

FINE SAND MINERALOGY OF VERTISOLS OF ANDHRA PRADESH

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The quantitative mineralogical make up of fine sand fractions in vertisols of Andhra Pradesh has been studied using petrological microscope. The study revealed that the feldspars were the dominant minerals followed by quartz and micas in six pedons, whereas in one pedon quartz was the dominant mineral followed by feldspars and micas. The dominant heavy minerals found in the pedons studied were zircon, rutile, chlorite, pyroxenes and hornblende. The presence of easily weatherable minerals like feldspars, pyroxenes, amphiboles and micas in higher amounts indicates that some of the pedons were of younger formation and had higher nutrient reserves.

Minerals are the primary source for most of the essential elements in the soil. The study of sand mineralogy helps to understand the nature of parent material, presence of lithologic discontinuities, nutrient reserves in the soils, degree of weathering and soil development. The sand mineralogy of black soils of India has been studied by many workers (Biswas *et al.*, 1966; Gaikwad *et al.*, 1974; Sharma and Kant, 1977). In Andhra Pradesh no systematic study on sand mineralogy has been undertaken so far on the vertisols.

EXPERIMENTAL

Soil samples from seven vertisol pedons developed on different types of parent materials were collected from different parts of Andhra Pradesh (Table 1). The soil samples were treated with 1N NaOAc, pH 5.0 followed by H₂O₂ and then dispersed with 8N NH₄

OH. The fine sand fraction was separated from dispersed soil suspension (Brewer, 1964). The light and heavy minerals were separated by suspending fine sand in a suitable quantity of Bromoform (2.84 sp.g) and mounted on glass slides using Canada balsam. The slides were examined under petrological microscope. After establishing a quantitative mineral distribution pattern, roughly 500 grains (for light minerals) and 300 grains (for heavy minerals) were counted for evaluating the quantitative distribution

RESULTS AND DISCUSSION

The results of the petrological microscopic examination of the light and heavy mineral fractions are presented in Table 2. A perusal of the results indicated the abundance of light minerals accounting for 91.4 to 98.5 per cent. Among the light minerals, feldspars were found to be the dominant

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fraction followed by quartz and micas in pedon 1, 2, 3, 4, 5 and 6 while in pedon 7 quartz was dominant followed by feldspars and micas. It might be due to the differences in chemical composition of the parent rock as soils rich in feldspars were mostly developed from the sedimentary rocks viz. shale, slate and limestone and the soil rich in quartz was developed from granite-gneiss. The accumulation of more quartz in surface horizons could be ascribed to the constant depletion of K from the surface horizons by crop removal which might have accelerated more weathering of feldspars to maintain the K equilibrium leading to the relative accumulation of quartz. The heavy minerals were found to be zircon, rutile, chlorite, iron ores, pyroxenes, hornblende, staurolite, epidote and sphene. But the distribution pattern was found to be inconsistent. Similar observations have also been made by Sharma and Kant (1977).

Zircon constituted more than 50 per cent of the heavy mineral fractions in pedons 2, 4 and 5 indicating prolonged weathering of these pedons. Bhargava *et al.* (1973) also reported a similar trend for black soils of Tungabhadra catchment area. However, this trend could not be taken as full proof for determining the degree of weathering, since the vertisols were found to have very little fine sand fraction. Biswas *et al.* (1966) reported more of monazite minerals in black soils of Kurnool district. In

general, the soils of shales origin had shown higher values of more than 20 per cent rutile indicating that the shales are comparatively rich in rutile.

Chlorite was more prominent in pedon 3 followed by pedon 7 which would have been accumulated due to alteration of biotite under reduced conditions. Similar trend was reported by Dasog and Hadimani (1980)

The pedons 1 and 7 were found to be rich in pyroxenes and hornblende ranging from 22 to 38 per cent indicating that these pedons were comparatively less weathered followed by the pedons 2, 3 and 4 with 10-15 per cent of these minerals revealing that these pedons had undergone moderate weathering. Pedons 5 and 6 had less than 10 per cent of these minerals which shows that these pedons had undergone comparatively strong weathering. Similar observations were recorded by Anjaneyulu and Ray Chaudhuri (1964) and Bhargava *et al.* (1973) for black soils of Andhra Pradesh.

Pedons 5 and 6 were found to be rich in iron ores indicating that these pedons were rich in iron bearing minerals, whereas the pedons 1, 4 and 7 were poor in iron bearing minerals. The pedons 2, 3 and 7 were very poor in tourmaline, whereas pedon 1 was found to be rich in tourmaline. All the pedons had minor amounts of staurolite. Pedons 1 and 2 were completely devoid of epidote and others had minor amounts. Pedons

Table 1. Geology of the study area

Pedon number and Location	District	Formation	Rock type
1. V. Kothapalli	Cuddapah	Cuddapah	Sedimentary rock shale
2. Singanapalli	Kurnool	Kurnool	Sedimentary rock shale
3. Jammalamadugu	Cuddapah	Cuddapah	Sedimentary rock shale
4. Sugamanchipalli	Cuddapah	Cuddapah	Sedimentary rock Limestone
5. Kandi	Medak	Archean	Granite-Gneiss
6. Tarturu	Kurnool	Kurnool	Sedimentary rock Pink shale
7. Vajrekarur	Anantapur	Dharwars	Kimberlite

1, 3 and 7 had minor amounts of sphene whereas the pedons 2, 4, 5 and 6 were completely devoid of this mineral. Such variations could be ascribed to the variation in chemical composition of the parent material.

A perusal of this mineralogical distribution pattern and weathering ratios of fine sand fraction as proposed by Ruhe (1960) revealed the following weathering sequences. On the basis of weathering ratios of quartz to feldspars the pedons 3 and 7 were comparatively more weathered and the pedons 1, 2, 4 and 5 were moderately weathered and the pedon 6 was weakly weathered. The weathering ratio of zircon plus tourmaline to hornblende plus amphiboles indicated that the pedons 5 and 6 were strongly weathered; pedon 4 was moderately wea-

thered and the pedons 1, 2, and 7 were weakly weathered. Thus, it could be concluded that the weathering is still going on in these soils and the different soils were at different stages of weathering. None of them had reached the equilibrium stage as evident from the inconsistent trend observed in different weathering indices. These further indicate the complexity of the pedogenesis of vertisols.

The perusal of the results of fine sand mineralogy also indicated that the pedons 1, 2, 5 and 7 were found to be rich in nutrient reserves than that of the pedons 3, 4 and 6. Some of the pedons viz., 1, 2, 3, 4, 5 and 6 were rich in feldspars and the pedons 1 and 7 were found to be rich in pyroxenes and amphiboles. Presence

Table 2. Light and Heavy mineral distribution in sand fractions of some vertisols of Andhra Pradesh.

Pedon and Horizon	Fine sand %	Light Mine-rals %	Heavy Mine-rals %	Light minerals percent to total light minerals				Heavy minerals/to total heavy minerals percent							Wr1	Wrh			
				Q	OC	PC	B	M	Horn	Pyrox	Tour	Zir	Ru	Sp			St	lo	Ep
Profile — 1. V. Kothapalli, Cuddapah dist.																			
1—AP	12.0	91.49	8.51	64	30	—	2	4	17.5	25.4	6.3	23.8	17.5	1.6	—	6.3	—	—	—
1—A12	10.0	91.59	8.41	50	46	2	—	2	27.1	20.0	11.5	18.5	16.7	2.8	—	2.8	—	—	—
1—A13	10.3	91.39	8.61	27	66	4	1	2	13.1	27.3	9.5	20.2	19.0	1.2	—	8.3	—	—	0.80
1—A14	8.2	91.88	8.12	34	60	4	1	1	10.5	29.8	7.0	21.1	24.2	—	—	5.8	—	—	—
1—A15	7.9	91.69	8.31	57	38	3	1	1	15.9	5.7	8.6	27.8	34.7	1.4	—	5.7	—	—	—
Profile — 2. Singanapalli, Kurnool dist.																			
2—AP	12.3	96.25	3.75	56	38	2	1	3	—	6.3	—	66.3	15.9	—	—	8.7	—	—	2.9
2—A12	12.9	96.85	3.15	44	55	—	1	—	10.2	6.1	1.0	54.1	8.9	—	—	12.2	—	—	6.1
2—A13	11.3	96.25	3.75	38	53	3	1	5	1.3	5.1	—	50.6	24.7	—	—	10.5	—	—	7.6
2—A15	8.2	96.50	3.50	47	41	1	3	8	2.6	23.7	2.6	42.1	13.2	—	—	5.2	—	—	7.9
2—C	9.0	94.45	5.55	30	66	—	1	3	—	3.2	—	43.5	49.2	—	—	—	—	—	4.3

Profile — 3. Jammalamadugu, Cuddapah dist.

3—AP	27.2	96.05	3.95	51	36	3	3	7	2.2	—	50.0	2.4	4.5	—	9.1	2.2	29.5	
3—A12	21.4	96.37	3.63	39	52	2	4	3	—	—	40.5	7.2	4.3	—	8.6	1.6	27.5	
3—A14	23.1	97.25	2.75	44	50	2	2	2	3.6	5.5	7.2	49.1	5.4	1.8	—	1.8	1.8	23.6
3—A15	20.6	97.55	2.45	41	42	1	12	4	6.3	23.8	1.6	41.3	11.1	1.6	1.6	1.6	4.4	6.7
3—A16	17.1	97.02	2.98	62	34	1	1	2	13.6	18.5	2.5	25.9	19.7	1.2	—	2.4	1.2	9.9

Profile — 4. Sugamanchipalli, Cuddapah dist.

4—AP	21.40	96.10	3.90	47	45	—	8	6	1.1	3.2	1.1	65.7	11.6	—	5.0	2.8	—	9.5
4—A12	21.2	96.50	3.50	41	52	—	5	2	0.8	7.7	3.3	39.6	26.4	—	—	3.3	5.5	5.5
4—A13	20.8	96.60	3.40	42	42	1	4	11	2.2	9.9	2.2	58.2	18.6	—	—	2.2	—	6.6
4—A15	19.1	96.75	3.25	29	65	—	8	8	3.2	7.7	1.1	67.0	13.4	—	—	3.2	—	4.4
4—A17	15.8	97.75	2.25	39	43	—	6	12	3.6	8.5	1.2	69.5	9.7	—	—	—	2.9	4.9

Profile — 5. Kandi, Medak dist.

5—AP	11.9	93.40	6.80	43	40	2	5	10	—	—	3.0	65.9	15.1	—	—	10.6	—	5.3
5—A12	11.7	93.85	6.15	37	42	3	3	15	0.9	7.6	1.0	46.7	27.6	—	—	6.6	—	9.5
5—A13	8.8	95.00	5.00	43	41	5	1	10	—	6.7	2.2	48.9	20.0	—	4.4	7.8	—	10.0
5—A15	6.2	95.00	5.00	41	45	4	2	8	—	6.3	1.0	55.5	32.7	—	—	2.7	—	1.8
5—AC	6.4	92.20	7.80	41	50	2	2	5	1.6	8.3	6.6	53.7	5.0	—	1.6	12.4	0.8	9.9

Pedon and Horizon	Fine sand %	Light Mine- rals %		Heavy Mine- rals %		Light minerals percent to total light minerals										Heavy minerals/to total heavy minerals										Wrt												
		Q	OC	PC	B	M	Horn	Pyrox	Tour	Zir	Ru	Sp	St	lo	Ep	Chlo	Q/F	Zr+T H+A																				
Profile - 6; Tarturu, Kurnool dist.																																						
6-A1	10.3	91.47	8.53	35	58	2	2	3	0.9	0.9	6.4	45.9	23.8	—	—	16.5	2.7	2.7																				
6-A12	10.2	91.87	8.13	24	70	2	1	3	2.5	1.7	8.5	42.7	24.0	—	—	13.7	—	6.8																				
6-A13	8.9	92.58	7.42	22	72	2	2	2	7.8	—	2.8	48.0	27.6	—	—	13.7	—	5.5	0.39	14.58																		
6-A14	7.2	93.20	6.80	17	72	2	3	6	1.9	—	3.9	55.3	18.4	—	2.9	4.8	—	12.6																				
6-CCA	2.3	93.94	6.06	34	61	—	1	4	4.3	2.2	3.2	45.2	34.2	—	—	6.4	2.2	4.3																				
Profile - 7. Vajrakarur, Anantapur dist.																																						
7-A1	14.0	93.74	6.26	42	32	2	8	16	—	24.2	3.0	37.8	10.6	6.1	—	1.5	1.5	15.1																				
7-A12	13.3	93.90	6.10	47	32	1	6	14	1.5	21.4	—	44.2	13.5	3.2	—	2.6	2.6	11.0																				
7-A13	11.4	95.53	4.47	42	26	2	6	24	—	29.3	—	40.0	13.3	4.0	—	1.3	—	12.0	1.13	1.15																		
7-A14	11.4	96.80	3.18	46	27	2	6	19	1.5	22.7	3.0	48.5	6.0	1.5	3.0	4.5	3.0	6.0																				
7-A15	12.4	93.75	6.25	57	33	1	4	5	1.7	32.2	—	42.3	8.5	—	5.1	3.4	—	6.8																				
7-CCA	19.6	93.08	6.92	22	70	—	4	4	25.4	54.2	—	5.1	3.4	—	5.1	—	—	5.1																				

Q=Quartz; OC=Ortho clase; PC=Plagioclase; B=Biotite; M=Muscovite; Horn=Hornblende; Pyrox=Pyroxene; Tour=Tourmaline
 Zir=Zircon; Ru=Rutile; Sp=Sphene; lo=Iron ores; Ep=Epidote; Chlo=Chlorite; Q/F=Quartz/Feldspars; Zr+T/H+A=Zircon+
 Tourmaline/Hornblende+Amphibole.

of readily weatherable minerals like feldspars, amphiboles pyroxenes and micas indicates the higher nutrient

reserves as they can undergo weathering and release ions like Ca, Mg and K etc. (Manickam 1977).

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