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Mineralogy of Soils from Different Agroecological Regions of Bangladesh: Region 25 – Level Barind Tract and Region 27 – North–eastern Barind Tract

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Bangladesh has been divided into 30 Agroecological Regions (AEZs) and the applied agricultural research has currently been conducted on this basis. In context of the lack of enough mineralogical information on the AEZ basis, an attempt has been taken to study mineralogy of important soils from all AEZs of Bangladesh in order to provide basic information for applied research. As a part of this attempt, the mineralogy of twelve soils from AEZ 25, Level Barind Tract, and that of ten soils from AEZ 27, North–eastern Barind Tract, has been reported in this paper. The soils of both AEZs were acidic in nature, had moderate to high amounts of clay, and the texture was medium (silt loam) to heavy (clay). The 2–20 μm silt fraction was composed mainly of quartz, with small amounts of mica, plagioclase, K–feldspar and in some cases chlorite. Mica, kaolinite and the interstratified kaolinite–smectite and mica–vermiculite–smectite minerals were predominant minerals in the $<2\,\mu$m clay fraction. The impact of genesis and weathering on the mineralogy of soils from the two AEZs has been discussed.

INTRODUCTION

Bangladesh is an agro–based country having a total land area of 147,570 km^2 (BBS, 2001). It has been divided into 30 Agroecological Regions (popularly known as AEZs) based on physiography, inundation land types, soils, and agroclimate (FAO–UNDP, 1988); refer to the previous paper (Islam *et al*., 2003) for the map of AEZs. Agricultural research, and technology generation and transfer etc. are now going on the AEZ basis. Mineralogical study emphasizing the AEZs of Bangladesh has not been carried out, although it is very important to have an idea on genesis, physico–chemical properties, nutrient behavior as well as inherent potentiality of soils. Under this concept, we have started analyzing the mineralogy of important soils from all AEZs of Bangladesh.

The present piece of work focused on the soils of the Level Barind Tract (AEZ 25) and North–eastern Barind Tract (AEZ 27) developed on Madhupur Clay. The AEZ 25 occupies about 80 percent of the Barind Tract and covers Dinajpur, Gaibandha, Jaipurhat, Naogaon, Natore, Rajshahi and Sirajganj Districts with an area of 5,049 km^2. This region is almost level, with 60–90 cm local differences in elevation. Relief is locally irregular near entrenched river channels with shallow gullies cutting back into the adjoining plain land. All soils become very dry in the surface during the dry season. Twelve general soil types occur in the region, of which Deep Grey Terrace Soils, Shallow Grey Terrace Soils and Brown Mottled Terrace Soils are predominant (FAO–UNDP, 1988).

On the other hand, AEZ 27 occupies an area of 1,079 km^2 comprising parts of Bogra, Dinajpur, Rangpur, Gaibandha and Joipurhat Districts. This region occupies about 10% of the Barind Tract, of them mainly occupies the northeastern and eastern edges of the Barind Tract which stand slightly higher than the adjoining floodplain land. Small interior areas lie slightly higher than the adjoining Level Barind Tract land and have been slightly dissected. Seven general soil types are found in this AEZ, of which Deep Red Brown Terrace Soils occupies 59% and Brown Mottled Terrace Soils occupies 20% of this AEZ (FAO–UNDP, 1988).

Very few works on the mineralogy of the soils from the Level Barind Tract have been reported so far while no report is available for the soils of the North–eastern Barind Tract (Egashira, 1988; Moslehuddin and Egashira, 1996). Moslehuddin *et al*. (1999), while preparing a tentative clay mineralogical map of Bangladesh, put soils of these AEZs in the mica–mixed–layer–minerals–kaolinite suite, where mica, interstratified mica–vermiculite–smectite, interstratified kaolinite–smectite, and kaolinite are major minerals. More study may be required to understand the comprehensiveness of this. The present study was planned to clarify the mineralogical composition of the Level Barind Tract and North–eastern Barind Tract and to verify the proposed mineralogical suite for these AEZs.

MATERIALS AND METHODS

Soils used

Major soil series of the two AEZs under study were identified from the semi–detailed soil survey reports of different Upazilas covering the area. Twelve samples representing twelve soil series of AEZ 25 and ten sam-

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ples of ten soil series of AEZ 27 were collected from the 0–15 cm depth. General features of these soils are presented in Tables 1a and 1b. The soil samples were dried at room temperature, crushed, mixed thoroughly, sieved with a 2–mm sieve and preserved in plastic bags for subsequent laboratory analyses.

Determination of pH and EC

The pH was determined by a glass–electrode pH meter in the soil suspension having a soil:water ratio of 1:2.5, after 30–min shaking. The electrical conductivity (EC) was measured by a EC meter in the soil suspension having a soil:water ratio of 1:5, after 30–min shaking.

Particle–size analysis

The soil samples were treated with hot 7% H_2O_2 to decompose organic matter, dispersed by mechanical stirring and adjusted to the pH 10 using 1 M NaOH. The <2 μm clay fraction was separated by repeated stirring–sedimentation–siphoning. The 2–20 μm fraction was separated by repeated sedimentation and siphoning, and the 20–53, 53–212 and 212–2,000 μm fractions were separated by wet–sieving. Weights of each fraction were determined to calculate the particle–size distribution.

Mineralogical analysis

Specimens for X–ray diffraction (XRD) of the clay fraction were prepared by taking duplicate clay sols containing 50 mg of clay (<2 μm). Of the duplicate sets, one was saturated with K and the other with Mg by washing three times with 1 M KCl and 0.5 M $MgCl_2$, respectively. Excess salt was removed by washing one time with water. An aliquot of 0.4 mL of the clay sol was dropped onto a glass slide (28×48 mm), covering two–thirds of its area, air–dried, and X–rayed (parallel powder mount). XRD patterns were obtained using a Rigaku X–ray diffractometer with CuKα radiation at 40 kV and 20 mA and at a scanning speed of 2° 2θ min^{-1} over a range of 3 to 30° 2θ. In addition to the air–dried specimen, the Mg–saturated clay was X–rayed after solvation with glycerol, and the K–saturated clay was X–rayed after heating at 300 and 550 °C for 2 hr.

Table 1a. General information of the soils from AEZ 25

Soil series	Location	Land type[1)]	General soil type[2)]	USDA Soil Taxonomy	Vegetation
Pauli	Vill.: Arian Upazila:Tanore Dist.: Rajshahi	MHL	Grey Valley Soil	Aeric Albaquepts	Boro, T. Aman, Vegetables
Nachol	Vill.: Notun para Upazila: Tanore Dist.: Rajshahi	HL	Grey Valley Soil	Aeric Paleaquults	T. Amon, Gram, Wheat, Vegetables, Fruits
Atahar	Vill.: Sadipur Upazila: Tanore Dist.: Rajshahi	HL	Deep Grey Terrace Soil	Aeric Albaquepts	T. Aman, Gram, Wheat, Vegetables, Fruits
Dudhnai	Vill.: Chandpur Upazila: Tanore Dist.: Rajshahi	MHL	Deep Grey Terrace Soil	Typic Ustochrepts	T. Amon, Gram, Wheat, Vegetables, Fruits
Amnura	Vill.: Chinasho Uapzila: Tanore Dist.: Rajshahi	HL	Deep Grey Terrace Soil	Aeric Albaquepts	T. Aman, Lentil, Wheat
Nijhuri	Vill.: Amsho Upazila: Tanore Dist.: Rajshahi	HL	Deep Grey Terrace Soil	Aeric Albaquepts	Boro, T. Aman, Jute, Wheat
Noadda	Vill.: Chanduria Upazila: Tanore Dist.: Rajshahi	MHL	Brown Mottled Terrace Soil	Ultic Ustochrepts	T. Aman, Wheat
Ekdala	Vill.: Buruz Upazila: Tanore Dist.: Rajshahi	HL	Shallow Grey Terrace Soil	Aeric Albaquepts	Boro, T. Aman, Wheat, Mustard, Gram
Belabo	Vill.: Najipur Upazila: Patnitala Dist.: Naogaon	HL	Deep Red–Brown Terrace Soil	Ultic Ustochrepts	T. Aman, Gram, Wheat, Vegetables, Fruits
Lauta	Vill.: Najipur Upazila: Patnitala Dist.: Naogaon	MHL	Shallow Grey Terrace Soil	Aeric Albaquepts	Boro, T. Aman, Jute, Wheat
Kahalu	Vill.: Bilchakla Upazila: Sherpur Dist.: Bogra	MHL	Shallow Grey Terrace Soil	Ultic Ustochrepts	T. Aman, Wheat, Jute
Sahapur	Vill.: Betra Upazila: Gobindaganj Dist.: Gaibandha	MHL	Deep Grey Terrace Soil	Typic Albaquepts	Boro, T. Aman, Maize

[1)] Land type: HL, highland; MHL, medium highland. HL: land which is above the normal flood level; MHL: land which is normally flooded up to a depth of about 90 cm during the monsoon season.
[2)] Soil classification based on the Bangladesh system.

Table 1b. General information of the soils from AEZ 27

Soil series	Location	Land type[1)]	General soil type[2)]	USDA Soil Taxonomy	Vegetation
Amnura	Vill.: Sadhu bari Upazila: Sherpur Dist.: Bogra	MHL	Brown Mottled Terrace Soil	Ultic Ustochrepts	Jute–T. Aman–Potato
Tejgaon	Vill.: Katabari Upazila: Gobindaganj Dist.: Gaibanda	MHL	Deep Red–Brown Terrace Soil	Aquic Ustochrepts	Boro–Maize–Potato
Kahalu	Vill.: Bilchakla Upazila: Sherpur Dist.: Bogra	MHL	Brown Mottled Terrace Soil	Ultic Ustochrepts	Maize–T. Aman–Boro
Lauta	Vill.: Betra Upazila: Gobindaganj Dist.: Gaibanda	MHL	Brown Mottled Terrace Soil	Ultic Ustochrepts	Boro–T. Aman–Potato
Noadda	Vill.: Mahipur Upazila: Sherpur Dist.: Bogra	HL	Deep Grey Terrace Soil	Ultic Ustochrepts	Aus–T. Aman–Potato
Nachol	Vill.: Bilchakla Upazila: Sherpur Dist.: Bogra	MHL	Deep Grey Terrace Soil	Aeric Paleaquults	Jute–T. Aman–Boro
Sahapur	Vill.: Betra Upazila: Gobindaganj Dist.: Gaibanda	HL	Deep Grey Terrace Soil	Aeric Paleaquults	Jute–Fallow–Boro
Ekdala	Vill.: Bon Moricha Upazila: Sherpur Dist.: Bogra	HL	Brown Mottled Terrace Soil	Aeric Paleaquults	Maize–T. Aman–Boro
Belabo	Vill.: Bon Moricha Upazila: Sherpur Dist.: Bogra	HL	Deep Red–Brown Terrace Soil	Ultic Ustochrepts	Jute–T. Aman–Potato
Kashimpur	Vill.: Fulhara Upazila: Nawabgonj Dist.: Dinajpur	HL	Deep Red–Brown Terrace Soil	Typic Haplustalf	Aus–T. Aman–Mustard

[1)] Land type: HL, highland; MHL, medium highland. HL: land which is above the normal flood level; MHL: land which is normally flooded up to a depth of about 90 cm during the monsoon season.
[2)] Soil classification based on the Bangladesh system.

For the silt fraction, the specimen was prepared by packing the 2–20 μm silt fraction into a groove of a glass slide (random powder mount) and was X–rayed using the same condition as for the clay specimen.

RESULTS

pH and EC

The soils of the Level Barind Tract (AEZ 25) and North–eastern Barind Tract (AEZ 27) were found to be acidic in nature having the pH values varied from 4.9 to 6.5 and from 5.3 to 6.5, respectively. The EC ranged from 0.02 to 0.06 dS m^{-1} for the AEZ 25 soils and from 0.01 to 0.05 dS m^{-1} for the AEZ 27 soils, indicating non–saline nature of these soils (Table 2).

Particle–size distribution

Particle–size distribution and textural classes of the soils as determined by the USDA system are shown in Table 2. The clay (<2 μm) content in the AEZ 25 soils varied widely from 12% in the Ekdala soil to 39% in the Noadda soil. The Nachol, Nijhuri and Belabo soils had lower amounts of clay (14 to 19%) while the Pauli and Sahapur soils had good amounts of clay (32 and 38%). Other soils had moderate amounts of clay ranging from 20 to 28%. On the other hand, the clay content of the AEZ 27 soils ranged from 21% in the Belabo soil to 48% in the Nachol soil. Other soils also had moderate to good amounts of clay (22 to 42%). Considerable amounts of clay in these soils are supposed to be inherited from their parent material of Madhupur Clay. In general, soils located on the higher sites had the lower clay content than those on the lower sites. This is due mainly to deposition of finer particles in the lower position from the surrounding upper elevation through run–off water. Higher amounts of clay may also be associated with the greater extent of weathering.

The 2–20 μm silt fraction varied from 22 to 63% for the AEZ 25 soils and 18 to 35% for the AEZ 27 soils. Seven out of twelve soils in AEZ 25 and four out of ten soils in AEZ 27 had this fraction dominating over all other fractions. The 20–53 μm fraction varied widely (8 to 40%) in the AEZ 25 soils but within a narrow range (19 to 30%) in the AEZ 27 soils.

The 53–212 μm sand fraction ranged from 1 to 34% for the AEZ 25 soils and from 4 to 26% for the AEZ 27 soils. The amount of coarse sand (212–2,000 μm) fraction was found in a low range between 0 and 5% except the Nijhuri (10%) soil in case of AEZ 25 while between 1 and 6% in the AEZ 27 soils. No marked relationship between particle–size distribution and general soil type was observed.

According to the USDA system for textural classes of the AEZ 25 soils, the Noadda and Sahapur soils belonged to clay loam, the Pauli soil to silty clay loam, the Nijhuri and Ekdala soils to sandy loam, and others to loam. In case of the AEZ 27 soils, the Nachol soil belonged to clay, the Amnura soil to silty clay, the Tejgaon and Lauta soils to silty clay loam, the Kahalu soil to loam, and others to silt loam. Egashira (1988) found the texture of terrace soils (surface horizon) as loam to silty clay loam according to the USDA system, which was almost similar to the present findings.

Mineralogy of the silt fraction

The approximate mineral composition of the 2–20 μm silt fraction is shown in Table 3. Calculation was made based on the relative peak intensities of the

Table 2. pH and EC, and particle–size distribution and texture of soils

AEZ	Soil series	pH	EC (dS m^{-1})	Particle–size distribution (%)					Soil texture (USDA)
				<2 μm	2–20 μm	20–53 μm	53–212 μm	212–2,000 μm	
Level Barind Tract	Pauli	5.0	0.03	32	59	8	1	0	Silty clay loam
	Nachol	5.9	0.02	18	63	17	2	0	Loam
	Atahar	6.2	0.03	25	29	33	12	1	Loam
	Dudhnai	6.4	0.04	27	36	29	7	1	Loam
	Amnura	6.2	0.03	20	34	40	5	1	Loam
	Nijhuri	6.5	0.05	14	29	28	19	10	Sandy loam
	Noadda	4.9	0.03	39	22	24	12	3	Clay loam
	Ekdala	5.9	0.02	12	26	24	34	4	Sandy loam
	Belabo	5.7	0.02	19	38	30	10	3	Loam
	Lauta	6.1	0.04	25	32	24	14	5	Loam
	Kahalu	6.4	0.06	28	30	24	16	2	Loam
	Sahapur	6.1	0.04	38	32	22	3	5	Clay loam
North–eastern Barind Tract	Amnura	5.4	0.03	42	34	19	4	1	Silty clay
	Tejgaon	5.3	0.02	37	35	20	7	1	Silty clay loam
	Kahalu	6.3	0.03	26	26	23	24	1	Loam
	Lauta	6.4	0.04	37	29	24	4	6	Silty clay loam
	Noadda	6.3	0.03	27	33	28	11	1	Silt loam
	Nachol	6.2	0.02	48	18	19	13	2	Clay
	Sahapur	6.5	0.02	23	24	26	26	1	Silt loam
	Ekdala	6.3	0.05	24	32	23	20	1	Silt loam
	Belabo	5.5	0.01	21	35	30	11	3	Silt loam
	Kashimpur	6.2	0.04	22	31	28	14	5	Silt loam

Table 3. Approximate mineral contents (%) in the silt fraction (2–20 μm) of soils

AEZ	Soil series	Minerals[1]				
		Mc	Ch	Qr	K–fd	Pl
Level Barind Tract	Pauli	4	–	92	2	2
	Nachol	3	–	91	2	4
	Atahar	2	–	83	5	10
	Dudhnai	8	–	83	2	4
	Amnura	3	–	87	3	4
	Nijhuri	3	–	90	3	5
	Noadda	9	–	88	4	9
	Ekdala	32	–	48	2	18
	Belabo	2	8	84	2	5
	Lauta	4	1	87	2	7
	Kahalu	13	4	66	1	16
	Sahapur	9	1	78	1	10
North–eastern Barind Tract	Amnura	2	–	93	2	2
	Tejgaon	2	–	94	2	2
	Kahalu	5	–	84	2	5
	Lauta	2	–	92	2	4
	Noadda	2	–	94	2	2
	Nachol	4	–	90	2	4
	Sahapur	6	2	88	2	2
	Ekdala	13	4	66	2	15
	Belabo	2	–	90	4	4
	Kashimpur	3	–	93	2	2

[1] Abbreviations: Mc, mica; Ch, chlorite; Qr, quartz; K–fd, K–feldspar; Pl, plagioclase.

respective minerals in the XRD charts (Moslehuddin and Egashira, 1996). Quartz was found to be a predominant mineral in all soils. In case of AEZ 25, the amount of quartz was very high ranging from 78 to 92% except 48% in the Ekdala soil and 66% in the Kahalu soil. The same thing is true for the AEZ 27 soils having more than 84% of quartz except the Ekdala soil (66%). The lower content of quartz in those three soils was associated with the relatively high contents of mica and plagioclase. Mica (2 to 32% in AEZ 25 and 2 to 13% in AEZ 27), K–feldspar (1 to 5% in AEZ 25 and 2 to 4% in AEZ 27) and plagioclase (2 to 18% in AEZ 25 and 2 to 15% in AEZ 27) were also identified in all soils while chlorite was identified in four soils (1 to 8%) of AEZ 25 and two soils (2 to 4%) of AEZ 27.

The results of the present study are in accordance with the findings of Egashira (1988), Egashira and Yasmin (1990), and Moslehuddin and Egashira (1996) for terrace soils. The land type and general soil type had no influence on the silt mineralogy.

Mineralogy of the clay fraction

The XRD patterns of the <2 μm clay fraction of the Pauli, Dudnai and Ekdala soils representing AEZ 25 are reproduced in Fig. 1a and those of the Kahalu, Lauta and Kashimpur soils representing AEZ 27 are in Fig 1b. Peaks were generally broad, indicating low crystallinity and/or small crystallite size of the minerals. Mica was identified by the presence of the 1.00 nm reflection appearing in all the treatments. Vermiculite was identified by the decrease in the peak intensity of the 1.42 nm reflection with the corresponding increase in the peak intensity of the 1.00 nm reflection by shifting from Mg–saturation to K–saturation followed by air–drying. The broad bulge around 1.80 nm in the Mg–saturated and glycerol–solvated specimen suggests the presence of smectite but was not identified in any soil. Chlorite was detected by the reflections at 1.42 nm and its rational orders and by remaining of the 1.42 nm reflection in the K–saturated and 550 °C–heated specimen. The peaks or shoulders at 0.716 and 0.357 nm in the Mg–saturated specimen suggested the presence of kaolinite.

The presence of vermiculite–chlorite intergrade is ascertained by the decrease in the peak intensity of the 1.42 nm reflection by heating in the K–saturated specimen. However, it was not positively detected in any soil. The peak at 1.25 nm in all the treatments suggested the presence of the interstratified mica–chlorite mineral.

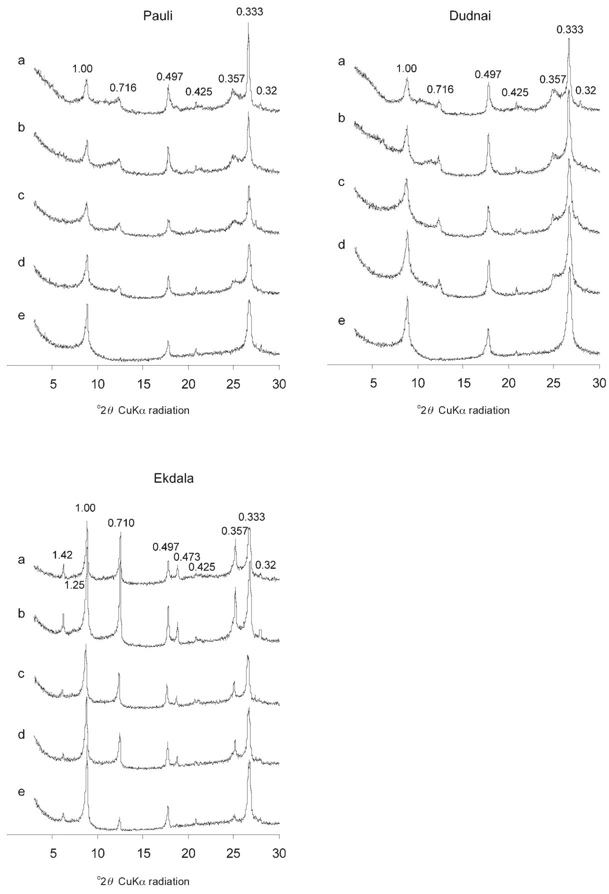

Fig. 1a. X–ray diffraction patterns of the <2 μm clay fraction separated from the Pauli, Dudnai and Ekdala soils in AEZ 25. Spacing is in nm. Treatments: a, Mg–saturation and glycerol–solvation; b, Mg–saturation and air–drying; c, K–saturation and air–drying; d, K–saturation and heating at 300 °C; e, K–saturation and heating at 550 °C.

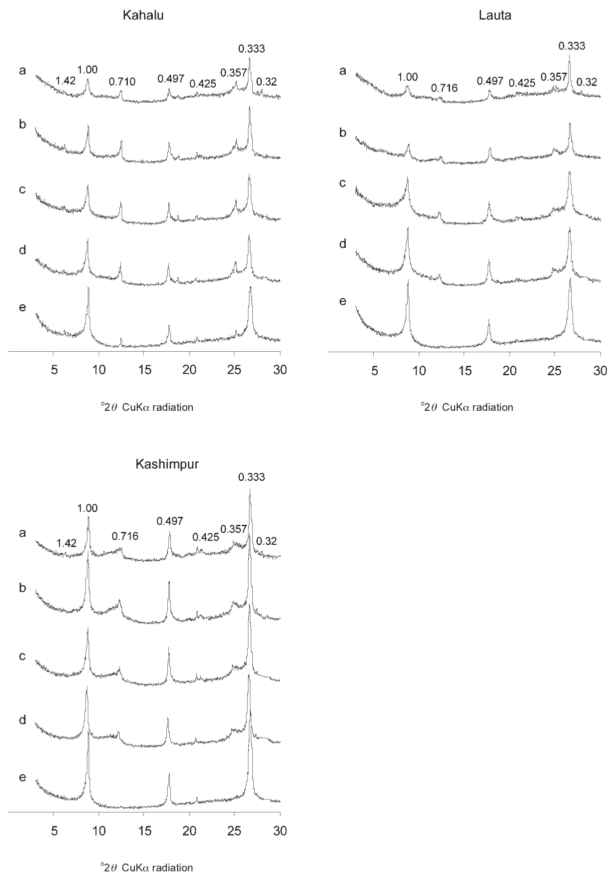

Fig. 1b. X–ray diffraction patterns of the <2 μm clay fraction separated from the Kahalu, Lauta and Kashimpur soils in AEZ 27. Spacing is in nm. Treatments: a, Mg–saturation and glycerol–solvation; b, Mg–saturation and air–drying; c, K–saturation and air–drying; d, K–saturation and heating at 300 °C; e, K–saturation and heating at 550 °C.

Table 4. Approximate mineral contents (%) in the clay fraction (<2 μm) of soils

AEZ	Soil series	Minerals[1]									
		Mc	Vt	Ch	Kt	Kt/St	Mc/Vt/St	Mc/Ch	Qr	Gt	Fd
Level Barind Tract	Pauli	45	–	–	13	15	12	–	11	1	1
	Nachol	35	–	–	14	12	11	–	22	4	1
	Atahar	45	–	1	7	12	10	–	22	1	2
	Dudnai	48	–	1	7	10	16	–	15	1	2
	Amnura	40	–	1	10	13	–	–	24	9	2
	Nijhuri	62	–	1	11	11	–	–	13	1	2
	Noadda	57	–	–	15	8	7	–	11	1	1
	Ekdala	63	4	19	3	–	–	4	4	–	2
	Belabo	57	–	15	3	–	–	1	15	7	1
	Lauta	57	1	2	8	11	–	–	13	3	5
	Kahalu	41	6	11	11	–	6	5	12	2	6
	Sahapur	48	–	10	10	–	10	4	13	2	2
North–eastern Barind Tract	Amnura	39	1	1	8	11	22	–	13	4	1
	Tejgaon	53	–	3	10	11	–	–	17	3	2
	Kahalu	58	1	10	3	–	9	–	12	1	6
	Lauta	41	1	1	5	10	29	–	9	1	3
	Noadda	43	–	–	9	17	–	–	25	4	1
	Nachol	53	–	–	13	14	6	–	10	1	4
	Sahapur	48	–	3	13	15	–	–	16	1	4
	Ekdala	38	–	2	10	–	30	–	17	1	3
	Belabo	45	3	1	8	8	–	–	23	6	6
	Kashimpur	49	2	1	12	17	–	–	16	2	2

[1] Abbreviations: Mc, mica; Vt, vermiculite; Ch, chlorite; Kt, kaolinite; Kt/St, interstratified kaolinite–smectite; Mc/Vt/St, interstratified mica–vermiculite–smectite; Mc/Ch, interstratified mica–chlorite; Qr, quartz; Gt, goethite; Fd, feldspars.

The presence of the interstratified kaolinite–smectite mineral was suggested by tailing of the 0.7 nm peak toward the higher angles. The poorly defined diffraction effect between 1.0 and 2.0 nm in the Mg–saturated and glycerol–solvated specimen and the great increase in the intensity of the 1.00 nm peak after K–saturation was an indication of the interstratified mica–vermiculite–smectite mineral (Egashira, 1988). The reflections of 0.425, 0.418 and 0.32 nm were used for identification of quartz, goethite and feldspars, respectively.

The approximate mineral composition of the <2 μm clay fraction was estimated based on the relative peak intensities of the respective minerals in the XRD charts following Moslehuddin and Egashira (1996), and is shown in Table 4. The results indicated that mica (35 to 63% in the AEZ 25 soils and 38 to 58% in the AEZ 27 soils) was a predominant mineral in all soils. Next to mica, kaolinite was present in all soils of both AEZs: 3 to 15% in AEZ 25 and 3 to 13% in AEZ 27. Considerable amounts of the interstratified kaolinite–smectite and/or mica–vermiculite–smectite minerals were present in all soils except the Ekdala and Belabo soils of AEZ 25. Small amounts of vermiculite were identified in 3 soils of AEZ 25 (1 to 6%) and 5 soils of AEZ 27 (1to 3%). Four soils of AEZ 25 (Ekdala, Belabo, Kahalu and Sahapur) had the chlorite content in a range of 10 to 19% with five other soils having 1 to 2% only, while one soil (Kahalu) of AEZ 27 had 10% of chlorite with other soils having 1 to 3% except the Noadda and Nachol soils. The interstratified mica–chlorite mineral was identified in four soils (1 to 5%) of AEZ 25 which had the relatively high content of chlorite.

Other than layer silicates, quartz (4 to 24% in the AEZ 25 soils and 9 to 25% in the AEZ 27 soils) was present in all soils, and small amounts of feldspars (1 to 6% in the soils of both AEZs) and goethite (1 to 9% in the AEZ 25 soils and 1 to 6% in the AEZ 27 soils) were identified in all soils except the Ekdala soil of AEZ 25 having no goethite. Clay mineralogical composition was hardly affected by the land type and general soil type.

DISCUSSION

The soils of the Level Barind Tract (AEZ 25) and North–eastern Barind Tract (AEZ 27) were acidic in reaction indicating suitability of acid–tolerant crops in this region. The soils were mostly of medium–texture (loam or silt loam) with 25% in the AEZ 25 soils (silty clay loam and clay loam) and 40% in the AEZ 27 soils (silty clay loam, silty clay and clay) of the heavy texture. Most soils had considerable amounts of clay with a wide range of the content from 12 to 39% in the AEZ 25 soils and from 21 to 48% in the AEZ 27 soils, and the variation was mainly related to the topographical position of soils on the landscape.

The 2–20 μm silt fraction was dominated by quartz, with some mica, plagioclase and K–feldspar, and chlorite in some cases. In the <2 μm clay fraction, mica was a predominant mineral in all soils. Kaolinite was present in all soils and in good amounts in most cases. The interstratified kaolinite–smectite mineral was present in considerable amounts in almost all soils except the Ekdala, Belabo, Kahalu and Sahapur soils of AEZ 25 and the Kahalu and Ekdala soils of AEZ 27. The interstratified mica–vermiculite–smectite mineral was identified in around 50% soils in both AEZs, mostly in a good amount.

Chlorite was found as a dominant mineral in four soils of AEZ 25 and one soil of AEZ 27. Vermiculite in three soils of AEZ 25 and five soils of AEZ 27, and the interstratified mica–chlorite mineral in four soils of AEZ 25 were identified in a small amount.

The present results indicate that all soils were almost similar in the clay mineralogical composition which was broadly similar to those obtained by Egashira (1988), Egashira and Yasmin (1990), and Moslehuddin and Egashira (1996) for terrace soils. However, the presence of good amounts of chlorite in four soils of AEZ 25 and one soil of AEZ 27 is an exception to the typical mineralogical composition of terrace soils. The Ekdala and Belabo soils of AEZ 25 had 19 and 15% chlorite, respectively, with no interstratified mica–vermiculite–smectite and kaolinite–smectite minerals but some interstratified mica–chlorite mineral and with lower amounts of kaolinite. Both soils had less amount of clay (<20%) (Table 2). Possibly there was any admixture of alluvial sediments with Madhupur Clay in these soils, and alluvial sediments were dominant over Madhupur Clay, resulting in such clay mineralogical composition. The Kahalu and Sahapur soils of the same AEZ and the Kahalu soil of AEZ 27 were in the almost similar case to the Ekdala and Belabo soils of AEZ 25 but the contribution of Madhupur Clay was not suppressed by alluvial sediments as suggested by the presence of the interstratified mica–vermiculite–smectite mineral.

Unweathered Madhupur Clay, the parent material of the terrace soils, contains illite (mica), kaolinite and possibly traces of montmorillonite (smectite) (Saheed, 1984). Egashira (1988) suggested that only mica (not kaolinite) has been under transformation in the terrace soils of Bangladesh. In the first phase, mica has been transformed into the interstratified mica–vermiculite–smectite mineral. In the second phase, it has been transformed into the interstratified kaolinite–smectite mineral and finally to kaolinite. Absence or presence of the interstratified mica–vermiculite–smectite and kaolinite–smectite minerals and variation in the amounts of these two interstratified minerals along with kaolinite indicate different stages of weathering of soils under study. However, the mineralogical composition of the clay fraction supports the mineralogical suite of mica–mixed–layer minerals–kaolinite for this region as proposed by Moslehuddin *et al*. (1999).

CONCLUSIONS

The soils of the Level Barind Tract and North–eastern Barind Tract are acidic in reaction, and have the medium to high clay content which is an indication to be highly weathered in nature. The clay fraction was dominated mostly by mica, kaolinite, the interstratified kaolinite–smectite and mica–vermiculite–smectite minerals with a little exception. Therefore, the result of the present study supports the mineralogical suite of mica–mixed–layer minerals–kaolinite for this region as proposed by Moslehuddin *et al*. (1999).

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