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Influence of Parent Material on Soil Characteristics in a Topo-sequence of Tamil Nadu Uplands

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Abstract: Studying the soils of different parent material is of utmost importance as it is the basic material upon which soil develops. Nature and characteristics of the soils developed from four different parent materials such as, granite-gneiss, charnockite, calcic-gneiss and colluvio-alluvium were studied in Palani block of Dindigul district, Tamil Nadu. Soils had legacy with the parent materials and showed significant differences in their colour, texture, drainage, soil reaction and nutrient status. The soils were deep to very deep (100 to >150 cm), dark reddish brown (5YR 3/4) to very dark grayish brown (10YR 3/1), well to somewhat poorly drained, moderately acid to strongly alkaline (5.8-8.9) with low to medium in organic carbon (0.14-0.56 %). Soils of granite-gneiss and charnockite origin had similarity in their texture, gravel content, horizon sequence (Ap-Bt), soil colour, clay content and soil reaction. Soils of calcic-gneiss were very dark gray in colour (10YR 3/1), non-gravelly, clay textured, clay content (55-66 %) and associated slickensides close enough to intersect. Soils of colluvio-alluvium had irregularity in the distribution of clay content and soil colour. Taxonomically the soils were classified as Fine-loamy, mixed, iso-hyperthermic Typic Paleustalfs, Fine-loamy, mixed, isohyperthermic Typic Haplustalfs, Fine, smectitic, iso-hyperthermic Typic Haplusterts and Fine-loamy, mixed, isohyperthermic Typic Haplustepts, respectively. Understanding the influence of parent materials on pedogenesis of these soils would help in optimal soil resource management for sustainable agriculture.

Keywords: *Parent material, pedogenesis, soil properties, soil classification*

Introduction

Parent material is one of the soil forming passive factors upon which the soil development happens (Jenny 1941). Under the same agro-ecological conditions, parent materials influence the morphological and physico-chemical properties of the soils (IUSS Working Group WRB 2006). Different elemental composition of parent materials would result in differential soil weathering products. Weathering rate of the parent materials determine the rooting depth, the quantity of cations and sesquioxides present in the parent materials which influence the soil structure, nutrient status and soil pH (Gray *et al.* 2016). In addition, stabilization of organic carbon and water holding capacity depends on type of clay minerals and its content inherited from the parent materials (Likhar and Jagdish Prasad 2011). Numerous studies have proven the direct influence of parent material on soil texture, pH, porosity and moisture content (Sierra *et al.* 2009) and nutrient status and mineral make up (Wakode *et al.* 2017).

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Although parent materials receive poor attention in soil taxonomy, it is nonetheless crucial for the classification of Andisols and Vertisols (Wilson 2019). In Palani study area, four different parent materials (granite-gneiss, charnockite, calcic-gneiss and colluvio-alluvium deposited soils) are observed. Charnockite is more likely to granulitic rocks with unusual presence of orthopyroxene instead of amphiboles and mica of granite. Calcic-gneiss is the parent materials having ribbed weathering nature interbedded in charnockite rocks. Difference in parent materials results heterogeneity in soil properties and understanding such heterogeneity may be crucial for soils series identification and suitable agro-managements. Otherwise, the suggestion offered to the farmers without taking the parent material into the account, it would become erroneous. With this consideration, a detailed soil characterization and classification of different parent material was attempted in Palani block of Dindigul district, Tamil Nadu.

Materials and Methods

Study area

Palani block (77°18'50" and 77°37'17" E; 10°21'18"and 10°32'27" N) of Dindigul district, Tamil Nadu with total area of 39,960 ha is situated in the leeward down direction of Palani hill ranges of Western Ghats and comes under Tamil Nadu uplands (AESR 8.1) (Fig. 1). It receives average annual rainfall of about 760 mm and falls under isohyperthermic temperature regime and ustic soil moisture regime. According to GSI, the major geology of palani block is granite-gneiss. However, under the same geology, different parent materials were seen and they showed specificity to catenary sequences such as charnockite in foot hills of palani hill ranges, granite gneiss in upper pediplain, calcic-gneiss in lower pediplain and colluvio-alluvium in valley landform (Table 1). Irrigated and rainfed upland crops such as maize (*Zea mays*), sorghum (*Sorghum bicolor*), beans, vegetable crops (tomato, onion, drumstick, cabbage, radish, *etc*.), coconut (*Cocos nucifera*) and mango (*Mangifera indica*) plantations are being cultivated on granite-gneiss and charnockite landforms. Major land uses of calcic-gneiss soils are cotton (*Gossypium sp.*), paddy (*Oryza sativa* L.), maize (*Zea mays*), guava (*Psidium guajava*) and coconut (*Cocos nucifera*). Rice (*Oryza sativa* L.) is the major crop being cultivated for two to three seasons in the low-lying colluvio-alluvium deposited soils due to the availability of irrigational water from Palar-Porundhalar dam, Kudhiraiyar dam and Varthamanathi dam.

Soil characterization

Site and their morphological characteristics were examined in the field as per standard procedures laid out in the Soil Survey Manual (Soil Survey Staff 2003). Based on detailed soil and site characterization and morphological features, four typifying pedons occurring on different parent materials were considered for the present study (P1-P4). Horizon-wise soil samples were collected from typifying pedons (Table 1). Soil samples were air dried and passed through 2 mm sieve and analyzed for particle-size distribution following International Pipette Method (Richards 1954) 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. The cation exchange capacity (CEC) was estimated as described by Jackson (1973). The available P content of acidic soils was estimated following Bray method (Bray and Kurtz 1945) and neutral and alkaline soils were estimated by Olsen's method (Olsen *et al.* 1954). Available potassium was extracted using neutral normal ammonium acetate and determined with flame photometer (Jackson 1973). DTPA extractable available micronutrients (Fe, Zn, Cu and Mn) were measured in Atomic Absorption Spectrometer (Lindsay and Norvell 1978). The soils were classified as per Soil Taxonomy (Soil Survey Staff 2003).

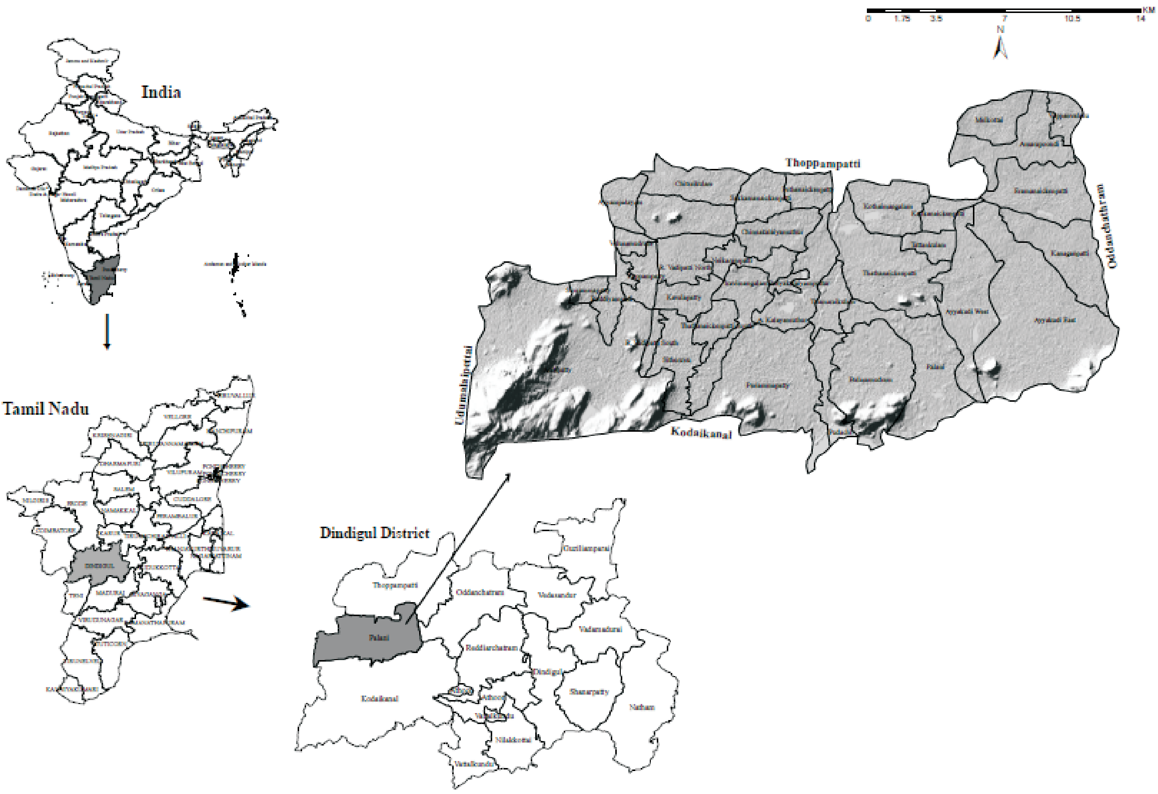

Fig. 1. Location map of the study area

Table 1. Landscape characteristics of pedons

Pedons	Parent material	Location	Landform	Elevation	Slope	Drainage
Pedon1	Granite-gneiss	10°29'7.1" N, 77°24' 52.9" E	Upper pediplain	347 m	0-1 %	Well drained
Pedon2	Charnockite	10°25'29" N, 77°20' 33.8" E	Foot hills of hill ranges	374 m	3-5 %	Well drained
Pedon3	Calcic-gneiss	10°28'53.2" N, 77°35' 53.7" E	Lower pediplain	319 m	0-1%	Somewhat poorly drained
Pedon4	Colluvio-alluvium	10°27'48.61" N, 77°27' 4.1" E	Valley	307 m	1-3%	Well drained

Result and Discussion

Soil morphology

The morphological characteristics of the soils are presented in table 2 and fig. 2. The solum depth of the studied soils varied from deep to very deep (100-150+ cm). Pedons 1, 2 and 4 were well drained while the pedon 3 had somewhat poor drainage. The texture of the soils varied from sandy loam to sandy clay loam barring pedon 3. In pedon 3, no discernable difference in soil texture was observed with depth. Pedoturbation (internal churning) inhibiting the horizons development as it is the major pedogeneic process in clay rich soils

(a) (b) (c) (d)

Fig. 2. Soils of different parent materials (a) Granite-Gneiss, (b) Charnockite, (c) Calc-Gneiss, (d) Colluvio-alluvium

(Bhattacharyya *et al.* 1997). Clay soils associated with reduced drainage signify the influence of clay on soil drainage. Pedons 1 and 2 had redder hue values (5YR) owing to pedogeneic process of rubrification and the colour of the Pedon 3 varied from black to very dark grayish brown (10YR) with value ranging from 2 to 3 and chroma 1 and 2. Dispersed forms of clay humus complex would be the reason for black colour of smectite dominated clay soils. Pedon 4 had soil colour in the 7.5YR of sub-surface soils and 10YR hue in surface soils. The darker colour of surface soils might be due to continuous inundation with water and masking effect of high organic matter under anaerobic condition. The reddish hue of pedons 1 and 2 might be due to iron and manganese compounds and their hydration in the parent material and climate (Chandran *et al.* 2013). Pedons 1 and 2 were gravelly with < 35 per cent coarse fragments. The presence of gravelliness associated with the landform and weathering rate of the parent material (Mishra 1987). Other soils, with the exception of Pedon 3, displayed medium, weak and sub-angular blocky structure, whereas, pedon 3 possessed medium to coarse, strong to moderate, and sub-angular to angular blocky structure. The angular structures of the pedon 3 might be attributed to the higher clay content and better ratio of fine clay to total clay (Kadao *et al.* 2003). The granite-gneiss soil (P1) was hard to very hard, friable to firm, moderately sticky and plastics, charnockite soil (P2) was slightly hard to hard, friable to firm, slightly to moderately sticky and plastic. Calc-gneiss soils (P3) had consistency ranging from hard to extremely hard (dry), firm to very firm (moist) and very sticky and very plastic (wet) whereas the consistency of the P4 relies upon the materials that have been deposited from other parent materials. Type of clay minerals and their amount and cementing agents determine the consistency of soils (Sathish *et al.* 2018). With respect to calcareousness, the pedons 3 and 4 had slight to violent effervescences. The calcareousness in pedon 3 is due to pedogeneic calcium carbonate formation (Kalaiselvi *et al.* 2020) whereas in pedon 4, the calcareousness might be due to the deposition of leachates from higher apex.

Physical characteristics

Particle-size analysis of soils of different parent materials indicated significant difference in particle-size fractions (Table 2). In contrast to the soils of calcic-gneiss, which showed the distribution of clay (>60 %)>silt (>25 %) >sand (20 %), the soils of granite-gneiss and charnockite origin had particle-size fraction (PSF) in the order of sand (>70 %) >clay (20-27 %) >silt (15 %).

Table 2. Morphological and physical characteristics of soils developed from different parent materials

Depth (cm)	Horizon	Soil colour (Moist)	Size class and Particle Diameter (mm) Total			Texture Class (USDA)	Gravel content (%)	Soil structure			Consistency		
			Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)			S	G	T	D	M	W
Fine-loamy, mixed, isohyperthermic Typic Paleustalfs (Granite-gneiss parent material)													
0-18	Ap	7.5YR4/4	87.5	7.2	5.2	ls	-	f	1	sbk	l	fr	s0/p0
18-36	Bt1	5YR3/4	66.4	10.9	22.6	scl	-	m	2	sbk	h	fi	ms/mp
36-61	Bt2	5YR3/4	63.3	9.8	26.8	scl	-	m	3	sbk	Vh	fi	ms/mp
61-96	Bt3	5YR3/4	58.7	13.7	27.5	scl	-	m	3	sbk	vh	fi	ms/mp
96-170+	BC	5YR3/4	65.9	11.9	22.0	scl	55	m	3	sbk	vh	fi	ms/mp
Fine loamy, mixed, isohyperthiermic Typic Haplustalfs (Charnockite parent material)													
0-15	Ap	5YR4/4	75.6	9.5	14.8	sl	-	Vf	0	gr	l	fr	s0/p0
15-45	Bt1	5YR4/4	64.9	10.3	24.7	scl	-	m	2	sbk	sh	fr	ss/sp
45-67	Bt2	5YR4/4	70.0	9.7	20.2	scl	20	m	2	sbk	sh	fr	ss/sp
67-100	Bt3	5YR4/3	71.4	7.7	20.8	scl	50	m	1	sbk	sh	fr	ss/sp
100-130	Bt4	5YR4/3	67.0	11.9	21.0	scl	70	m	2	sbk	h	fi	ms/mp
WPM													
Fine, Smectitic, isohyperthermic (calcareous), Typic Haplusterts (Calc-Gneiss parent material)													
0-19	Ap	10YR 3/1	15.0	29.6	55.3	c		m	2	sbk	h	fi	vs/vp
19-50	Bw1	10YR 3/1	16.4	25.7	57.8	c		m	2	sbk	vh	vfi	vs/vp
50-83	Bw2	10YR 3/1	10.6	29.0	60.3	c		c	3	sbk	vh	vfi	vs/vp
83-126	Bss1	10YR 3/1	7.5	30.4	61.9	c		c	3	abk	vh	vfi	vs/vp
126-165	Bss2	10YR 3/1	6.3	28.0	65.6	c		c	3	abk	vh	fi	vs/vp
Fine loamy, mixed, isohyperthermic (calacareous) Typic Hplustepts (Colluvio alluvium parent material)													
0-19	Ap	10YR 3/4	78.09	11.27	10.65	sl	-	m	1	sbk	sh	fr	ss/sp
19-60	Bw1	7.5YR4/4	76.80	11.40	11.81	sl	-	m	1	sbk	h	fr	ms/mp
60-84	Bw2	7.5YR3/3	63.74	10.42	25.84	scl	-	m	2	sbk	h	fi	ms/mp
84-113	Bwk1	7.5YR3/4	59.71	13.14	27.15	scl	-	m	2	sbk	h	fi	ms/mp
113-125	Bwk2	7.5YR6/3	69.90	10.94	19.17	sl	-	m	1	sbk	sh	fr	ss/sp

Texture: c - clay, sl- sandy loam, scl - sandy clay loam.
Structure: Size (S) - m - medium, c - coarse; Grade (G) –1- weak, 2 - moderate, 3 - strong; Type (T)- abk - angular blocky, sbk - sub-angular blocky.
Consistence: Dry: sh - slightly hard, h – hard; Moist: fr - friable, vfr-very friable, fi - firm, vfi - very firm; Wet: ss - slightly sticky, ms – moderately sticky, vs-very sticky ; sp – slightly plastic, mp – moderately plastic, vp-very plastic.

The deposited soils of colluvio-alluvial parent material had high sand fractions (>60 %) than silt (10-15 %) and clay (12-27 %). The fact that clay content increased with depth could be attributed to the downward movement of finer particles from the surface. The dominance of sand particles in P1 and P2 might be due to quartz rich parent materials such as granite-gneiss and charnockite (Wilson 2019) and removal of finer particle through run-off (Surekha *et al.* 1997). Regardless of the parent material, silt fractions registered an irregular trend with depth, which might be attributed to the weathering variability of the parent materials (Satish Kumar and Naidu 2012). Available water content of P1 to P4 ranged between 5.57 per cent and 16.7 per cent. Soils of calc-gneiss (P3) had high available water content, whereas, the higher porosity and hydraulic conductivity of granite materials (P1-P2) showed low available water content. It supports the hypothesis that clay and soil water-holding capacity are positively correlated. Invariable to the soils, water holding capacity increased with depth attributed to the increment of clay content with depth (Sathish *et al.* 2018).

Chemical characteristics

The chemical characteristics of the soils depend on the composition of parent materials, which were apparently seen in this study (Table 3). Pedon 1 belongs to granite-gneiss and was associated with moderately to slightly acidic pH while, pedon 2 of charnockite origin was more acidic (very strongly to moderately acid). Acidic nature of the granite-gneiss and charnockite, intense weathering, high solubility of bases and leaching from the parent materials might be the reasons for the acidic nature of P1 and P2 (Anda *et al.* 2008). Pedon 3 of calcic-gneiss parent material had slightly alkaline (pH7.88) to strongly alkaline (pH 8.85) might be attributed to the calcic nature of the parent material, topographical variance, leaching, fertilizer management and exchangeable sodium. Regardless of the parent material and landform, the soils have shown the increasing trend of pH with depth that might be due release of organic acids during decomposition of organic matter, application of acid forming fertilizers and leaching losses of bases in the surface soils (Sathish *et al.* 2018). Overall, the soils of study area were non-saline except of calc-gneiss parent material (pedon 3) wherein, the presence of calcium content would resulted an increase in the EC of sub-surface horizons. Similarly, the valley soils (P4) observed with high EC due to deposition of high exchangeable bases from higher elevation by slope gradient. Cation exchange capacity of the soils varied from 4.1 to 73 cmol (+) kg^{-1} soil. The soils of P1 and P2 had low CEC in their control section (25-100 cm) ranging from 10.76-17.67 cmol (+) kg^{-1} which was positively related to soil acidity. In contrary, the soils of P3 registered high CEC ascribed to high smectitic clay content (Gaikwad *et al.* 2020). In pedon 1& 2, the exchangeable calcium (Ca^{2+}) was observed very high followed by magnesium (Mg^{2+}) in the order of Ca^{2+}>Mg^{2+}>K^{+} >Na^{+} whereas, the pedon 3 and 4 manifested contradict trend of Na^{+} and K^{+} in sub-surface horizons as Ca^{2+}>Mg^{2+}>Na^{+}>K^{+}. $CaCO_3$ was found in Pedon 3 and 4 and the presence of high free $CaCO_3$ content might be due to formation of pedogeneic calcium carbonate under semi-arid climate and their deposition in low-lying areas (Khanday *et al.* 2017). The exchangeable sodium percentage (ESP) was high in pedon 3 (8-14 %), which might be ascribed to the formation of pedogenic carbonates leading to the development of sub-soil sodicity (Kalaiselvi *et al.* 2020). Despite the criteria for sodic soils (ESP>15 %), the high clay of soils with the ESP of >5% is considered as chemical degradation of soils and critical for crop production (Kadu *et al.* 2003).

Available nutrient status

Mineral composition of parent materials influences the nutrient constituents of the soils mainly, Fe, Al, P and Ca (Gray *et al.* 2016). Organic carbon (OC) was low to medium ranging from 0.9 to 6.4 g kg^{-1} in the pedons (Table 4). Despite the parent material influence the landuse, the organic carbon content did not show any specific difference between the parent materials. Though many studies have proven the effect of texture, clay content on soil organic carbon, in the present study such effects are non-evident as the area recorded with low SOC content which might be due to higher

Table 3. Physico-chemical and chemical properties of soils developed from different parent material

Horizon	pH	EC	O.C	Exchangeable bases (cmol (+) kg^{-1})				CEC (cmol (+) kg^{-1})	Clay/CEC	FC (%)	PWP (%)	AWC (%)	$CaCO_3$ (%)	ESP (%)
		dSm^{-1}	%	Ca	Mg	Na	K							
Fine-loamy, mixed, isohyperthermic Typic Paleustalfs (Granite -gneiss parent material)														
Ap	6.40	0.043	0.29	1.53	0.64	0.06	0.17	4.10	0.78	7.98	1.61	6.37	-	1.45
Bt1	6.68	0.035	0.33	7.46	3.71	0.08	0.12	14.16	0.63	18.84	8.05	10.79	-	0.56
Bt2	6.77	0.083	0.17	8.92	4.61	0.14	0.10	16.26	0.61	21.14	8.91	12.33	-	0.88
Bt3	6.91	0.036	0.13	9.70	4.55	0.14	0.09	17.67	0.64	22.37	9.92	12.45	-	0.81
BC	7.10	0.034	0.09	8.47	4.39	0.16	0.12	15.91	0.72	18.46	7.73	10.73	-	1.03
Fine loamy, mixed, isohyperthiermic Typic Haplustalfs (Charnockite parent material)														
Ap	5.36	0.078	0.30	3.94	2.13	0.02	0.14	8.31	0.56	14.04	7.07	6.97	-	0.25
Bt1	5.89	0.031	0.24	6.04	3.28	0.07	0.13	12.64	0.51	20.40	9.11	11.29	-	0.59
Bt2	6.14	0.033	0.18	5.26	3.23	0.12	0.11	11.12	0.55	17.67	7.67	10	-	1.07
Bt3	6.32	0.038	0.16	4.81	2.88	0.18	0.10	10.76	0.52	18.26	8.47	9.79	-	1.71
Bt4	6.39	0.043	0.14	5.33	3.02	0.36	0.12	12.17	0.58	18.38	9.52	8.86	-	2.92
Fine, Smectitic, isohyperthermic (calcareous), Typic Haplusterts (Calc -Gneiss parent material)														
Ap	7.88	0.247	0.56	47.81	13.98	0.31	0.99	45.60	0.82	39.90	24.60	15.3	3.64	0.68
Bw1	8.40	0.247	0.36	56.69	26.18	1.63	0.38	55.22	0.95	37.98	26.42	11.56	6.24	2.96
Bw2	8.85	0.471	0.39	46.73	25.77	4.88	0.36	60.94	1.01	43.66	30.99	12.67	6.11	8.01
Bss1	8.00	3.290	0.39	67.21	20.36	6.79	0.31	61.40	0.99	49.39	32.70	16.69	7.41	11.1
Bss2	8.16	3.670	0.50	70.78	21.27	8.9	0.25	64.15	0.98	51.77	35.11	16.66	8.97	13.9
Fine loamy, mixed, isohyperthermic (calacareous) Typic Hplustepts (Colluvio alluvium parent material)														
Ap	6.54	0.132	0.64	5.168	2.502	0.104	0.115	9.6	0.90	10.48	4.91	5.57	0.00	1.96
Bw1	7.53	0.105	0.20	5.180	2.877	0.198	0.134	10.09	0.85	13.66	5.94	7.72	0.00	0.42
Bw2	8.26	0.156	0.20			0.304	0.178	18.72	0.72	20.1	9.2	10.9	2.40	1.63
Bwk1	8.57	0.187	0.17			0.480	0.173	20.70	0.76	24.2	10.08	14.12	10.9	2.32
Bwk2	8.47	0.212	0.19			0.430	0.107	19.76	1.03	16.75	4.67	12.08	10.9	2.18

Table 4. Fertility properties of soils developed from different parent material

Depth (cm)	Horizon	EC (dSm^{-1})	OC%	P(kg/ha^{-1})	K(kg/ha^{-1})	S	B	Cu	Fe	Mn	Zn
						mg kg^{-1}		mg kg^{-1}			
Fine-loamy, mixed, isohyperthermic Typic Paleustalfs (Granite -gneiss parent material)											
0-18	Ap	0.043	0.29	27	156	19.82	0.14	1.08	15.80	15.36	0.36
18-36	Bt1	0.035	0.33	3	106	9.48	0.33	2.38	13.08	17.72	0.06
36-61	Bt2	0.083	0.17	4	95	5.17	0.31	2.04	9.52	13.56	0.08
61-96	Bt3	0.036	0.13	4	83	0.86	0.44	1.92	7.62	12.94	0.08
96-170+	BC	0.034	0.09	2	75	7.75	0.30	1.08	6.70	8.10	0.08
Fine loamy, mixed, isohyperthiermic Typic Haplustalfs (Charnockite parent material)											
0-15	Ap	0.078	0.30	41	117	2.50	0.08	0.80	23.08	13.22	0.08
15-45	Bt1	0.031	0.24	23	116	8.33	0.14	0.60	12.38	13.58	0.04
45-67	Bt2	0.033	0.18	11	126	6.66	0.22	0.62	11.36	10.90	0.04
67-100	Bt3	0.038	0.16	6	120	16.66	0.15	0.66	10.86	6.65	0.08
100-130	Bt4	0.043	0.14	8	122	10.00	0.21	0.60	9.66	7.44	0.02
WPM											
Fine, Smectitic, isohyperthermic (calcareous), Typic Haplusterts (Calc -Gneiss parent material)											
0-19	Ap	0.247	0.56	17	520	7.75	0.39	0.80	1.30	2.42	0.46
19-50	Bw1	0.247	0.36	2	298	4.31	0.35	0.74	1.26	1.58	0.32
50-83	Bw2	0.471	0.39	2	328	4.31	0.37	1.24	1.72	1.36	0.92
83-126	Bss1	3.290	0.39	1	309	930.1	0.66	1.26	1.42	1.24	0.62
126-165	Bss2	3.670	0.50	4	306	977.5	0.73	1.48	1.02	0.86	0.58
Fine loamy, mixed, isohyperthermic (calacareous) Typic Hplustepts (Colluvio alluvium pare nt material)											
0-19	Ap	0.132	0.64	66	104	26.66	0.17	2.60	113.80	5.48	0.78
19-60	Bw1	0.105	0.20	13	94	10.00	0.10	1.10	6.60	3.70	0.06
60-84	Bw2	0.156	0.20	8	116	10.00	0.07	1.26	1.98	1.96	0.04
84-113	Bwk1	0.187	0.17	7	110	16.66	0.13	0.96	0.70	1.04	0.04
113-125	Bwk2	0.212	0.19	14	68	17.50	0.08	0.66	4.04	0.76	0.08

decomposition rate of OM at tropical conditions (Nayak *et al.* 2002). Available phosphorus content varied from low to high range, wherein surface soils had high available phosphorus than sub-surface soils. The availability of phosphorus on surface soils might be attributed to fertilizer management whereas, in sub-surface available phosphorus, the calcic-gneiss parent material had very low availability of phosphorus that might be due to phosphorus fixation at high calcium content as calcium phosphate at alkaline pH (Kalaiselvi *et al.* 2020). The parent materials influence the available P not only through fixation and mineralization, also by altering the texture of the soils (Renneson *et al.* 2010). The available K content was low to medium in all the soils except the soils of calcic-gneiss parent material wherein the available K content was high in pedon 3. Reduced availability of K in granulite parent material (P1 & P2), conversely high availability in P3 might be attributed to intense weathering of parent material, high leaching rate, topographic gradients and K rich smectitic clay minerals. The sulphur content was low to medium (<10 and 10-20 mg kg^{-1}) in pedons 1 and 2. Pedon 3 recorded significantly high available S in sub-surface (>900 mg kg^{-1}), which might be due to the accumulation of the partial calcretes and partial gypsic ($CaSO_4$) nodules. This was in concordance with black cotton soils of Tamil Nadu (GSI 2006). Boron and Zinc were found to be low in the study area irrespective of the parent materials. Availability of iron was high in pedons 1 and 2, as these soils were developed from ferromagnesium rich parent materials like granite-gneiss and charnockite.

Soil taxonomy

Based on morphological, physical and physico-chemical properties, the typifying pedons of each parent material were classified according to Soil Taxonomy (Soil Survey Staff 2003). The soils of granite gneiss and charnockite were classified into Alfisols due to >35 per cent base saturation and presence of clay cutans (illuviation) whereby indicating the argilluviation pedogenesis. Pedon 1 had more stabilization than Pedon 2 by having 20 per cent or more clay increase with depth and redder than 7.5YR hue and classified as Typic Paleustalfs, whereas, the pedon 2 was classified as Typic Haplustalfs as did have other Ustalfs. Sub-soils of Pedon 3 on calc-gneiss parent material was noticed with slickensides close enough to intersect in upper 100 cm of mineral soils, >30 per cent weighted average clay content and intersection of cracks, hence it is classified under Vertisols at order level and further as Usterts at sub-order level due to ustic soil moisture regime and Typic Haplusterts at sub-group level as it does not show any intergradation or extragradation. Pedon 4 was classified under Inceptisols order due to presence of cambic horizon owing to alteration in colour, texture, structure and does not qualify for any other diagnostic horizons and brought under subgroup of Typic Haplustepts. While taxonomic classification of soils, mineralogy classes are added for each soil as it could aid in predicting soil behaviour. In such way, the pedon 3 has smectitic mineralogy due to the predominance of swell-shrink clay, whereas others have mixed mineralogy.

Conclusion

The present study manifested that the soils developed from different parent material possessed the signature of their parent material. The soils of granite-gneiss and charnockite had low nutrient retention, water holding capacity and acidic pH, while the soils of calcic-gneiss parent material had higher in nutrient content, water retention capacity with alkaline pH and increased calcium carbonate content. Based on the characterization, the soils are classified into Typic Paleustalfs, Typic Haplustalfs, Typic Haplusterts and Typic Haplustepts at sub-group level. The study proved the influence of parent material in controlling the pedogeneic processes of soils. The detailed characterization and scientific evaluation for crop suitability will undoubtedly help in taking effective measures such as nutrient management, suitable crop cultivation and sustainable land management.

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