

Characterization and classification of soils of granitic terrain in Jabalpur district of Madhya Pradesh

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Abstract

The soils observed around granitic terrain occurring on low (Kanchanpur), middle (Garha) and high (Gupteshwar) topographic positions in the district of Jabalpur were characterised for their morphology, physical and chemical properties. The Kanchanpur soils are very deep, very dark grayish brown to very dark gray in colour and dominantly clayey in texture, and classified as Typic Haplusterts. Moderately deep, dark gray and clayey Garha soils have been placed as Vertic Ustochrepts. The deep Gupteshwar soils having clay skins on ped surfaces find their placement in Typic Haplustalfs.

Additional keywords: Granite derived soils, landscape, soil taxonomy.

Introduction

The soils developed over a parent material on different topographic situations differ greatly in their morphology, physical and chemical properties in a said pedo-environment.

Manickam *et al.* (1973) reported that the soils from granite origin of higher levels were sandy loam and that of lower levels became as sandy clay loam/clay loam and in some cases, clayey. The black soils might have originated from a variety of parent materials including granite/gneiss. Roy and Barde (1962) and Hirekurubar *et al.* (1991) reported the development of Vertisols in some parts of India having granite-gneiss as parent material. Initially the base status of such parent materials seems to be low but it may increase later on due to the release of bases from mineral weathering and/or from external sources e.g. leaching from uplands, flood waters or base rich water tables (Coulombe *et al.* 1996).

Granite rocks occur very extensively around Jabalpur but, no information was available on the characteristics of soils in granitic terrain. Hence the present investigations were undertaken to study the morphology, physical and chemical properties and classify them into an appropriate taxa.

Materials and methods

The study area is located around Jabalpur between 23°8' and 23°12'N latitudes and 79°50' and 79°58'E longitudes with an average elevation of 400 m above mean sea level. The climate is subtropical with an average rainfall of 1275 mm. Soil temperature and moisture regimes are hyperthermic and ustic, respectively. Three pedons observed around granite rock were selected in the villages Kanchanpur, Garha and Gupteshwar on lower, middle and higher topographic positions, respectively.

Soil profiles were exposed to a depth limited to parent material or 2 m. The soils were morphologically characterized and horizon-wise soil samples were analysed as per the standard procedures. These soils were later on classified up to family level (Soil Survey Staff 1975, 1994).

Results and discussion

The morphological properties of the pedons have been shown in table 1. The pedon 1 exhibits very dark grayish brown to very dark gray colour. The surface layer of Garha pedon is very dark grayish brown in hue (10YR) but subsurface horizons are dark gray to dark grayish brown. The Alfisol profile is dark grayish brown upto 24 cm but the Bt horizon exhibits pale brown to brownish yellow colour. The colour variations in profiles seem to depend upon topography, drainage conditions of the soils (Biswas *et al.* 1966).

The Kanchanpur is dominantly a clayey textured soil and clay content ranges from 51 to 59 per cent. Garha soils showed clayey texture upto 70 cm and then after sandy loam texture. The sandy loam texture on surface and clay enriched horizon (sandy clay loam) in lower horizons are the characteristics of the Gupteshwar soils. Hirekurubar *et al.* (1991) while studying Vertisols derived from different parent materials, reported the extent of clay ranging from 58 to 65.5 per cent in soils derived from granite gneiss. The presence of higher clay content in Kanchanpur soils might be due to its topographic position which favoured the accumulation and retention of bases thus promoting the formation of smectite.

Table 1. Morphological characteristics of soils

Horizon	Depth (cm)	Soil colour (moist)	Texture	Structure	Consistency (moist)	Concretions	Other features
Kanchanpur pedon (P1)							
Ap	0-24	10YR 3/2	c	m2 sbk	ws & wp	ff conca	2 cm or more
Bw	24-47	10YR 3/1	c	m2 sbk	ws & wp	ff conca	wider
Bss1	47-69	10YR 3/1	c	m2 sbk	ws & wp	ff conca	cracks
Bss2	69-100	10YR 3/1	c	m2 sbk	ws & wp	ff conca	upto 69 cm
Bss3	100-125	10YR 3/1	c	m2 sbk	ws & wp	--	
BC	125-158	10YR 3/2	c	m2 sbk	ws & wp	--	
Garha pedon (P2)							
Ap	0-20	10YR 3/2	c	m1 sbk	ws & wp	cm	Less than
Bw1	20-37	10YR 4/1	c	m2 sbk	ws & wp	cf-cm	1 cm wide
Bw2	37-58	10YR 4/1	c	m2 sbk	ws & wp	cf-cm	cracks
Bw3	58-70	10YR 4/1	c	m2 sbk	ws & wp	cm	upto 37 cm
BC	70-90	10YR 4/2	sl	m1 sbk	ws & wp	mm	
Gupteshwar pedon (P3)							
Ap	0-11	10YR 4/2	sl	f1 sbk	wss & wsp	cf-cm	Thin clay
Bw	11-24	10YR 4/2	sl	m2 sbk	wss & wsp	cf-cm	film
Bt1	24-45	10YR 6/6	scl	m2 sbk	ws & wp	fm-cm	coating on
Bt2	45-120	10YR 6/3	scl	m2 sbk	ws & wp	fm-cm	the grains and pores

The soil structure ranges from subangular blocky to angular blocky in all the soils. The slickensides were observed close enough to intersect within the depth of 47 to 125 cm with weakly developed wedge shaped structural aggregates or parallelepipeds in Kanchanpur soils. Few and fine lime nodules were present only in soil profiles of Kanchanpur. Few to many, fine to coarse and faint to prominent mottles were also noticed in Kanchanpur soils after 100 cm of depth. Many thin clay coatings were observed on mineral grains and pores of Gupteshwar soils.

The coarse fragments were less than 1 per cent in Kanchanpur, 2 to 10 per cent in Garha and 22 to 51 per cent in Gupteshwar soils. Bulk density ranges from 1.3 to 1.5 in Kanchanpur, 1.4 to 1.8 in Garha and 1.4 to 1.6 Mg/M³ in Gupteshwar soils.

Table 2. Physical properties of soils

Horizon	Depth (cm)	Coarse fragments (>2 mm)	Coarse sand	Fine sand	Silt	Clay	B.D. (Mg/M ³)
			----- (%) -----				
Kanchanpur pedon (P1)							
Ap	0-24	0.6	5.5	21.9	16.2	52.4	1.35
Bw	24-47	0.4	1.9	28.9	14.4	54.8	1.49
Bss1	47-69	0.3	1.9	26.7	14.6	46.8	1.47
Bss2	69-100	0.4	1.5	25.2	17.2	56.1	1.38
Bss3	100-125	0.1	3.7	20.0	17.3	59.0	1.44
BC	125-158	0.1	1.2	12.5	29.0	57.3	1.40
Garha pedon (P2)							
Ap	0-20	2.5	16.1	15.7	24.7	43.5	1.41
Bw1	20-37	2.7	11.9	13.9	24.6	49.6	1.44
Bw2	37-58	4.7	17.3	13.7	24.0	44.9	1.44
Bw3	58-70	2.5	14.5	20.9	22.5	42.1	1.51
BC	70-90	9.5	40.7	27.7	16.4	15.2	1.74
Gupteshwar pedon (P3)							
Ap	0-11	15.2	22.9	50.6	11.9	14.5	1.56
Bw	11-24	13.5	31.0	42.2	11.7	14.9	1.61
Bt1	24-45	26.9	50.0	15.7	13.1	21.2	1.41
Bt2	45-120	27.3	44.7	18.9	14.4	22.0	1.55

All the soils were neutral to mildly alkaline and calcareous. Surface soils of all the pedons had more than 6 g/kg organic carbon but it decreased significantly with depth (Table 3). Cation exchange capacity of the soils varied from 14.7 to 55.4 cmol (p+)/kg which was mostly related to the clay content of soils. Similar observations were recorded by Biswas *et al.* (1966) and Hirekurubar *et al.* (1991) in some soils of Andhra Pradesh derived from granitic parent material.

Table 3. Chemical properties of soils

Depth (cm)	pH (1:2.5)	EC dS m ⁻¹ (1:2.5)	CaCO ₃ g/kg	Org. C.	CEC and exchangeable cations (cmol (p+) kg ⁻¹ soil)				
					CEC	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
Kanchanpur pedon (P1)									
0-24	7.1	0.36	14.6	8.0	49.2	25.6	14.7	2.3	0.7
24-47	7.3	0.13	9.9	3.0	50.4	27.7	12.1	2.2	0.5
47-69	7.4	0.16	9.1	2.5	53.8	28.6	11.2	2.3	0.5
69-100	7.2	0.13	8.0	2.8	50.5	26.3	11.8	2.1	0.6
100-125	7.1	0.11	9.2	2.6	55.4	29.1	12.1	2.2	0.6
125-158	7.2	0.30	9.2	2.5	48.2	30.6	8.1	1.9	0.6
Garha pedon (P2)									
0-20	7.5	0.12	12.3	6.6	47.1	26.3	16.1	1.1	1.1
20-37	7.5	0.10	13.2	3.5	44.3	24.8	17.7	1.2	0.7
37-58	7.6	0.11	13.9	3.8	43.6	24.4	16.1	1.3	0.6
58-70	7.5	0.12	13.4	3.5	35.0	20.8	10.9	1.3	0.6
70-90	7.6	0.09	2.5	2.0	17.2	9.2	6.3	0.6	0.4
Gupteshwar pedon (P3)									
0-11	7.3	0.12	4.9	8.3	15.2	10.4	3.3	1.1	0.5
11-24	7.5	0.10	4.5	6.3	18.6	11.1	2.9	1.1	0.2
24-45	7.3	0.11	5.0	0.7	24.0	13.8	4.5	0.8	0.3
45-120	7.2	0.19	4.8	1.0	20.0	12.7	4.9	0.9	0.2

Kanchanpur soils showed the presence of ochric epipedon and slickensides within 47 to 125 cm depth. They have more than 35 per cent clay throughout the profile. They are classified as fine, smectitic, hyperthermic family of Typic Haplusterts. The presence of cracks, clay content >35% and cambic B horizon in Garha soils necessitated its placement under fine, smectitic, hyperthermic family of Vertic Ustochrepts. Due to the presence of ochric epipedon and clay coatings on peds (Bt horizon) the Gupteshwar soils were classified as coarse-loamy, mixed, hyperthermic family of Typic Haplustalfs.

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