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Clay mineralogy of soils developed from granite-gneiss and alluvium in Ramachandrapuram mandal of Chittoor district in Andhra Pradesh

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Clay is an important soil constituent controlling its properties. Clay with cementing agents contributes to the structural stability that helps in resisting the destructive effects of rain and water. Moreover, clays have a large specific area that is mostly negatively charged and these sites retain nutrients like K^+ and $NH4^+$ ions and also adsorb many toxic elements. Much information is not available on the clay mineralogy of soils of Ramachandrapuram mandal of Chittoor district in Andhra Pradesh. Hence, the present investigation was carried out to identity the clay minerals in these soils for their sustainable management.

The area qualifies for '*Isohyperthermic*' temperature regime. The soil moisture control section remains dry for more than 90 cumulative days or 45 consecutive days in four months following summer solstice and it qualifies for '*Ustic*' soil moisture regime. The localized rock types are granite and gneiss.

Three typical pedons in Ramachandrapuram mandal of Chittoor district of Andhra Pradesh were selected and samples collected for analysis. The samples were air dried at room temperature and stored in cotton cloth bags. The air-dried samples were crushed, passed through a 2 mm sieve, mixed and

Table 1. Chemical composition of the soils (%)

Horizon	Depth (m)	SiO_2	R_2O_3	Fe_2O_3	Al_2O_3	P_2O_5	K_2O	Na_2O	CaO	MgO
Pedon 1 : Fine-loamy, smectitic, iso-hyperthermic Vertic Haplustept										
Ap	0.00 – .23	83.60	9.15	2.01	7.14	0.11	0.45	0.12	2.98	1.49
Bw1	0.23 – .61	81.30	12.15	3.22	8.93	0.09	0.51	0.17	2.80	1.00
Bw2	0.61 –.1.08	80.10	13.25	3.02	10.23	0.08	0.48	0.13	2.63	0.87
Bw3	1.08 – 1.57+	80.00	12.75	2.93	9.82	0.08	0.48	0.14	2.80	1.00
Pedon 4: Fine-loamy, kaolinitic, iso-hyperthermic Typic Haplustalf										
Ap	0.00 – 0.17	82.50	10.25	2.54	7.71	0.10	0.33	0.08	2.45	1.37
E	0.17 – 0.36	80.80	12.75	2.86	9.89	0.08	0.39	0.06	2.10	1.00
Bt1	0.36 – 0.68	79.20	14.25	3.29	10.96	0.09	0.39	0.10	1.93	0.87
Bt2	0.68 – 1.21	78.30	15.50	3.21	12.29	0.09	0.42	0.11	1.93	0.75
Bt3	1.21 – 1.65+	78.30	16.25	4.53	11.72	0.09	0.36	0.13	1.75	0.75
Pedon 6: Fine-loamy, kaolinitic, iso-hyperthermic Typic Ustorthent										
Ap	0.00 – 0.10	79.50	11.75	2.67	9.08	0.10	0.39	0.11	2.24	1.25
A1	0.10 – 0.26	81.30	10.75	2.31	8.44	0.07	0.48	0.09	2.10	1.12
A2	0.26 – 0.60	83.20	11.00	2.43	8.57	0.06	0.45	0.08	1.05	0.87
Cr	------ Weathered genesis ----------									

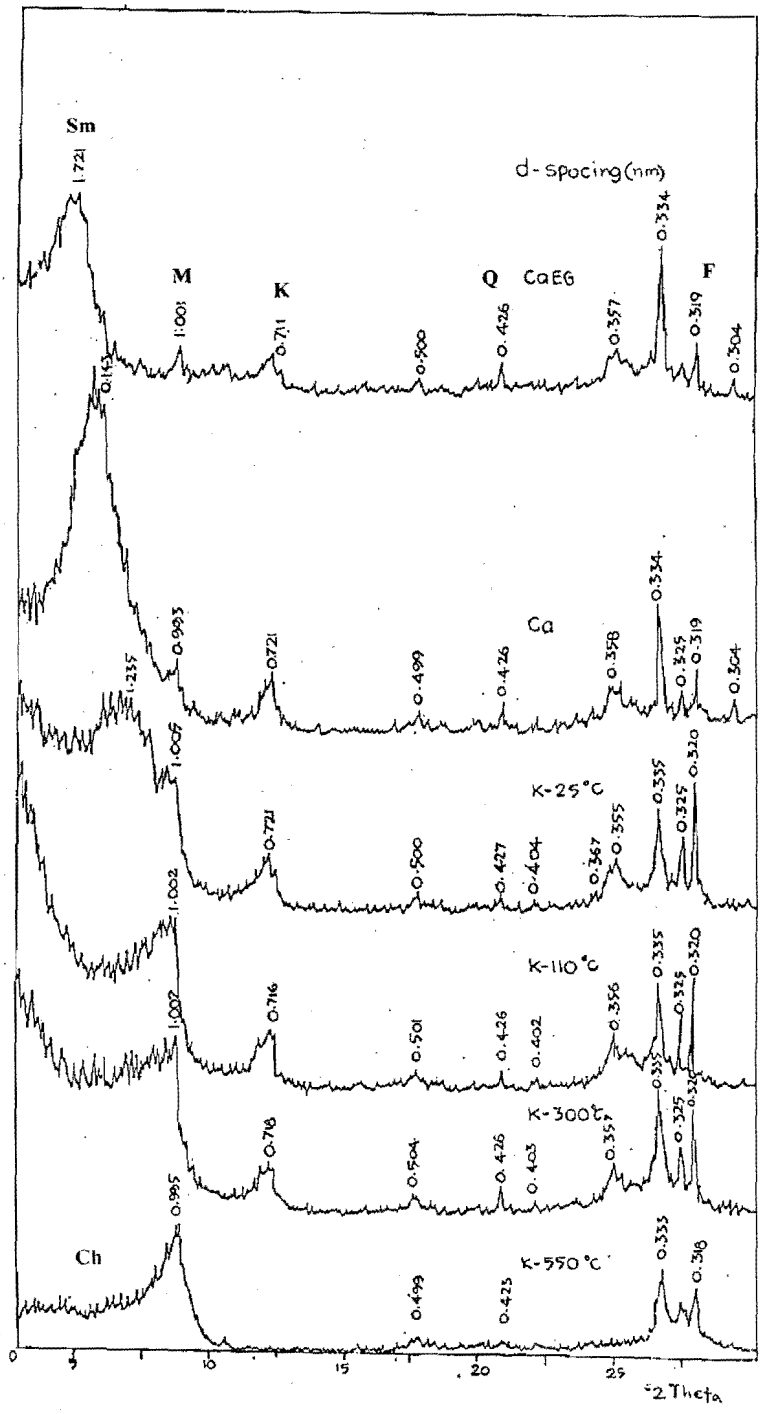

Fig. 1. Representative X-ray diffractograms of clay fractions of pedon I (Vertic Haplustept), Ca-Ca treated, CaEG - Calcium treated and glycerol solvated, K25°, K110°, K300° and K550° -K treated at 50°, 110°, 300° and 550°C respectively.

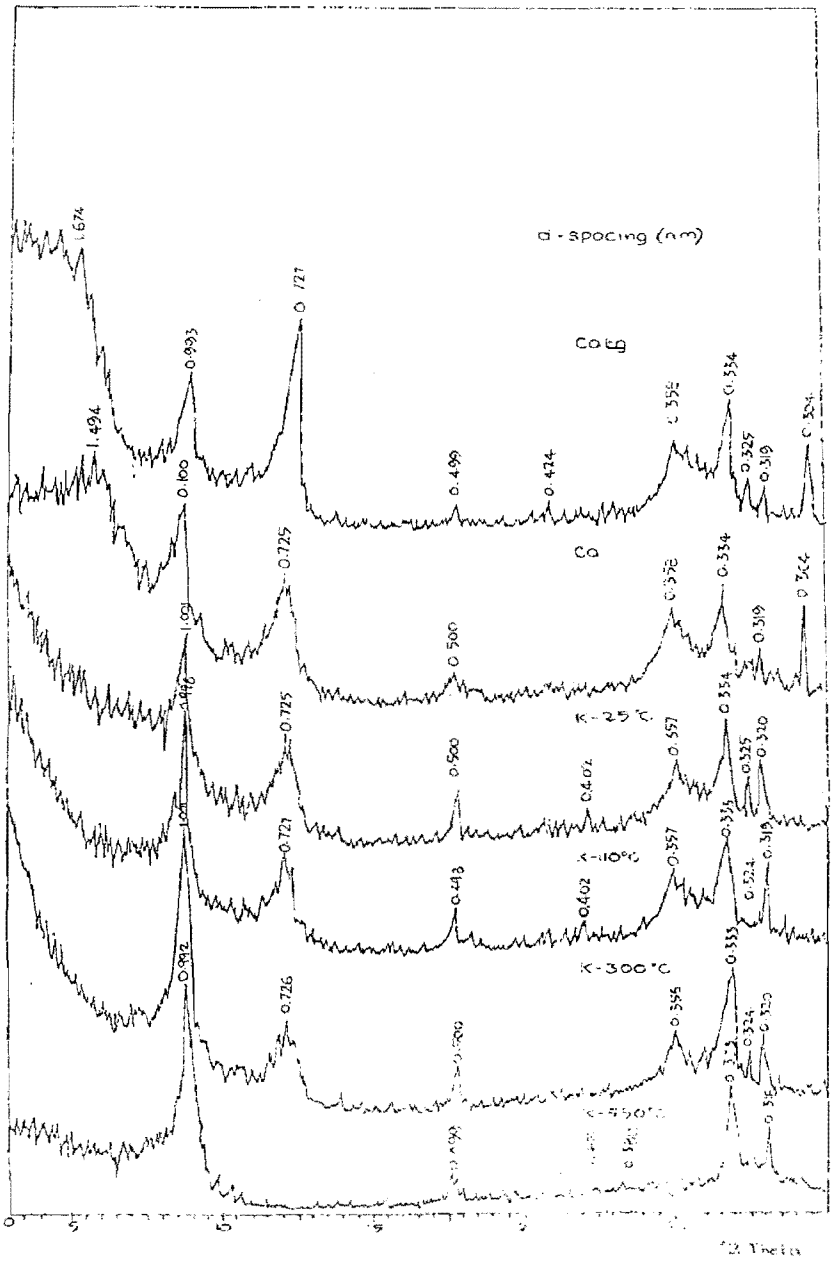

Fig. 2. Representative X-ray diffractograms of pedon 4 (Typic Haplustalf)

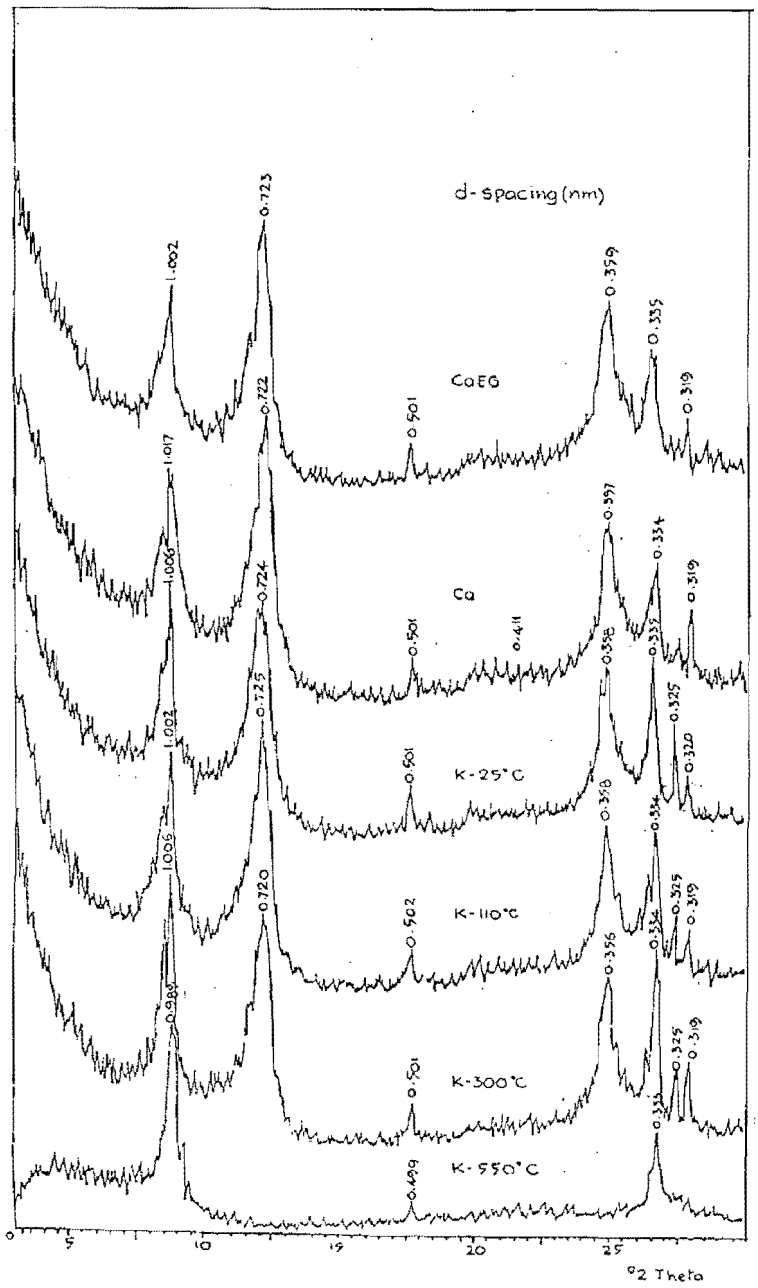

Fig. 3. Representative X-ray diffractograms of pedon 6 (Typic Ustorthent)

stored for analysis. The chemical and mineralogical analysis (Jackson 1979) and semi-quantitative estimation (Gjems 1967) were done using standard procedure.

The clay samples were primarily aluminosilicate minerals as indicated by appreciable amount of Fe_2O_3, MgO and less amount of K_2O (Table 1). Presence of Fe_2O_3 and MgO indicated the possible occurrence of smectite group of mineral (Mall and Mishra 2000). Relatively high P_2O_5 in the soil might be due to the occurrence of P-bearing minerals like apatites.

The clay fraction of the pedon 1 contains smectite, feldspars, kaolinite, mica and traces of quartz (Fig.1). An intense large peak at 1.430 nm d-spacing in Ca-saturated sample which shifted to 1.721 nm d-spacing on ethylene glycol solvation indicated the presence of smectite. Small and sharp peaks at 0.325, 0.319 and 0.304 nm d-spacings in Ca-saturated sample are indicative of occurence of feldspars. The small peak at about 0.711 nm and 0.355 nm d-spacing in all treatments except in K-saturation and heating at 550°C is indicative of kaolinite. The nature and intensity of peaks at 1.001 nm and 0.500 nm (second order) and 0.334 nm (third order) in all treatments confirmed the presence of mica clay mineral. Small quantities of quartz were noticed by the small peak at 0.426 nm d-spacing, in the clay fraction.

Kaolinite is the dominant clay mineral in pedon 4 which was detected by large peas at 0.727 nm d-spacing in Ca-saturated ethylene glycol solvation treatment and persistence of these peaks in all other treatments except in K-550°C treatment confirmed the presence of kaolinite (Fig. 2). Ca-saturated sample showed a peak at 1.494 nm which was shifted on glycolation to 1.674 nm is an indicative of smectite. The peaks of 0.993 nm, 0.499 nm and 0.334 nm d-spacings in Ca-saturated with ethylene glycol solvation treatment and persistence of these peaks in all other treatments indicated the presence of mica clay mineral. Feldspars were identified by small peaks at 0.319 and 0.304 nm d-spacings in Ca-saturated samples at room temperature treatment and similar peaks in all other treatments. A very small peak observed at 0.424 nm d-spacing indicated the presence of small amount of quartz.

Kaolinite was pre-dominant in pedon 6, showing large intense peak at 0.722 nm d-spacing (Fig. 3) and presence of similar peaks in all other treatments except in K-550°C treatment confirmed the presence of kaolinite. Small peaks at 1.002 nm (first order), 0.501 nm (second order) and 0.335 nm (third order) d-spacings in Ca-saturated ethylene glycol solvated treatment and persistence of these peaks in all six treatments confirmed the presence of mica. Presence of small peak at 0.319 nm d-spacing in Ca-saturated with ethylene glycol solvated sample and similar peaks in all other treatments indicated the presence of feldspars.

Pedon 1 is dominated by smectite minerals, pedon 4 has sub-dominant amount of smectites (dominated by kaolinites) whereas pedon 6 has almost negligible amount of smectites (dominated by kaolinite). This is due to the geomorphic position of these profiles in the landscape.

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