Clay Mineralogy of Assam Soils Developed in Alluvium

D. N. CHAKRAVORTY[1], J.L. SEHGAL[2], D.K. PAL[2] AND G. DEV[3]

Soils Department, Punjab Agricultural University, Ludhiana

Abstract *: Eight alluviumderived soils from the southern bank of the Brahmaputra river in Assam were investigated for clay mineralogy by X-ray diffraction technique. The study suggests an almost similar clay mineralogical make-up consisting of clay mica, mixed-layer minerals, vermiculite, smectite and kaolinite. In general, kaolinite content is more than vermiculite/smectite in the coarse clay fractions (2-0.2 μm), whereas a reverse trend is observed in the fine clay fractions. The observed hydroxy interlayering in vermiculite/smectite and also the interstratification of smectite-kaolinite are believed to have occurred in the low soil pH conditions induced by the intense weathering resulting from thermic temperature and udic moisture regimes prevailing in the study area.*

Studies on the formation of clay minerals in high rainfall zones of north-eastern part of the country are meagre (Ghosh & Kapoor 1982; Sahu *et al.* 1986). The present investigation is an attempt to provide basic information in this regard which will be helpful in better understanding the pedogenesis in the alluvium of Brahmaputra valley.

MATERIALS AND METHODS

The study area forms a portion of the southern bank of the Brahmaputra valley in Assam. It is bounded by mighty Brahmaputra river in the north and Assam plateau in the south. The area is situated between 25°35' to 27°10' N latitude and 91°31' to 94°18' E longitude. Three pedons from the eastern region (P1, P2 and P3), two pedons from the middle region (P4 and P5) and three pedons from the western region (P6, P7 and P8) were selected. The soils show definite profile development ranging from A-C to A-Bt-C soils (Entisols-Inceptisols-Alfisols). physical and chemical properties of the soils studied have been reported elsewhere (Chakravorty, 1977).

The Brahmaputra alluvia are derived from a variety of igneous, metamorphic and sedimentary rocks occurring in Assam plateau and Assam Himalayas. The sand fractions of the soils contain quartz, zircon, biotite, muscovite, feldspar and chlorite (Chakravrty, 1977).

The clay fractions (2-0.2 μm and less than 0.2 μm) were separated from soil samples after dispersion according to size segregation procedure of Jackson (1956). Parallel oriented Mg/K saturated clay samples were subjected to X-ray analysis in a Philips diffractometer using Ni-filtered Cu K α radiation and a scanning speed of 1°20/min. Clay minerals were identified according to the procedure outlined by Jackson (1956).

1.College of Agriculture, Assam Agric. Univ., Jorhat (Assam); 2. National Bureau of Soil Survey and Land Use Planning, Nagpur-440 010; 3. Potash Research Institute of India, Gurgaon, Haryana

TABLE 1. Relative estimates of clay mineral assemblage in soils

Physiographic location	Clay size	Mica	Mixed-layer mineral		Vermi-culite	Smectite	Kaolinite
			1.0-1.4	0.7-1.4			
			<------- nm -------->				
Pedon P1: Aeric Ochraqualf							
Upland	Coarse	++	+	-	+	+	++++
	Fine	+	+	+	+	++++	++
Pedon P2: Aeric Haplaquept							
Old flood plain	Coarse	++	+	-	+	+	++++
	Fine	++	+	+	-	++++	++
Pedon P3: Aeric Haplaquept							
Old flood plain	Coarse	+	+	-	++++	+	++
	Fine	+	+	-	++++	+	++
Pedon P4: Typic Paleudalf							
Upland	Coarse	+	+	-	+	++	++++
	Fine	+	+	+	+	++++	++
Pedon P5: Aeric Haplaquept							
Old channel	Coarse	+	+	-	+	++	++++
	Fine	+	+	-	+	++	++++
Pedon P6: Typic Paleudalf							
Upland	Coarse	+	+	-	++	-	++
	Fine	+	+	+	++++	-	++
Pedon P7: Aeric Ochraqualf							
Old flood plain	Coarse	+	+	+	-	+ +	++
	Fine	++	+	-	+	-	++++
Pedon P8: Thaptopaleudalfic Udorthent							
Recent flood	Coarse	++	+	-	+	-	++
plain	Fine	++	+	+	+	-	++++

+ = Relative abundance ; – = Not present

RESULTS AND DISCUSSION

Mineralogy of the coarse and fine clay fractions: The data (Table 1) indicate that the soils have an almost similar clay mineral assemblage. Consisting of mica, mixed-layers of 1.0-1.4 and 0.7- 1.4 nm minerals, vermiculite, smectite and kaolinite. Relative XRD intensity of minerals indicate that the kaolinite content is more than vermiculite/smectite in the coarse clay fractions of pedons P1, P2, P4, P5, P6, P7 and P8, whereas a reverse trend is observed in the fine clay fractions, except in pedons P5, P7 and P8 wherein both the clay fractions are dominated by kaolinite.

XRD diagrams of representative soil clay fractions are given in figure 1 which shows that the 1.4 nm peak on glycerolation shifted to high angle spacing ranging from 1.63 to almost 1.9 nm indicating the presence of smectite. The presence of such expanding lattice minerals in these acid soils is not uncommon (Sahu *et al.* 1986; Pal & Durge, 1989). In many a soils, a part of 1.4 nm remained after glycerol treatment and collapsed to 1.0 nm on heating K-clay to 550°C. This indicates the presence of vermiculite. The peaks at 1.22 and 0.8 nm were found to persist even after heating to 550°C, indicating the presence of chloritic layers in mixed-layer (1.0-1.4 nm) minerals. Smectite and/or vermiculite on K saturation and subsequent heating to 550°C collapsed to 1.0 nm leaving shoulders and broadening on the low angle side of the 1.0 nm peak. This indicates chloritisation of smectite/vermiculite interlayers due to the induction of hydroxy Al-interlayering; a chemical process quite common in acid soils of Assam (Pal *et al.* 1987). Such interlayering is facilitated at low soil pH condition (Rich 1968).

In the fine clay fractions of the surface soils of pedons P1, P2, P4, P6, P7, P8 and also beyond the lithological discontinuity zone of pedons 5 and 8, a peak around 0.75 - 0.76 nm appeared on glycerolation. The same

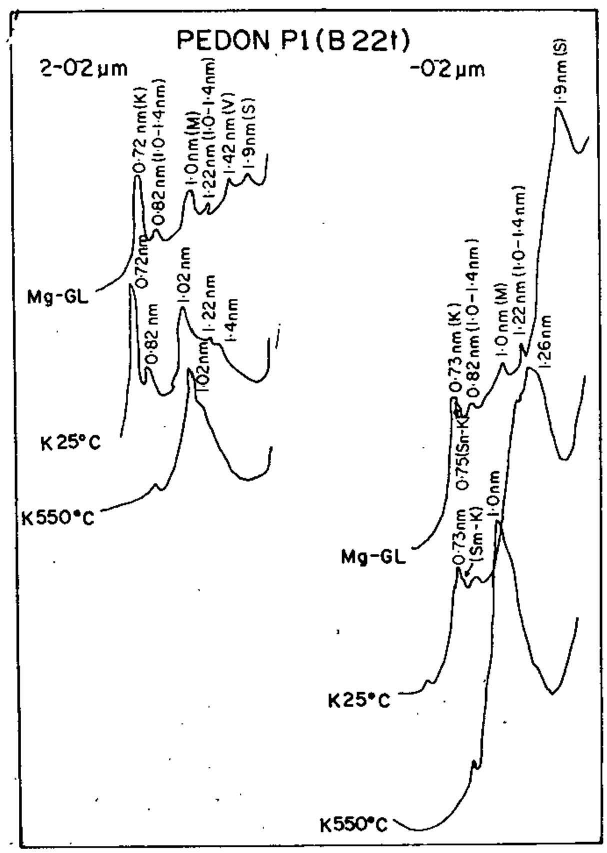

Figure 1.

XRD of clay fraction Mg-Gl=Mg saturated and Gycerolated; K25° / 550° = K saturated and heated; S/Sm smectite; K=Kaolinite; M=Mica; V=Vermiculite feature is similar to one described by many workers (Herbillon *et al.* 1981; Tomar, 1985; Yerima *et al.* 1985) for irregular interstratification of kaolinite and smectite. The position of the peak was not significantly affected by K saturation and heating to 300°C, indicating partial filling of smectite interlayers with hydroxy aluminium polymers (Herbillon *et al.* 1981).

Genesis of clay minerals: The 1.0 nm peak of mica is broader and more asymmetrical towards low angles in the clay fractions. These characters indicate the replacement of interlayer K of mica. Presence of mica, mixed-layer minerals (1.0-1.4 nm), vermiculite and smectite indicates that these minerals appeared to have originated from mica. During the early stage of weathering, mica involved in its expansion to 1.0-1.4 nm minerals with concurrent formation of vermiculite. As the weathering continued, progressive build up of the 1.0-1.4 nm minerals, followed by the formation of vermiculite and smectite appears to have occurred. Kaolinite has developed at the expense of smectite through smectite-kaolinite intermediate phase. The lack of evidence of such an intermediate phase in other pedons may be due to the dilution effect with the subsequent enrichment of kaolinite formation (Herbillon *et al.* 1981). However, the formation of kaolinite from the weathering of feldspars may not be totally ruled out.

It is difficult to conclude whether such transformation of minerals occurred during pre-or post depositional period of the alluvia. The similarity in the mineralogy among and within the pedons, even beyond the zone of lithological discontinuity, indicates that the weathering of minerals might have taken place in the source area and that the minerals were transported and deposited as alluvia in the valley. However, considering the extent of pedogenesis in these alluvium derived soils developed under thermic, humid climate (Chakravorty 1977), the possibility of *in-situ* weathering of micas, especially biotite, during post depositional period can not be discounted.

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