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Morphology, Chemistry and Classification of Two Red Soil Series

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Two major soil series of Coimbatore District viz., Irugur series and Palathurai series were studied in detail for their morphology, physicochemical characteristics and clay minerology. The parameters of the profiles revealed *in-Situ* development of the soil series from weathered gneissic rocks. The clay minerology was found to be dominated with kaolinite clay mineral. The calcareous nature of the Palathurai series was found to be due to the influence of parent material.

Coimbatore district presents a wide variety of soils of which the red soils occupy 60% of the total area. Irugur series occepy 4, 01,230 hectares (26%) and Palathurai series is spread over 60, 190 hectares (4%) representing non-calcareous and calcareous soils respectively. The current study is envisaged to provide basic information like genetic make up, clay minerology, geology etc., and to aid in planning in these soils, as these two soil series support a wide variety of crops in the district.

MATERIALS AND METHODS

Eight profile pits were dug besides examining several roadcuts, wellcuts, other excavations etc., and four profiles two in each series were taken for study. Detailed macromorphological characters were recorded (Anon. 1970). The various genetic horizons were analysed for the particle size distribution and for physico-chemical properties by conventional methods. Clay-fraction was prepared (Piper, 1966) and fusion analysis was done. Cation exchange capacity of clay, (Jackson, 1956) differential thermal analysis (Eberbach portable apparatus 1946) and minerologyof sand fraction were done(Hameed Khan and Hanuman Ram, 1975). Physiography, relief, drainage, geology and climate of the region were recorded.

The profile descriptions of the soil series under study is given below :

(a) Irugur series - Sandy clay loam - cultivated.

Hori-zon	Depth	Macromorphology
Ap	0-16 cm	Dark red (2.5 YR 3.5/4) moist; sandy clay loam; moderate, coarse, crumb structure; dry hard, moist firm, sticky and plastic when wet; violent effervescence; pH 7.8; moderately rapid permeability; many, coarse

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Hori-zon	Depth	Macromorphology
		roots; abrupt smooth boundry.
B_2t	16-37 cm	Dark reddish brown (2 5 YR 3/4) dry and moist; clay loam; moderate, medium subangular black; slightly hard; moist friable, sticky and plastic when wet; pH 7.6; moderately rapid permeability; patchy thin clay skins on pedfaces; clear smooth boundry.
B_3t	37-116 cm	Dark reddish brown (2. 5YR 3/4) dry and moist; gravelly clay, moderate medium subangular blocky; dry slightly hard; moist friable; sticky and plastic when wet; continuous thin clay skins on quartz gravel; 1 to 10 cm sized quartz gravel - 80%; pH 7.4; moderately rapid permeability diffuse boundry.
C	116-147 cm	Weathered gneiss with traces of clay movement.

(b) Palathurai series - Sandy loam - Cultivated

Ap	0-18 cm	Dark reddish brown (5YR 3/4) dry and moist; sandy loam; weak, medium, crumb structure; dry slightly hard, moist friable, slightly sticky and slightly plastic when wet; slight effervescence; pH 7.8; moderately rapid permeability; coarse few roots, clear smooth boundry.
B_1	18-31 cm	Dark reddish brown (5 YR 3/3) moist; sandy clay loam; weak, medium, subangular blocky structure; dry slightly hard, moist friable, wet slightly sticky and slightly plastic, no cutans; slight effervescence; pH 7.6; moderate permeability; coarse few to many roots; clear smooth boundry.
B_2t	31-83 cm	Dark reddish brown (5 YR 3/2) moist; sandy clay loam; strong, medium subangular blocky structure; patchy, thick clay skins on pad faces; dry hard; moist very firm, sticky and plastic when wet; 2 to 3 mm sized quartz gravel 7-8%; 3 to 5 mm sized calcium carbonate concretions about 10%; slight effervesence; pH 7.8; moderate permeability; few fine roots; clear smooth boundry.
Cca	83-120 cm +	Gravelly sandy clay loam violent effervescence; 70-80% of calcium carbonate concretions with illuviated clay; pH 8.

RESULTS AND DISCUSSION

1. Morphology of the soils : The Irugur series are moderately deep to deep with the absence of any mottlings and concretions in the solum exhibiting a well drained morphology. The most striking feature of these soils is the presence of a conspicuous quartz gravelly horizon (B3) which occurs also as a band. Ruhe (1959) attributed the presence of stonelines to the transported nature of soils. But in these soils the lithological fractions are a part and parcel of the profile. The absence of soil beneath the quartz band, existence of quartz as angular pieces with sharp edges, similar clay mineralogy with depth, constant geological make up suggest the origin of the Irugur series from the underlying weathered gneissic rocks. As weathering of the rocks proceeded from parent material upwards the resistant quartz veins which were inserted in normal geological processes were compressed due to metamorphic changes has remained in place; soil formation proceeded and later the solum was differentiated into various horizons which are exhibited in the present morphology. Such quartz accumulations were also reported as sedentary elsewhere (Dhanapalan Mosi *et al.* 1964; Roonwal and Bhumbla 1968/69). A textual B horizon indicating the eluviation and illuviation of clay and free iron oxides is also met with. It is worth mentioning that even 1-2% of the free iron oxides (Sodium dithionite extractable) are sufficient to impart the reddish hues to the soil. The presence of about 1% of iron oxides in the C horizon (weathered gneiss) can only be attributed to the eluviation of the same from surface horizon along with the colloidal clay.

In contrast to the Irugur series the Palathurai series are calcareous and well drained with the absence of any mottlings. But the presence of $CaCO_3$ concretions in the solum suggests the influence of the weathering of the parent rock and the redistribution of $CaCO_3$ in the form of concretions under the influence of the capillary rise and fall of water (Table I). Earlier workers (Govindarajan *et al.* 1964) suggested high temperature, poor drainage, low precipitation as causes for lime accumulations. The patchy thin clay skins and mechanical composition indicates the presence of an argillic horizon and the gradual strengthening of the structure down below also supports the above claim. But the subsoil horizons are not heavier. This can be due to poor mechanical eluviation.

The distribution of clays and its accumulation in the intermediate layers is much pronounced in Irugur series than in Palathurai series thereby indicating matured nature of Irugur series than Palathurai series.

II. Chemistry :

a. Chemical composition of the soil series : In Irugur series the sesquioxides and free iron oxides show an increasing trend with depth, the former having close association with clay, the Al_2O_3 being predominent suggesting a downward movement of alumina and iron either as free oxides or as part of the clay. CaO shows an increasing

TABLE. I. Physico chemical properties of the soil series

Series	Horizon	Depth	pH	$CaCO_3$ %	Organic matter %	Coarse sand %	Fine sand %	Clay %	Silt %
Irugur series	Ap	0-16	7.8	0.5	0.414	35.02	26.21	26.15	10.96
	B_2t	16-37	7.6	0.5	0.456	32.50	27.15	30.86	7.11
	B_3t	37-116	7.4	0.5	0.465	30.07	14.51	45.89	14.67
	C	116-147+	7.8	0.5	0.051	65.19	22.71	5.49	5 58
Palathurai	Ap	0-18	7.8	1.0	0.543	49.10	31.65	14.09	3 62
series	B_1	18-31	7.6	1.5	0.465	43.10	25.13	20.14	10.22
	B_2t	31-83	7.8	1.5	0.491	34.53	24.55	25.64	5.97
	Cca	83-120	8.0	17.5	0.750	38.87	14.73	28.96	19.76

Series	Horizon	Depth	R_2O_3	Fe_2O_3	Al_2O_3	CaO	MgO	Ex. Ca M. eq.	Ex. Mg M.eq.	Free iron oxide	C. E. C. Soil M.eq / 100 gr	C. E. C. Clay M.eq / 100 gr.
Irugur	Ap	0-16	13.89	6.93	6.96	1.701	0.131	8.00	0.55	1.823	16.1	42.53
	B_2t	16-37	16.11	7.36	8.75	0.544	0.118	1.05	0.55	1.028	13.4	33.42
	B_3t	37-116	24.63	8.29	16.34	0.623	0.074	1.60	0.55	3.412	22.4	30.29
	C	116-147	18.81	6.94	11.87	0.749	0.151	0.65	3.15	0.981	10.9	32.03
Palathurai	Ap	0-18	7.35	3.27	4.08	0.965	0.321	1.50	0.35	0.561	13.4	45.72
series	B_1	18-31	8.09	3.81	4.28	0.649	0.341	2.05	0.20	0.981	18.0	47.18
	B_2t	31-83	10.76	4.58	6.18	1.969	0.243	3.70	0.20	1.262	25.5	41.06
	Cca	83-120	9.77	4.77	5.00	11.748	0.306	6.15	0.60	0.841	23.9	46.11

trend with depth while MgO behaves irregularly. The CEC is closely related with clay and silt contents. The near neutral to alkaline pH and CEC indicate moderate weathering.

The calcareous Palathurai series is comparitively low in R_2O_3, eventhough the same increases with depth. The Al_2O_3 and Fe_2O_3, are comparitively evenly distributed. The CaO, MgO and exchangeable calcium are higher which can be attributed to the nature of the parent material. The analysis of Cca horizon shows the dominance of CaO over MgO which is in accordance with

the calcareous nature of the profile and parent material. The Cca horizon contains as high as 12.5 per cent to 17.5 per cent of calcium carbonate. Such accumulation of $CaCO_3$ is a typical observation in the calcisols of the whole district viz. Tulukkanur, Palladam Singanallur, Ammapettai etc., series. Similar observations in arid and semi-arid regions were made and were found to correlate the calcareous nature of the profile to parent materials (Buol, 1965).

(b) **Clay minerology :** Irugur and Palathurai series registered high loss on ignition values suggesting a possible admixture in the clay mineral make up. The Irugur series exhibited a uniform distribution of SiO_2, Al_2O_3, Fe_2O_3, etc., with depth, whereas a gradual increase in the SiO_2 content with depth in Palathurai series indicated a lesser degree of alkaline hydrolysis in these soils (Mohr and Van Baren 1959). In both the soils SiO_2 /Al_2O_3 ratio varied in the profiles from 1.79 to 2.65 suggesting a siallitric nature (Robinson 1949). The Sio_2 /R_2O_3 ratio was found to range between 1.62 to 1.95 for Irugur and 1.53 to 2.19 for Palathurai series, respectively. (Table II). The results are in agreement with the findings of Augustine Selvaseelan *et al.* (1973), and the slightly higher ratios may be due to resilicification of silica. The ratios suggested that the clay complex is dominated by kaolinite with a possible admixture of halloysite and illite. The differential thermal analysis also indicatad the presence of halloysite and slightly disordered nature of the Kaolinite mineral. This fact can be attributed to the high C. E. C. values of the clay and to the presence of free sesquioxides (Radwanski and Ollier 1959). The endo-thermic reactions between 400°C to 500°C and weak exothermic

TABLE. II. Chemical composition of clay fraction

Soil series	Horizon	Depth (cms)	Loss on ignition	Percentage on iginition basis					Molar ratios	
				SiO_2	Al_2O_3	Fe_2O_3	TiO_2	R_2O_3	SiO_2/ Al_2O_3	SiO_2/ R_2O_3
Irugur	Ap	0-16	17.48	47.210	40.940	9.563	2.208	52.711	1.97	1.71
Series	B_2t	16-37	11.12	46.770	38.446	11.480	2.103	52.027	2.09	1.76
	B_3t	37-116	16.88	45.000	40.184	10.952	2.107	53.153	1.91	1.62
	C	116-147	13.32	49.370	35.067	12.197	1.544	48.808	2.40	1.95
Palathurai	Ap	0-18	17.28	59.620	34.126	9.841	1.618	45.585	2.65	2.26
series	B_1	18-31	18.04	53.700	34.723	8.520	1.521	44.764	2.63	2.27
	B_2t	31-83	18.40	43.970	42.270	7.447	1.064	50.781	1.76	1.58
	Cca	83-120	22.24	55.930	34.673	8.654	1.614	44.941	2.75	2.37

reactions around 900°C to 1000°C even though indicate the predominance of kaolinite mineral the endothermic peaks from 0°C to 250°C suggest the occurrence of partially dehyderated halloysite in addition to the absorbed water. In Palathurai series the exothermic reactions around 700°C to 900°C may be due to the presence of vermiculite also as these profiles are calcareous in nature. TiO_2 content of the various horizons in both the soils indicated a weathered nature of the soils (Tanda 1951, Jackson 1965).

III. Classification : Based on the rainfall, soil temperature, presence of argillic horizon, ochric epipedon, clay minerology etc., the Irugur series can be classified as Fine loamy, Kaolinitic Isohyperthermic non-acid, Udic Rhodustalfs; and the Palathurai series as Fine loamy, Kaolinitic, Isohyperthermic; non-acid calcareous Typic Rhodustalfs.

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REFERENCES

ANON. 1970. *Guide lines for soil profile description.* Soil Survey and fertility Branch, Land and Water Development division, F. A. O. of United Nations, Rome.

AUGUSTINE SELVASEELAN, D., D. RAJ and T. S. MANICKAM. 1973. Clay Mineral Identification in Red Soils by Chemical Analysis. *Madras agric. J.* 60 : 941-44.

BUOL, S. W. 1965. Present Soil Forming Factors and Processes in Arid and Semi-arid regions. *Soil Sci.* 99 : 45-49.

DHANAPALAN MOSI, A., P. KANDASWAMY, and G. V. KOTHANDARAMAN. 1964. Studies on a Catena in Coimbatore District. I. Profile Description. *Madras agric. J.* 62 : 253-62.

GOVINDARAJAN, S. V., R. S. MURHTY, and N. S. SRINIVASAN. 1968. Occurrence of Lime in the Red Soils of Koppal district, Raichur (Mysore) under the Tungabhadra Watershed and their genesis. *Indian J. agric. Chem.* I : 31-34.

HAMEED KHAN, H. and HANUMAN RAM. 1975. Minerology of sand Fractions of two red soil series of Coimbatore district (Unpublished).

JACKSON, M. D. 1965. Clay transformations in soil genesis during the quarternary. *Soil Sci.* 99 : 15.

MOHR, E. C. J. and F. A. VAN BAREN. 1959. Tropical soils. Royal Tropical Institute. Amsterdam.

PIPER, C. S. 1966. Soil and Plant Analysis. Asia Publishing House. Bombay.

RADWANSKI, S. A., and C. D. OLLIER, 1659. A study of an East African Catena. *J. Soil Sci.* 10 : 149.

ROBINSON. 1949. *Soils, their Origin Constitution and Classification. An Introduction to pedology.* Thomas Murby G. Co., London.

ROONWAL, G. S. and D. R. BUMBLA. 1968/69. Contribution to the Minerology of the sand fractions and Geochemistry of the soils developed over gneissic rocks in the Kulu area (Central Himalayas) India. *Geoderma.* 2 : 309-12.

RUHE, R. V. 1959. Stonelines in Soils. *Soil Sci. Vol.* 87 : 223-37.

TANADA, T. 1951. Certain properties of the inorganic colloidal fraction of Hawaiian soils. *J. Soil Sci. Vol.* 11 : 83-86.