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STUDIES ON THE CHEMICAL COMPOSITION OF CERTAIN VERTISOLS IN RELATION TO PARENT MATERIAL

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The parent material and the relative abundance of the coarse and fine textural fractions are the prime causes for the variation in the chemical composition of the Vertisols. The soils of granite origin recorded the highest SiO_2 content and those developed from base rich granite-gneiss and kimberlite recorded the least values followed by the soils of shales origin. The SiO_2 content decreased with the depth. The Al_2O_3 content increased with increase in clay content and showed an oppsite trend of distribution to that of SiO_2. The Fe_2O_3 content greatly varied among the pedons but showed more uniformity within the horizons of each pedon. The CaO, MgO, K_2O and Na_2O contents were found to be least in soils developed from granite while the soils derived from other parent materials were fairly rich in these bases. All these bases had shown an increasing trend with the depth except the K_2O. The soils developed from lime stone and kimberlite were poor in P_2O_5 content.

Black soils are potentially more productive than the red soils in particular under dry land farming In Andhra Pradesh, black soils are main supporting area for groundnut, sorghum, safflower, cotton, tobacco and chillies. A detailed study of such highly potential soils is much more useful and necessary. Tamhane (1950) and Raychaudhuri *et al.* (1963) studied the various aspects of black soils. Such studies are meagre in the black soils of Andhra Pradesh. Present investigation was taken up to generate the data on the chemical composition of the Vertisols as influenced by the parent material.

MATERIALS AND METHODS

Thirteen Vertisol pedons were selected for the present investigation in the black soil area of Andhra Pradesh (Table 1). Horizonwise soil samples were collected and subjected to fusion analysis as per the procedure described by Kanehiro and Shermam (1965). Silica in the fusion extract was determined as per the procedure given by Dewis and Freitas (1970). Iron and Aluminium were estimated as per the procedure described by A. O. A. C. (1960). Calcium, Magnesium, Sodium and Potassium were determined as per the procedures described by Jackson (1973).

RESULTS AND DISCUSSION

The results of the chemical analysis presented in table 2 revealed that the loss on ignition varied widely according to the clay and $CaCO_3$ contents More the clay more will be the loss on ignition due to loss of crystal lattice water and more the $CaCO_3$ more will be weight loss due to conversion of $CaCO_3$ to CaO. In case of Vertisols, the variation is mainly due to the variation in primary and altered minerals in sand fraction inherited from the parent material. The SiO_2 content varied from 31.79 to 74 60 per cent. The soils derived from granite had shown the highest SiO_2 content whereas the soils developed

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Table 1 : Climatic Data and parent material of the study area

Pedon number and location	District	Mean annual rainfall (mm)	Mean annual temperature (°c)	Parent material
1 Hindupur	Mahaboobnagar	643.7	27.8	Granite-gneiss
2 Vujjali	"	643.7	27.8	Granite-gneiss
3 Devarakadara	"	643.7	27.8	Granite
4 V. Kothapalli	Cuddapah	601.0	29.3	Shale
5 Singanapalli	Kurnool	574.0	28.1	Shale
6 Jammalamadugu	Cuddapah	594.4	29.3	Slate
7 Sugamanchipalli	"	632.3	29.3	Lime stone (Cuddapah slab)
8 Pellur	Prakasam	842.9	28.5	Granite-gnessic-complex
9 Kandi	Medak	802.6	25.9	Granite-gneiss
10. Tarturu	Kurnool	606.9	28.1	Pink shale
11. Lam	Guntur	904.9	29.0	Charnokite
12. Podalakur	Nellore	843.7	29.2	Pegmatite
13. Vajrekarur	Ananthapur	507.1	27.6	Kimberlite

from base rich granite-gneiss and kimberlite recorded the least SiO_2 content followed by the soils from shales origin Soils derived from slate and limestone also recorded comparatively higher SiO_2 content because of more coarse fraction. The SiO_2 content in the soils of different origin was found to be in the order of

granite > slate limestone > charnockite pegmatite granite schist > shales > base rich granitegneiss kimberlite

The SiO_2 content decreased with the depth because of more sand fraction in surface layers and more $CaCO_3$ in deeper layers. Similar results and trends were reported by Karale *et al.* (1969) and Biswas *et al.* (1966).

The Al_2O_3 content ranged from 11.35 to 21.43 per cent and showed an opposite trend of distribution with depth to that of SiO_2 indicating that the Al_2O_3 contents go hand in hand with the clay (Manickam, 1977). The variation in the Al_2O_3 content among the pedons could be ascribed to the variation in the proportion of the textural fractions and also to the variation in the degree of substitution of octahedral Al^{3+} by Mg^{2+} or Fe^{2+}. Similar trends were reported by Prasad *et al.* (1977)

The Fe_2O_3 content widely varied among the pedons (3 to 10.73%) but more uniformly distributed within the horizons of each profile except marginal increase with the depth. The murrum layers recorded either low or high values than the upper horizons. The original source of Fe_2O_3 was found to be the parent material and the relative accumulation of Fe_2O_3 in black soils does not arise because of restricted drainage. The only other posibility was the absolute accumulation due to internal weathering indicating higher the clay content more would be the Fe_2O_3 as revealed in the present investigation. Biswas *et al.* (1966) also reported similar trend of results for black soils.

Table 2 : Physical and chemical composition of the soils

Pedon and Horizon	Horizon thickness (cm)	Sand	Silt	Clay	Loss on ignition	SiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5
		Percent												
1. Hindupur														
AP	0-12	31.4	15.3	49.2	6.70	63.40	18.35	5.86	0.09	5.48	1.88	0.82	0.16	0.13
A 12	12-28	29.0	15.1	51.3	6.48	62.60	19.16	5.58	0.09	5.43	1.63	0.66	0.28	0.12
A 13	28-52	29.4	13.3	52.0	5.97	59.84	18.91	6.01	0.09	5.43	1.70	0.82	0.46	0.13
A 14	52-20	27.7	15.0	52.0	7.41	57.60	19.69	6.01	0.10	5.83	1.88	0.76	0.59	0.10
A 15	90-120	18.9	13.4	59.2	6.97	57.30	20.06	5.86	0.10	6.58	1.73	0.82	0.69	0.14
A 16	120-153	18.9	14.6	58.8	7.17	45.00	16.28	5.86	0.11	8.23	1.73	0.80	0.74	0.14
CCR	153-200	25.3	5.2	17.7	25.88	31.79	11.41	3.00	0.03	26.66	1.75	0.64	0.55	0.13
2. Vujjali														
AP	0-12	37.3	18.4	40.9	3.63	69.31	14.33	4.15	0.07	3.33	1.38	0.88	0.32	0.08
A 12	12-35	31.3	20.0	44.3	3.92	67.10	14.87	4.29	0.07	3.15	1.38	1.36	0.59	0.10
A 13	35-72	31.9	19.8	46.5	3.67	66.08	14.99	4.29	0.07	5.43	1.25	1.06	0.59	0.10
A 14	72-95	32.7	16.3	47.0	5.98	60.83	16.20	4.86	0.07	4.38	1.13	1.30	0.71	0.10
A 15	95-150	33.1	17.8	48.7	5.93	67.84	16.44	4.72	0.07	3.50	0.75	1.58	0.54	0.09
3. Devarakadara														
AP	0-12	30.1	15.7	51.7	6.01	67.40	13.51	5.43	0.07	1.75	2.38	1.06	0.14	0.14
A 12	12-35	31.8	12.1	55.6	5.68	69.51	15.37	5.15	0.08	1.58	1.00	1.10	0.24	0.14
A 13	35-55	27.2	14.9	56.8	6.40	74.45	15.33	5.15	0.07	1.93	1.88	1.48	0.32	0.14
A 14	55-90	24.8	17.0	58.7	7.50	72.26	17.83	5.53	0.07	2.45	1.63	1.54	0.39	0.20
A 15	90-150	17.0	15.1	64.5	8.50	67.85	18.20	6.15	0.08	2.55	2.00	1.74	0.54	0.14
4. V. Kothapalli														
AP	0-15	13.2	18.2	65.8	9.55	60.89	18.76	8.58	0.12	3.85	2.88	1.28	0.15	0.08
A 12	15-35	11.8	16.0	68.3	8.53	60.21	19.06	8.22	0.12	4.38	3.00	1.20	0.15	0.10
A 13	35-65	11.4	17.3	68.8	8.74	59.30	19.70	8.40	0.12	4.82	3.00	1.20	0.18	0.11
A 14	65-110	9.2	16.8	67.5	8.64	59.94	21.26	8.76	0.11	3.68	3.13	1.14	0.17	0.14
A 15	110-160	8.6	18.5	68.6	8.43	58.92	20.91	9.03	0.11	3.68	3.38	1.30	0.27	0.10

5. Singanapalli														
AP	0-16	18.6	15.1	54.2	13.56	66.00	13.85	5.72	0.08	9.63	3.25	1.20	0.27	0.14
A 12	16-38	18.0	16.0	55.2	13.53	63.31	14.14	5.86	0.09	8.75	3.50	1.08	0.41	0.13
A 13	38-74	15.3	15.0	57.8	13.95	62.60	14.78	5.72	0.07	9.83	3.38	1.00	0.53	0.11
A 14	74-110	12.0	16.6	55.3	15.24	63.48	14.31	6.01	0.07	10.85	3.13	1.32	0.68	0.14
A 15	110-132	11.5	13.6	55.2	16.82	58.63	13.35	6.29	0.10	15.57	3.00	1.20	0.95	0.13
C	132 +	22.8	8.5	35.4	18.82	54.89	11.35	5.43	0.09	20.13	1.97	1.00	0.80	0.11
6. Jammalamadugu														
AP	0-19	53.8	10.4	32.5	7.78	74.60	14.18	3.58	0.06	3.33	0.75	1.50	0.11	0.08
A 12	19-38	42.8	13.5	38.5	5.78	67.59	17.11	4.15	0.06	3.85	0.50	1.28	0.26	0.10
A 13	38-60	43.4	13.7	38.8	5.56	67.50	18.42	4.00	0.05	3.68	1.37	1.30	0.33	0.06
A 14	60-90	41.9	12.0	40.3	5.34	69.03	16.07	4.29	0.06	3.50	1.50	1.58	0.57	0.08
A 15	90-152	39.8	13.7	43.4	5.27	62.75	13.81	4.43	0.06	2.98	1.50	1.20	0.62	0.10
A 16	152-196	29.8	13.8	50.9	5.75	62.00	13.18	4.58	0.07	3.98	1.75	1.40	0.88	0.11
7. Sugumanchipalli														
AP	0-18	26.3	15.2	55.1	7.11	69.10	15.21	5.58	0.12	4.03	1.83	0.70	0.32	0.10
A 12	18-34	25.4	16.4	56.3	8.11	68.90	16.09	6.09	0.11	4.33	2.13	0.76	0.34	0.05
A 13	34-61	25.0	17.6	53.2	6.18	69.30	16.40	6.15	0.10	4.62	2.20	0.56	0.42	0.05
A 14	61-85	24.7	17.9	56.3	6.40	63.70	17.13	6.15	0.10	3.35	2.50	0.58	0.45	0.05
A 15	85-122	23.5	17.1	53.8	8.02	68.40	16.99	5.86	0.11	3.65	2.50	0.56	0.46	0.06
A 16	122-145	23.5	18.0	54.1	9.09	67.00	17.20	6.18	0.10	5.60	0.90	1.02	0.45	0.11
A 17	145-187	22.0	15.1	53.0	6.95	66.40	16.75	5.58	0.12	5.95	0.85	1.30	0.54	0.20
8. Pelluru														
AP	0-11	21.8	24.2	50.4	4.56	72.50	14.35	5.86	0.12	3.15	2.25	0.88	0.14	0.14
A 12	11-34	23.5	22.0	53.8	4.03	71.80	14.33	6.01	0.12	3.50	1.50	0.89	0.14	0.20
A 13	34-61	18.5	23.6	52.9	3.00	69.05	14.05	6.29	0.13	3.50	1.63	0.84	0.16	0.07
A 14	61-101	19.9	22.5	57.6	6.14	68.38	14.73	6.44	0.12	4.03	2.38	0.86	0.32	0.07
A 15	101-129	16.4	20.0	58.1	8.14	66.02	15.63	6.58	0.14	5.78	2.75	0.86	0.49	0.08
CCa	129-177	12.3	18.7	38.0	6.67	59.68	15.75	8.81	0.15	12.13	2.30	0.92	0.43	0.08
9. Kandi														
AP	0-20	19.1	13.0	67.3	6.53	63.91	17.52	8.76	0.13	2.63	2.60	1.30	0.11	0.10
A 12	20-46	16.9	12.5	68.9	8.40	62.79	18.68	9.03	0.14	3.15	2.63	0.88	0.11	0.11
A 13	46-67	12.9	15.5	67.8	9.36	61.75	21.43	9.03	0.12	3.50	2.50	1.08	0.12	0.10
A 14	67-96	13.8	15.2	68.6	8.72	59.55	20.64	9.39	0.12	3.50	2.13	1.14	0.11	0.08
A 15	96-136	8.8	14.9	69.5	8.02	54.80	21.48	9.39	0.14	4.38	2.63	0.76	0.14	0.16
AC	136-200	9.0	14.4	71.8	7.02	57.67	21.83	10.73	0.15	4.82	2.13	1.06	0.15	0.12

Pedon and Horizon	Horizon thickness (cm)	Sand	Silt	Clay	Loss on ignition	Si O_2	Al_2O_3	Fe_2O_3	Mn O	Ca O	Mg O	K_2O	Na_2O	P_2O_5
		Percent												
10. Tarturu														
AP	0-12	11.1	15.9	68.7	7.13	63.90	16.88	8.76	0.14	4.73	1.13	0.86	0.11	0.08
A 12	12-45	11.7	16.3	68.8	7.50	62.25	18.30	8.31	0.14	5.43	1.25	0.90	0.11	0.09
A 13	45-82	9.8	17.1	70.0	7.98	61.58	18.68	8.23	0.12	5.43	1.38	0.84	0.11	0.09
A 14	82-140	7.7	1.60	69.8	10.15	61.20	18.66	8.22	0.14	5.43	2.50	0.82	0.11	0.09
CCa	140+	4.7	13.2	55.2	8.90	49.00	16.98	7.01	0.11	10.15	5.38	0.64	0.15	0.07
11. Lam														
AP	0-20	18.9	16.2	62.0	6.53	70.38	19.29	7.01	0.10	2.45	2.50	1.06	0.16	0.09
A 12	20-52	17.2	16.9	63.4	8.68	66.78	19.92	7.01	0.10	2.80	2.50	0.70	0.28	0.10
A 13	52-95	15.1	17.5	64.7	7.95	65.85	19.59	7.29	0.10	2.98	2.50	0.86	0.55	0.11
A 14	95-139	12.5	15.9	66.1	5.91	64.33	19.55	7.58	0.10	3.15	3.13	1.06	0.80	0.09
A 15	139-187	9.4	17.5	67.8	9.52	62.16	19.67	7.43	0.12	3.50	3.50	0.96	0.89	0.09
A 16	187-195	10.0	15.2	68.5	10.58	61.85	20.47	7.82	0.13	3.68	4.13	0.90	0.91	0.09
12. Podalakur														
AP	0-17	47.3	11.7	40.2	8.49	71.76	18.09	5.29	0.11	2.98	1.13	0.32	0.12	0.08
A 12	17-48	40.5	13.1	42.5	8.60	68.20	19.65	5.01	0.10	2.63	1.50	0.28	0.13	0.06
A 13	48-87	42.7	14.7	42.6	8.14	67.64	20.36	5.43	0.10	3.68	1.75	0.30	0.10	0.05
A 14	87-135	34.6	12.0	51.5	8.85	66.85	16.48	6.15	0.10	3.30	1.63	0.42	0.13	0.05
C	135-155	26.5	10.3	54.8	9.54	64.44	15.43	6.15	0.13	4.55	1.75	0.50	0.23	0.08
C1	155-184	26.4	12.5	57.6	10.30	62.58	14.83	6.75	0.15	4.73	1.73	0.40	0.23	0.10
C2	184 +	53.3	7.6	38.2	8.49	58.38	14.07	5.01	0.09	4.90	1.85	0.32	0.20	0.07
13. Vajrekarur														
AP	0-20	24.1	12.2	58.2	9.25	62.45	15.41	5.43	0.10	6.60	3.00	0.70	0.03	0.08
A 12	20-45	21.2	13.2	58.5	8.45	61.03	17.03	5.72	0.10	6.60	3.00	0.43	0.10	0.08
A 13	45-65	18.3	12.4	61.7	8.04	59.02	17.51	6.01	0.11	7.60	2.75	0.68	0.10	0.09
A 14	65-89	17.3	12.1	62.5	10.16	59.45	18.00	5.86	0.11	9.57	3.00	0.62	0.10	0.09
A 15	89-102	31.3	8.5	43.0	14.27	54.95	18.34	4.72	0.09	9.53	3.19	0.62	0.13	0.10
CCa	102 +	41.8	8.8	22.5	20.85	39.06	14.38	4.70	0.08	14.53	10.37	0.34	0.19	0.18

The CaO, MgO, KO and Na_2O contents were found to be least in soils developed from granite while the soils derived from other type of parent materials were fairly rich in these bases. The proportion of CaO was higher than the other bases except in few cases where both CaO and MgO were equal The CaO content varied from 1.58 to 26.66 percent and showed an increasing trend with the depth and reached maximum in murrum layers Such wide variation among the pedons could be ascribed to the variation in the chemical composition of the parent material. The MgO content varied from 0.75 to 5 38 per cent except in pedon 13 where it had gone upto 10.37 per cent in murrum layer. The high MgO content in some of the profiles could be ascribed to the Mg^{2+} present in octahedral layer substituted for Al^{3+} and also to the variation in the Mg^{2+} bearing minerals in the sand fraction. The K_2O content was more or less uniform throughout the depth ranging from 0 5 to 1 5 per cent except in pedon 12 which had shown less than 0.5 per cent K_2O in all the horizons indicating that this pedon had low orthoclase feldspars and other K bearing minerals. The Na_2O content largely varied among the horizons from 0.1 to 0.9 per cent and strictly followed an increasing trend with the depth. Similar observations were recorded by Biswas *et al* (1966).

The P_2O_5 content in general varied from 0.05 to 0.16 per cent and distributed more uniformly among the horizons of each pedon rather than between the profiles. The pedons 7 and 12 were comparatively poor in P_2O_5 content than the other pedons indicating that these pedons were poor in phosphorus bearing minerals. The MnO content varied from 0.05 to 0.15 percent. The pedons 8, 9 and 10 were found to be rich in MnO than the rest of the pedons.

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