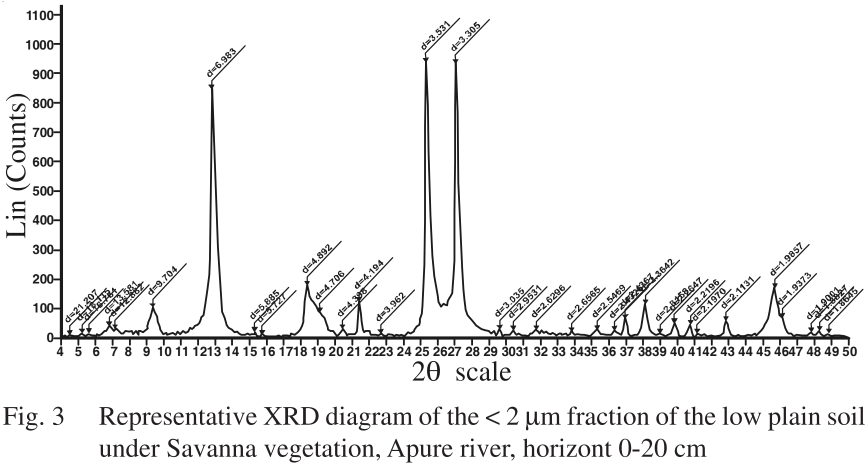

Fig. 3 Representative XRD diagram of the < 2 μm fraction of the low plain soil under Savanna vegetation, Apure river, horizont 0-20 cm

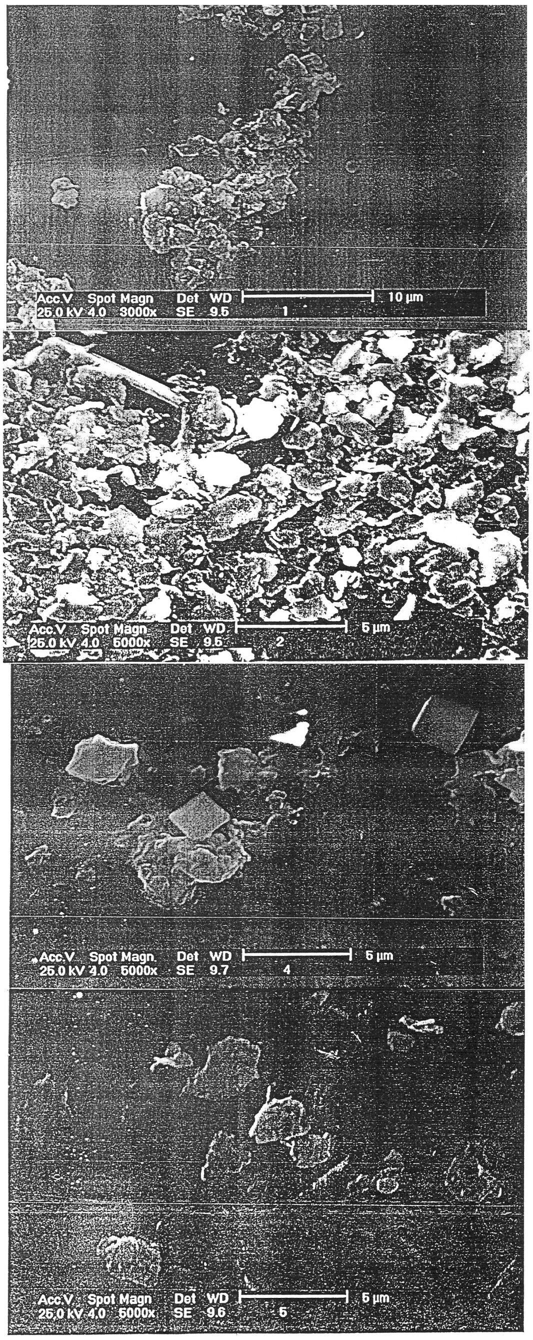

Fig. 4. Representative XRD diagram SEM photograph:
1) High plain soil (Forest), horizont 99-120 cm
2) High plain soil (Trachy Pogon), horizont 99-120 cm
3) High plain soil (Axonopos), horizont 63-120 cm
4) Apure low plain soil, horizont 0-20 cm

interstratified clays. SEM photographs clearly indicate the presence of quartz, kaolinite and illite minerals. These results also demonstrate the goodness of the particle size separation method (clay-size fraction).

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