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Characterization of soils of Kymore plateau and Satpura hills, Madhya Pradesh

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Abstract : Six representative pedons of Banganala watershed of Kymore plateau and Satpura hills in Rewa district, Madhya Pradesh were characterized and classified. The pedons were very deep and their textures varied from sandy loam to clay in surface horizons and clay loam to clay in sub-soils. Subangular and angular blocky were the dominant structures. The soils were calcareous and neutral to mildly alkaline in soil reaction. Organic carbon was low to medium in surface layer and decreased with depth. Cation exchange capacity and Ca^{++} and Mg^{++} ions were high in horizons having high clay. Based on morphological, physical and chemical characteristics, these pedons were classified as Typic Haplustalfs, Vertic Haplustalfs, Typic Haplustepts, Vertic Haplustalfs, and Typic Haplusterts at subgroup level.

Additional key words: *Soil morphology, physical and chemical characteristics, taxonomy*

Introduction

The nature and properties of a soil are mainly dependent on geological formation, topography and climate of the region in which it occurs. Sand stone, shales and lime stone enriched sedimentary rocks are of common occurrence in Rewa district of Madhya Pradesh (MP). A variety of soils ranging from a light textured shallow sandy loam to black clay occur in Banganala watershed. An adequate information on characterization of these soils is lacking and hence the present investigation was undertaken.

Materials and Methods

Geographically, the study area lies in between 24°30'45" to 24°37'51" N latitude and 81°24' to 81°31' E longitude at an elevation ranging from 300 to 340 m above mean sea level. The area is almost level except in the vicinity of Nala. The drainage patterns are dendritic type.

The climate of area is hot sub humid with a mean annual precipitation of 1106 mm. The area remains fairly dry during winter and has Ustic soil moisture regime.

Based on topography, texture and colour during traversing of the area, six pedons were exposed and studied for morphological properties as per Soil Survey Manual (Soil Survey Division Staff, 1995). Horizon-wise soil samples were collected, dried, processed and analysed for particle-size distribution by Bouyoucos Hydrometer method and pH and electrical conductivity (EC) in 1:2.5 soil:water suspension (Piper 1966). Organic carbon was estimated by Walkley and Black (1934) method and calcium carbonate by rapid titration method (Piper 1966). The cation exchange capacity (CEC) and exchangeable cations were determined as described by Bower *et al.* (1952) and Black (1965), respectively. The soils were classified according to Soil Taxonomy (Soil Survey Staff 1998).

Table 1. Morphological characteristics of selected pedons

Horizon	Depth (cm)	Colour (moist)	Texture	Structure	Concretions	Effervescence	Root distribution	Cracks
Pedon 1: Fine-loamy, mixed, hyperthermic Typic Haplustalfs								
Ap	0-12	10YR4/3	sl	1sbk	-	-	ff	-
Bw1	12-33	10YR3/3	scl	m1sbk	-	-	ff	-
Bw2	33-56	10YR3/3	cl	m2sbk	vff conca	-	ff	-
Bt1	56-90	10YR3/3	cc	m2cabk	vff conca	-	ff	-
Bt2	90-130	10YR3/3	cl	m2cabk	ff-m conca	e	-	-
Bt3	130-150	10YR4/3	ccl	c3abk	ff-m-conir	ev	-	-
Cca	150-190	10YR4/4	ls	1sbk	ff-m-conca	ev	-	-
Pedon 2: Fine, smectitic, hyperthermic Vertic Haplustalfs								
Ap	0-12	10YR4/3	cl	m2sbk	-	-	ff	1-2
Bw1	13-28	10YR4/3	cl	m2cabk	-	-	ff	-
Bw2	28-45	10YR3/3	cl	3abk	ff-m-conca	-	ff	-
Bt1	45-80	10YR3/2	c	3abk	ff-m-conca conir	es	-	-
Bt2	80-114	10YR3/2	c	3cabk	ff-m-conca conir	ev	-	-
Bk	114-200	10YR4/4	cl	massive	ff-m-conca conir	ev	-	-
Pedon 3: Fine-loamy, mixed, hyperthermic, Typic Haplustept								
Ap	0-12	10YR4/3	scl	f1sbk	-	-	ff	-
A12	12-20	10YR4/3	scl	f1sbk	ff conca	-	ff	-
Bw1	20-40	10YR3/3	scl	m2sbk	ff conca	-	-	-
Bw2	40-78	10YR3/3	scl	m2sbk	ff conca	-	-	-
Bt2	78-150	10YR4/3	scl	massive	cf conca	-	-	-
C1	150-200	10YR4/3	scl	massive	cf conca	-	-	-
Pedon 4: Fine, mixed, hyperthermic Vertic Haplustalfs								
Ap	0-14	10YR4/3	cl	f1sbk	-	-	ff	
Bw	14-32	10YR4/2	cl	m2sbk	-	-	ff	2-4 cm wide cracks
Bt1	32-52	10YR3/2	c	f2abk	Ff coir	-	ff	2-4 cm wide cracks
Bt2	52-80	10YR3/2	C	c3abk	conir	-	-	2-4 cm wide cracks
Bt3	80-137	10YR3/2	c	c3abk	conir	-	-	-
Bt4	137-176	10YR3/3	c	c3abk	-	-	-	-
Ck	176-200	10YR4/3	c	m2sbk	conca	-	-	-
Pedon 5: Fine, mixed, hyperthermic Typic Haplusterts								
Ap	0-17	10YR2/3	c	1fsbk	-	-	ff	-
Bw1	17-39	10YR4/3	c	2msbk	ff conca	-	ff	2-4 cm wide cracks
Bw2	39-72	10YR4/3	c	3cabk	cfmconca	-	vff	2-3 cm wide cracks
Bss1	72-117	10YR4/3	c	3cabk	cfmconca	-	vff	2-4 cm wide cracks
Bss2	117-181	10YR4/3	c	3cabk	cfmconca	-	-	-
C	181-200	10YR5/3	c	2mcbbk	cfmconcacv	-	-	-
Pedon 6: Fine, mixed, hyperthermic Typic Haplusterts								
Ap	0-14	10YR5/4	c	2msbk	ffconir	-	ff	-
Bw	14-47	10YR5/3	c	3cabk	ff conir	-	ff	2-4 cm wide cracks
Bss1	47-110	10YR3/3	c	3cabk	ffconir	-	ff	2-4 cm wide cracks
Bss2	110-150	10YR3/3	c	massive	-	-	-	2-4 cm wide cracks
BC	150-200	10YR5/3	c	massive	-	-	-	-

Table 2. Physical and chemical properties of pedons

Horizon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH	EC (dSm^{-1})	$CaCO_3$ (gkg^{-1})	0.C ($g\ kg^{-1}$)	CEC (cmol (p+) kg^{-1})	Exchangeable cations (cmol (p+) kg^{-1})			
										Ca^{+}	Mg^{++}	Na^{++}	K_{+}
Pedon 1 : Fine-loamy, mixed, hyperthermic Typic Haplustalfs													
Ap	0-12	55.72	25.13	19.15	6.9	0.12	15.0	6.1	16.23	11.31	3.15	1.08	0.70
Bw_1	12-33	51.24	25.34	23.42	6.9	0.12	20.0	6.0	18.81	13.19	4.09	1.05	0.42
Bw_2	33-56	47-95	26.25	25.80	7.0	0.15	25.0	5.7	23.30	16.94	4.93	1.01	0.41
Bt_1	56-90	41.46	24.89	32.70	7.2	0.17	25.0	5.2	16.03	11.68	2.72	1.03	0.60
Bt_2	90-130	39.25	23.07	37.68	7.2	0.17	35.0	3.0	27.23	19.46	6.54	0.83	0.41
Bt_3	130-150	53.30	24.34	22.36	7.5	0.18	25.0	3.0	18.50	13.20	4.13	0.67	0.51
Cca	150-190	81.7	10.20	8.09	7.7	0.21	40.0	2.4	6.22	3.97	1.43	0.49	0.38
Pedon 2 : Fine, smectitic, hyperthermic Vertic Haplustalfs													
Ap	0-12	32.50	34.00	33.50	7.0	0.11	7.0	5.2	30.15	20.14	8.16	0.90	0.72
Bw1	13-28	30.50	35.00	34.50	7.0	0.11	12.4	2.0	32.70	21.37	9.80	0.73	0.46
Bw2	28-45	29.25	32.10	38.65	7.1	0.12	9.0	1.6	35.56	23.50	10.62	0.70	0.94
Bt1	45-80	26.00	32.50	41.50	7.1	0.13	14.0	1.6	38.66	25.10	12.08	0.92	0.83
Bt2	80-114	23.05	32.45	44.50	7.2	0.19	22.0	1.5	42.91	28.54	13.30	0.61	0.56
Bk	114-200	30.50	33.10	36.40	7.3	0.20	32.3	1.4	31.07	21.71	10.48	0.43	0.45
Pedon 3 : Fine-loamy, smectitic, hyperthermic Typic Haplustepts													
Ap	0-12	57.00	21.4	21.60	6.8	0.11	25.0	3.5	15.31	8.24	4.36	0.81	0.91
A12	12-20	48.07	26.81	24.12	6.9	0.11	32.0	1.4	18.46	11.70	4.95	1.02	0.64
Bw1	20-40	44.00	30.00	26.00	7.0	0.12	53.0	1.3	19.30	13.60	5.03	0.86	0.53
Bw2	40-78	52.45	19.14	28.41	7.8	0.13	60.3	1.11	21.53	16.18	4.23	0.80	0.42
C1	78-150	51.25	20.25	28.50	7.8	0.13	80.0	1.0	24.54	19.24	4.67	0.69	0.45
C2	150-200	47.75	24.00	28.25	7.8	0.19	102.0	0.9	25.79	20.55	4.32	0.74	0.45

contd.

Pedon 4 : Fine, smectitic, hyperthermic Vertic Haplustalfs

Ap	0-14	42.36	25.14	32.50	7.1	0.11	5.0	6.5	25.06	18.30	5.16	0.93	0.73
Bw	14-32	34.24	30.51	35.25	7.2	0.25	7.2	4.5	25.06	18.30	6.32	0.93	0.64
Bt1	32-52	27.25	31.18	41.57	7.1	0.34	8.2	2.3	33.17	22.64	9.15	0.84	0.61
Bt2	52-80	25.50	29.00	45.50	7.2	0.41	8.0	1.7	37.50	24.50	11.20	0.89	0.63
Bt3	80-137	23.00	29.00	48.00	7.2	0.42	12.0	1.2	43.13	30.61	11.45	1.01	0.63
Bt4	137-176	24.00	30.00	46.00	7.2	0.43	12.3	1.0	41.27	28.71	11.26	0.90	0.63
Ck	176-200	23.27	30.53	46.20	7.4	0.44	15.1	0.9	41.27	28.71	11.26	0.90	0.63

Pedon 5 : Fine, smectitic, hyperthermic Typic Haplusterts

Ap	0-17	32.25	27.25	40.50	7.2	0.22	4.0	6.2	36.42	28.18	5.89	1.32	0.62
Bw1	17-39	29.25	30.25	40.50	7.3	0.23	5.8	4.5	36.76	28.11	5.67	0.81	0.60
Bw2	39-72	17.25	30.00	42.75	7.3	0.25	7.7	3.5	37.10	29.70	6.26	0.81	0.42
Bss1	72-117	24.50	29.00	48.75	7.0	0.26	9.2	2.9	41.54	30.23	8.85	0.78	0.42
Bss2	117-181	21.25	30.25	48.50	7.2	0.28	11.1	1.40	43.28	30.81	8.81	0.79	0.43
BC	181-200	22.50	30.27	36.23	7.2	0.31	9.7	1.0	43.12	29.94	7.40	0.65	0.44

Pedon 6 : Fine, smectitic, hyperthermic Typic Haplusterts

Ap	0-14	32.25	25.50	42.50	7.2	0.31	11.0	6.4	37.50	26.38	8.29	0.63	0.71
Bw	14-47	33.25	21.50	45.25	7.2	0.34	13.1	4.8	38.13	29.40	8.30	0.83	0.64
Bss1	47-110	29.35	22.50	48.15	7.0	0.29	12.0	2.5	42.35	31.21	8.25	0.93	0.64
Bss2	110-150	28.60	21.20	50.20	6.9	0.30	14.7	2.1	44.65	32.63	10.75	0.90	0.65
BC	150-200	34.20	20.50	45.30	7.1	0.30	16.0	1.3	38.27	26.71	9.73	0.78	0.54

Results and Discussion

Morphological features of the pedons

The morphological characteristics of the pedons are presented in table 1. The pedons are very deep and their colour is in 10YR hue. The colour of surface horizons varied from dark brown to yellowish or grayish brown. In general, structure of the soils ranged from subangular (surface) to angular blocky (sub-soils). The consistency was slightly hard to hard in surface layers and hard to very hard in dry condition in middle and lower horizons. Lime and Fe-Mn concretions were found in P2, P4 and P6 and only lime concretions in P1, P3 and P5.

Physical and chemical characteristics

The data on particle-size distribution (Table 2) indicated that the texture of P1 was sandy loam in surface horizons and sandy clay loam to clay loam in middle horizons, except in C horizon. Textures of P2, P4, P5 and P6 were clay throughout the profile, except surface horizons of P2 and P4. Pedon 3 had sandy clay loam throughout the profile.

The pH of the soils ranged from 6.8 to 7.8 and electrical conductivity from 0.10 to 0.44 dS m^{-1}(Table 2). The calcium carbonate in the soils varied from 4.0 to 102.0 g kg^{-1} and increased with depth. Chinchmalatpure *et al.* (1998) also reported similar findings. Organic carbon ranged from 0.9 to 6.5 g kg^{-1} in all the pedons with a tendency to decrease with depth. The CEC of the soils ranged from 6.22 to 44.65 (cmol (p+) kg^{-1}) and increased with depth (Table 2). Gupta and Tembhare (1984) reported similar findings in Chambal command soils of MP. The exchangeable Ca^{++} and Mg^{++} were higher in B horizons than in A and C horizons. The pedons had higher exchangeable K^{+} and Na^{+} in the surface horizons and decreased with depth. The soils remained saturated with water for a longer period thereby showing the existence of Fe and Mn concretions.

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