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CHARACTERISTICS AND GENESIS OF SOME ALLUVIUM-DERIVED SOILS OF JAMMU AND KASHMIR

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Characteristics and genesis of five alluvium-derived pedons collected by Reconnaissance Soil Survey from different localities of Jammu district, Jammu and Kashmir State were studied. As locally named, these pedons represented *Kalar Ali Mitti* (Profiles 1 and 2), *Maira I* (Profile 3), *Maira II* (Profile 4) and *Rohi* (Profile 5). The results indicated that soils from *Maira I*, *Maira II* and *Rohi* had light texture compared with those from *Kallar Ali Mitti* which showed relatively heavy texture. There was development of textural B-horizon and some structural development in one of the *Kallar Ali Mitti* profiles. The water holding capacity of the soils appears to be affected by the amount of clay and organic carbon rather than type of the clays. Organic carbon status was generally low. Exchangeable Na^+ not exceeding 15 per cent of CEC, Ca^{2+} and Mg^{2+} together constituting for its major portion and *p*H remained upto 8.6 in all soil profiles indicated that these are not alkali soils but have soluble salts. The CEC appears to vary with texture and organic carbon.

Quartz, feldspar and mica were the main minerals of light sand fractions, whereas the heavy sand fractions contained epidote, hornblende and ferruginous minerals. Mica was the dominant clay mineral followed by chlorite, kaolinite, chloritic and mixed layer minerals.

On the basis of morphological, physical and chemical characteristics, the soil profiles 1 and 2 have been classified as typic Eutrochrepts and aeric Haplaquents at sub-group level, and those of 3, 4 and 5 as typic Ustorthents and typic Ustochrepts.

Key Words : Alluvium-derived Soils; Jammu District; Jammu and Kashmir State; Genesis; Characteristics; Classification of Soils

INTRODUCTION

THE Jammu district in the State of Jammu and Kashmir comprises of hills and interspersed with flood plains of the rivers Chenab, Tawi, Manawar Tawi and their tributaries. The area is well known for growing of superior varieties of rice. It is also suitable for growing wheat, millets and vegetables. There are a variety of soils in the district, locally named as *Maira I, Maira II, Rohi, Kalar Ali Mitti* etc., depending upon their general features and the significance attached to them from angle of agricultural production. However, no systematic studies have so

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far been made in respect of their morphogenic, physico-chemical, mineralogical characteristics and classification which are prerequisites these days for scientific exploitation and management of the soils. The present study was undertaken with this point in view.

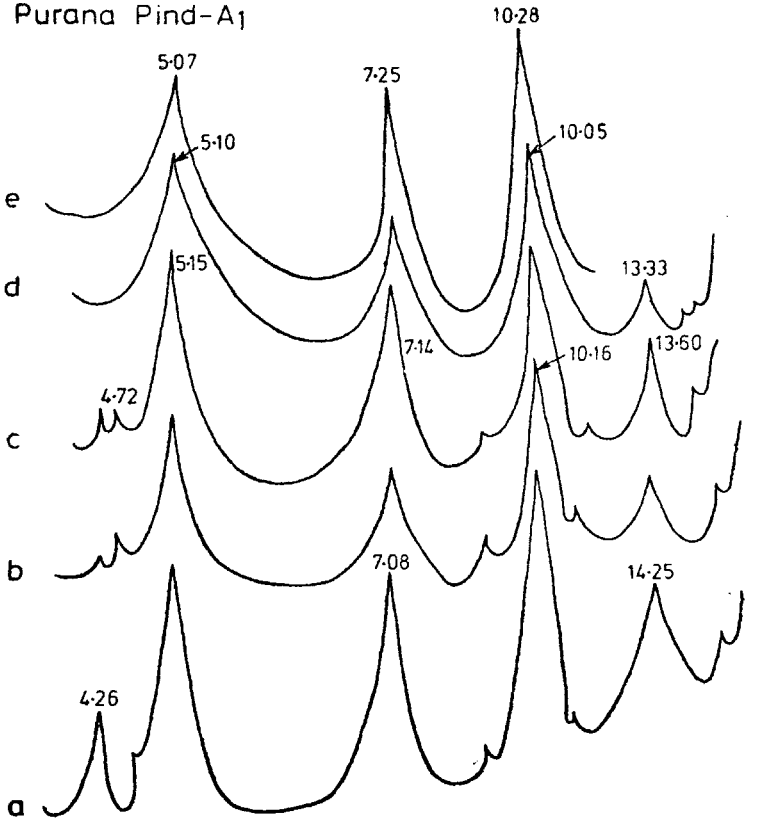
Experimental

Description of the Area

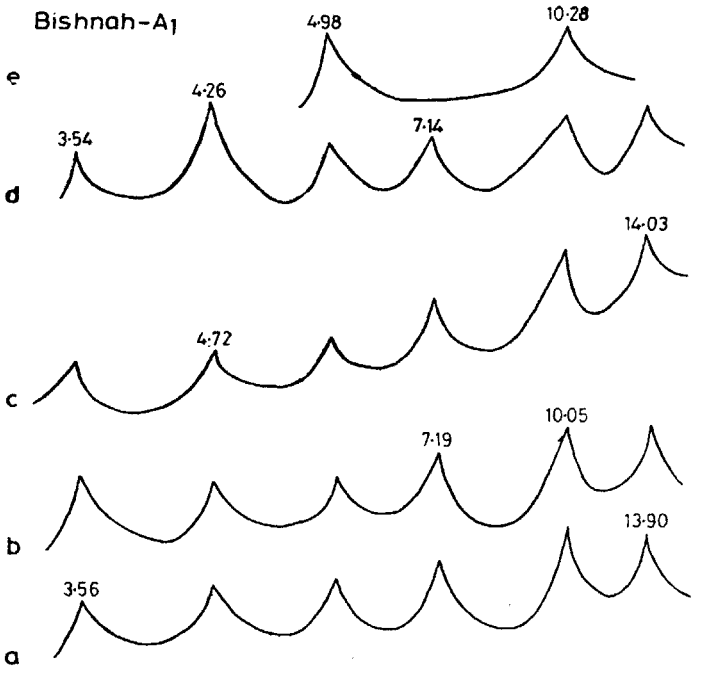
The studied area, located between 32° 38′ and 32° 44′ N latitude and 74° 48′ and 74° 55′ E longitude, is mostly flat in topography. Geologically, the area is of recent deposits with variable textural characteristics. The river terraces consist mainly of pebbles and cobbles of quartzite. The average annual rainfall is 1000 mm, the bulk of which occurs during rainy season i.e. July to September. The temperature ranges between 23.4 to 39.9 °C during summer and 6.5 to 26.2 °C during winter. The vegetation consists of deciduous trees.

Methods

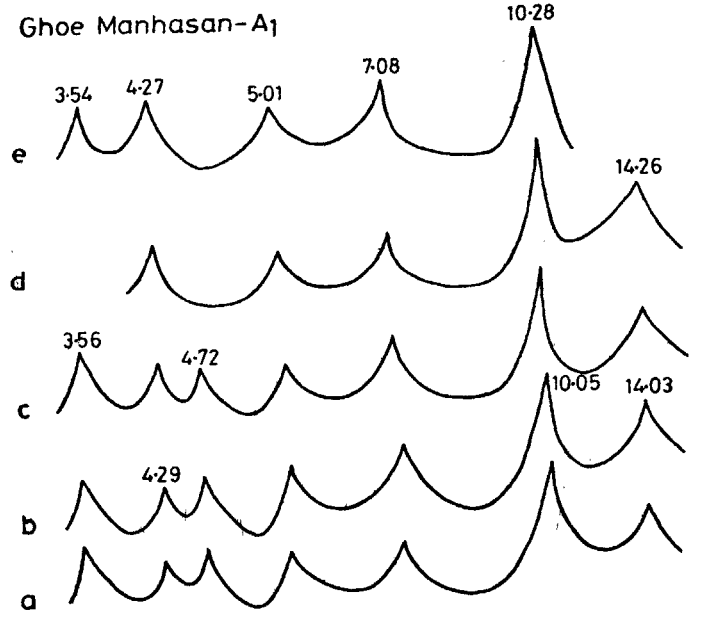
Five soil profiles were selected for the purpose of this study representing *Kalar Ali Mitti* (profiles 1 and 2), *Maira I* (profiles 3), *Maira II* (profile 4) and *Rohi*



Profile 1



PROFILE 2

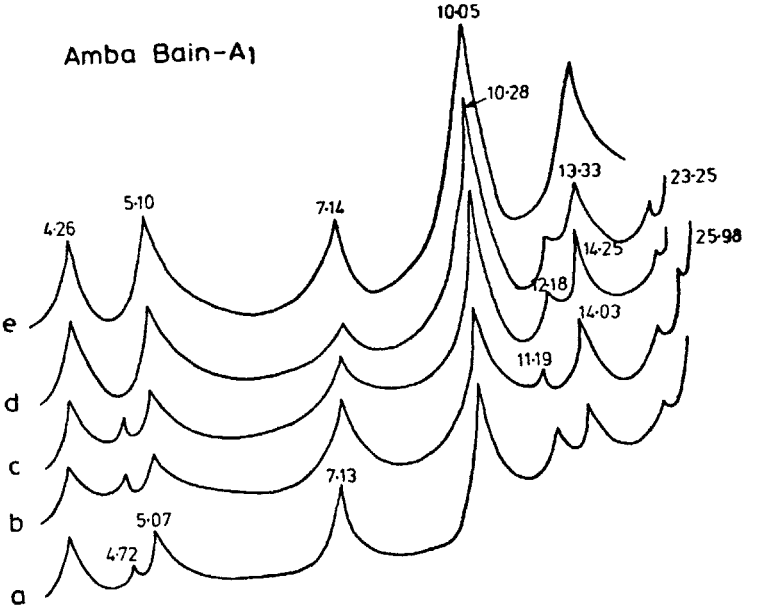


PROFILE 4

Note: Clay mineralogical make-up of all the soil profiles being similar Profile 3 is not illustrated.

(Profile 5). Their morphological characters were described using the methods of soil survey manual.[1,2] The particle size distribution of the processed soil samples (< 2mm) was conducted by the International Pipette Method.[3] Standard methods were followed for determining various chemical properties.[4]

Heavy and light fractions of sand were separated using bromoform after treating them with sodium dithionite. Canada Balsam mounts were prepared, and primary minerals were examined using petrographic microscope. The clay minerals were identified by X-ray diffraction with a Philips diffractometer (Cuk α) radiation using various treatments such as Mg-saturated, Mg-saturated and glycolated and heating the K-clays at 550 °C for two hours. The effect of HCl-treatment on the clay fraction was also studied.



PROFILE 5

RESULTS AND DISCUSSION

Morphology

The colour of the soils of profiles 1, 3, 4 and 5 (Table I) vary from yellowish brown (10Yr 5/4); pale brown (10Yr 8/3) or brown (7.5Yr 4/3) on the surface to pale brown (10Yr 6/3); pale yellowish brown (10Yr 6/6); dark yellowish brown (10Yr 4/4) or light yellowish brown 10Yr 6/4, in the sub-surface horizons, while those of profiles 2 range from very dark grey brown (10Yr 3/2) to dark brown (7.5Yr 4/2). This suggested that the soils of the former are comparatively well-drained than the latter. The dark grey brown colour in pedon 2 may be the result of prevailing reduced conditions due to high water table and/ or more calcareous nature of the soil.

The texture of the soils (Table I) of profile I changes from loam at the surface to clay loam/loam in the subsurface, whereas it remains silty loam throughout the depth of profile 2. In the soils of profile 3, 4 and 5 it was either sandy loam, loamy sand or loam. There is less structural development in profiles 2, 3, and 4. The soils are rather granular, loose, porous and single grained which suggest their recent origin. However, the soils of profile I show some structural development which is moderate coarse sub-angular blocky/medium angular blocky to blocky.

TABLE I

Morphological characteristics of the typical pedons

Profile 1

Location : Purana Pind about half km south of Ranbir Singh Pur Bus stand

Topography : Flat, elevation 300 m above mean sea level.

Parent Material : Alluvium

Drainage : Well drained with high water table (1–2m).

Climate : Sub-tropical, rainfall around 1000 mm.

Vegetation : Kikar (*Acacia arabica*), Shisham (*Dalbergia sissoo*)

A_1 (0–8*cm*) : Yellowish brown (10Yr 5/4) dry; brown (10Yr 5/3) moist; loam; medium weak crumbstructure; slightly hard, dry, friable and slightly sticky moist; moderate rapid permeability; strong effervescence with dilute HCl; clear smooth boundry, few very coarse roots present.

A_3/B_1 (8–16*cm*) : Pale brown (10Yr 6/3) dry; Brown (10Yr 5/3) dry; brown (10 Yr 5/3) moist; clay loam; moderate coarse sub-angular blocky structure; hard, firm, dry, sticky and plastic moist; moderate permeability; strong effervescence with dilute HCl; clear smooth boundary, a few thin roots present.

B_{21} (16–46*cm*) : Pale yellowish brown (10Yr 6/6) dry; dark greyishbrown (10 Yr 3/2) moist; clay; moderate medium angular blocky structure; hard, dry, firm and very sticky moist; moderately slow permeability; very strong effervescence with dilute HCl; diffused boundary, roots absent.

B_{22} (46-82*cm*) : Dark yellowish brown (10Yr 4/4) dry; dark brown (10Yr 5/4) moist; clay loam; medium angular blocky structure; hard, firm and sticky moist; moderately slow permeability, strong effervescence with dilute HCl; diffused boundary.

B_{23} (82–127*cm*) : Dark Yellowish brown (10Yr 4/4) dry and moist; clay loam; angular blocky to blocky structure; hard, very firm, dry and sticky moist; slow permeability, no effervescence with dilute HCl.

Profile 2

Location : Bishnah, about 6 km west of National Highway Road from Bari Brahamana.

Topography : Flat well-levelled land

Parent Material : Alluvium

Drainage : Well drained with high water table (1–2 *m*)

Climate : Subtropical, rainfall around 1000 mm.

Contd.

Table 1 (*Contd.*)

Vegetation : Phulai (*Acacia modesta*) Shisham (*Dalbergia sisso*).

A_1 (0–15 *cm*) : Very dark grey brown (10 Yr 3/2) dry and moist; silty loam; fine granular structure; soft friable, dry, non-sticky moist; rapid permeability; strong effervescence with dilute HCl; clear smooth boundry; many coarse roots present.

C_1 (15–40 *cm*) : Very dark brown (10 Yr 3/2) dry and moist; silty loam; moderate weak granular structure; slightly hard and firm, dry, slightly sticky moist; moderate rapid permeability; strong effervescence with dilute HCl: diffused boundary; few thin roots present.

C_2 (40–106 *cm*) : Dark brown (7.5 Yr 4/2) dry and moist; silty loam; moderate coarse granular structure; hard, firm, dry and very sticky moist; slow permeability; strong effervescence with dilute HCl; diffused and smooth boundary.

Profile 3

Location : Village Mandaal, about 8 km towards west from Jammu Aerodrome, Profile was located in low land near the river Tawi.

Topography : Well-levelled land, elevation 252 m above mean sea level.

Parent Material : Alluvium

Climate : Subtropical

Vegetation : Shisham (*Dalbergia sissoo*).

A (0–37 *cm*) : Pale brown (10 Yr 8/3) dry; brown (7.5 Yr 4/4) moist; sandy loam, single grained loose structure; friable soft and nonsticky moist; very rapid permeability; slight effervescence with dilute HCl; clear smooth boundary.

C (37–117 *cm*) : Pale yellowish brown 10 Yr 6/6) dry; dark greyish brown (10 Yr 4/2) moist; sandy loam; single grain porous structure; friable, soft and almost nonsticky moist; rapid permeability; slight effervescence with dilute HCl; diffused boundary.

Profile 4

Location : Ghoe Manhasan, about half km towards south from Govt. high school.

Topography : Well-levelled land with elevation of 270 m above mean sea level.

Parent Material : Alluvium

Climate : Subtropical, rainfall around 1000 mm

Vegetation : Kikar (*Acaci arabica*), Amb (*Mengifera indica*)

A_1 (0–43 *cm*) : Brown (7.5 Yr 4/4) dry; very dark grey (10 Yr 3/1) moist; sandy loam; weak medium granular structure; soft, friable and nonsticky moist; rapid permeability; slight effervescence with dilute HCl; clear and smooth boundary; many very thin roots present.

C_1 (43–113 *cm*) : Light yellowish brown (10Yr 6/4) dry: yellowish brown (10Yr 5/4) moist; loamy sand; weak medium granular structure; slightly hard, firm and non-sticky moist; rapid permeability; strong effervescence with dilute HCl; clear and smooth boundary.

C_2 (113–158 *cm*) Yellowish brown (10Yr 5/3) dry; dark yellowish brown (10Yr 4/4) moist; loam sandy; weak medium granular structure; slightly hard and firm moist; moderately slow permeability; slight effervescence with dilute HCl; diffused boundary.

Profile 5

Location : Village Ambabain, about 5 km away from Akhnoor town.

Topography : Flat to well-levelled land with an elevation of 270 m above mean sea level.

Contd.

Table 1 (*Contd.*)

Parent Material : Alluvium

Climate : Subtropical, rainfall around 900 mm.

Vegetations : Scrubs and bushes.

A_1 (0–22 *cm*) : Yellowish brown (10Yr 5/4) dry; dark yellowish brown (10Yr 4/4) moist; loam; fine sub-angular blocky, breaking into fine granular structure, slighty hard, firm and slightly sticky moist; slow permeability; no effervescence; clear and abrupt boundary; few coarse roots present.

B_1 (22–49 *cm*) : Pale brown (10Yr 6/3) dry; dark yellowish brown (10Yr 4/4) moist; loam; moderate coarse subangular blocky structure; slightly hard, firm and slightly sticky moist; moderately slow permeability, no effervescence; diffused boundary; many fine roots.

B_{21} (49–103 *cm*) : Pale brown (10Yr 6/3) dry; dark brown (10Yr 4/3); loam; moderate coarse sub-angular blocky structure; slightly hard, firm and slightly sticky moist, no effervescence; diffused boundary.

Physical and Chemical Characteristics

There is no evidence of downward movement of silt or clay (Table II) in all profiles except in profile 1. In profile 1, maximum clay content has been indicated in B_{21} horizon followed by B_{23} and B_{22} and thus there is development of textural B-horizon in this profile. More sand content in profiles 3, 4 and 5 can be ascribed to the alluvium rich in coarse material brought by the river Tawi and its tributaries from time to time. The water holding capacity was low in all soils (30–33 per cent) except those of profile I (38–47 per cent). The differences can be due to the amount of clay and organic carbon rather than type of clays which are almost similar.

The *p*H varied from 7.3 to 7.6 in soils of 3, 4 and 5 profiles and 7.7 to 8.6 in those of 1 and 2 profiles. It was found to increase with depth in soils of 1 and 2 profiles which is suggestive of leaching of $CaCO_3$ and exchangeable bases. The electrical conductivity range from 1.2 to 2.8 mmhos/cm in soils of 3, 4 and 5 profiles, whereas it is mostly greater than 4 and often increases with depth in soil profiles of 1 and 2. However, exchangeable Na^+ is not beyond 15 per cent of CEC, Ca^{++} and Mg^+ together constitute for its major portion and *p*H remains upto 8.6. This shows that these soils are not alkali soils but have soluble salts. The presence of appreciable amount of $CaCO_3$ (Table II) in some of these soils despite absence of time concretions or nodules could be due to its inheritance from alluvium parent material.[5]

CEC varies from 6.1 to 11.9me/100g and was found to vary with texture and organic carbon. It was comparatively high in soils of profile 1. Ca^{++} was the dominant cation followed by Mg^{++} and K^+.

Mineralogy of Sand and Clay Fractions

Quartz, felsdpar are the predominant minerals (Table III) in the light sand fraction followed by mica (muscovite and biotite). Epidote, hornblende and ferruginous minerals are dominant in the heavy sand fraction. Kyanite was

TABLE II

Physical and chemical properties of soil profiles

Profile No.	Profile Location	Depth (cm).	Horizon	Mechanical Components (%)				pH	EC	OC %	$CaCO_3$	CEC & Exchangeable bases me/100g				
				Coarse sand	Fine sand	Silt	Clay					CEC	Ca	Mg	K	Na
1.	Purana Pind	0-8	A_1	2.7	46.2	23.1	30.1	7.7	2.1	0.75	6.2	9.6	6.2	1.4	0.8	0.9
		8-16	A_3/B_1	0.8	42.0	24.8	34.0	7.9	4.2	0.70	6.6	10 8	6.8	1.6	0.9	1.0
		16-46	B_{21}	3.3	39.0	21 4	37.4	8.4	5.3	0.62	6.1	11.9	6.6	1.9	0.9	0.8
		46-82	B_{22}	5.6	40.8	24.0	33.2	8.0	5.2	0.60	6.6	10.6	6.8	1.9	0.8	0.6
		82-127	B_{23}	3.6	41.7	18.0	35.2	8.1	4.1	0.49	6.6	10.9	6.9	0.9	0.9	0.5
2.	Bishnah	0-15	A_1	0.6	32.8	49.5	19.0	8.2	4.6	0.49	8.8	7.7	5.1	0.9	1.7	0.6
		15 40	C_1	0.3	33.1	50.2	19.8	8.6	6.2	0.37	8.2	6.9	4.6	0.6	0.5	1.7
		40-106	C_2	1.8	34.8	48.1	16.6	8.6	4.2	0.22	8.3	6.7	4.1	0.8	0.6	1.1
3.	Mandaal (Near	0-37	A	4.0	64.0	13.0	16.8	7.4	1.5	0.36	1.1	6.6	4.0	1.2	0.8	0.3
	Makwa 1)	37-117	C	2.8	65.0	12.8	16.9	7.5	1.2	0.31	2.9	6.1	3.0	1.1	1.4	0.4
4.	Ghoe	0-43	A_1	8.6	60.0	15.5	15.4	7.4	2.8	0.65	1.7	7.5	5.2	0.9	1.0	0.2
	Manhasan	43-113	C_1	6.5	66.0	12.9	17.2	7.6	1.6	0.45	2.1	7.2	4.2	1.0	1.4	0.4
		113-158	C_2	7.2	64.9	14.6	18.9	7.5	2.0	0.61	1.6	6.8	3.2	0.8	0.8	0.8
5.	Amba Bain	0-22	A_1	4.7	59.4	19.3	20.4	7.5	1.5	0.30	Traces	7.6	4.9	0.9	0.4	0.6
	(Akhnoor)	22-49	B_1	6.2	61.2	14.7	18.5	7.4	2.4	0.22	-do-	6.2	3.8	1.5	0.6	0.2
		49-103	B_{21}	7.2	57.4	17.0	15.2	7.3	2.8	0.15	-do-	5.9	2.8	1.2	0.8	0.3

TABLE III

Mineralogy of sand fraction in soil profiles

Profile No.	Location	Horizon	Light minerals				Heavy minerals						
			Qu.	Fels.	Musco.	Bio.	Epi.	Horn.	Ferru	Kya.	Aug.	Zir.	Tour
1.	Purana Pind	A_1	++++	+++	++	+	++	++	+++	+	+	+	+
		A_3/B_1	+++	++++	++	+	++	++	+++	+	+	+	+
		B_{21}	+++	++++	++	+	++	++	++	—	+	+	+
		B_{22}	+++	++++	+	+	++	++	++	—	+	+	+
		B_{23}	+++	++++	+	+	++	++	++	—	+	+	+
2.	Bishnah	A_1	++++	+++	+	++	++	++	++	+	—	—	—
		C_1	++++	+++	+	++	++	++	++	+	—	—	—
		C_2	++++	+++	+	++	++	++	++	+	—	—	—
3.	Mandaal	A	++++	++	++	++	++	++	++	+	+	—	—
		C	++++	++	++	++	++	++	++	+	+	—	—
4.	Ghoe Manhasan	A_1	++++	++	+	++	++	++	++	+	+	—	—
		C_1	++++	++	+	++	++	++	++	+	—	—	—
		C_2	++++	+++	+	++	++	++	++	+	+	—	—
5.	Amba Bain	A_1	++++	+++	+	+	++	++	++	+	+	+	+
		B_1	++++	++++	+	+	++	++	++	+	+	+	+
		B_{21}	++++	++++	+	+	++	++	++	+	+	+	+

Qu : Quartz, Fels—Felspars, Musco—Muscovite, Bio—Biotite, Epi—Epidote, Horn—Hornblende, Ferru—Ferruginous minerals, Kya—Kyanite, Aug—Augite, Zir—Zircon, Tour—Tourmaline

present in all profiles except some horizons of profile 1, where it was fouund to be misssing.

X-ray diffraction analysis data (Table IV) and representative diffraction patterns (Fig. 1-Profile 1.) show a strong reflection at 10.05Å in Mg-saturated

TABLE IV

Relative abundance of clay minerals in selected horizons of soil profiles

Profile No.	Location	Horizon	Minerals				
			Mica	Chlorite	Kaolinite	Mixed layers	minerals
1.	Purana Pind	A_1	+++	++	+	++	
		B_{21}	+++	++	+	++	
		B_{23}	+++	++	+	++	
2.	Bishnah	A_1	+++	+++	—	—	+
		C_2	+++	+++	—	—	+
3.	Mandaal	A	+++	+++	—	—	
		C	+++	+++	—	—	
4.	Ghoe Mahasan	A_1	+++	++	+	—	+
		C_2	+++	++	+	—	+
5.	Amba Bain	A_1	+++	++	+	++	
		B_{21}	+++	++	+	++	

+++ = Abundant, ++ = Moderate, + = low, — = absent

clays which remain unaffected with glycol and thermal treatments. The higher order peaks occur at 4.98-5.15Å and 3.34Å (not shown in Fig). This suggests the presence of mica in the studied clay samples. A more broadening of 10Å reflection at the base in clays (A horizons) of profiles 1 and 5 indicates more weathering at the top. Reflections between 13.81-14.41 Å (Mg clays) which remain stable on heating the clays at 550 °C point to the occurrence of chlorite. However, the higher order reflections of chlorite (4.7-4.72 and 3.54-3.57 Å) practically disappear on heating at 550 °C, indicating the trioctahedral nature of chlorite.[6] 7 Å reflection; however, can not be only of 2nd order of chlorite but of kaolinite also, being evident from its persistence on 6NHCl treated sample. Thus, its presence is inferred in clay samples of profile 1, 4 and 5. Kaolinite does not develope in soils having free $CaCO_3$ until it is leached out. However, its presence could be explained primarily to inheritance from the alluvium derived from the weathered and erosion products of rocks in the adjoining hilly areas.

The X-ray diffractograms in clay samples of profiles 1 and 5 (A-horizons) indicated the presence of mixed layer minerals by 25.98 Å and also by the area above base line between 10 Å and 14 Å. Chloritic layers were represented by 23.25 Å and a broad horizontal region between 10 and 14 Å in the heated (550 °C) clays.

Classification of Soils

On the basis of morphological, physical and chemical properties an attempt has been made to classify these soils according to USDA system of classification :—

Profile No.	Profile location	Diagnostic horizons		Order	Sub-Order	Great Group	Sub-Group
		Surface	Sub-surface				
1.	Purana Pind	Ochric	Cambic	Inceptisol	Ochrept	Eutrochrepts	Typic Eutrochrepts
2.	Bishnah	—do—	—do—	Entisol	Aquents	Haplaquents	Aeric Haplaquents
3.	Mandaal	—do—	—do—	—do—	Orthents	Ustorthents	Typic Ustorthents
4.	Ghoe Manhas	—do—	—do—	—do—	Orthents	Ustorthents	Typic Ustortherts
5.	Amba Bain	—do—	Cambic	Inceptisol	Ochrepts	Ustrothepts	Typic Ustochrepts

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