'Studies on the Soils of Kuttanad-Part III The Nature of Clay Minerals Present''

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WATER-LOGGED TRACT OF KUTTANAD is an important rice growing region of the Kerala State, extending to about 330 square miles Pillay and Subramonyam (1931) Nair (1945), and Subramoney (1947 and 1951) dealt with the origin and nature, physicochemical analayses of surface soils, the effect of liming and microbiological processes respectively, of the soils of this tract.

No detailed study regarding the chemical composition of the clay fraction of these soils have been reported. Raychoudhuri and Anantharaman (1960) studied one soil profile from the Thottapally area. But they have not attempted the analysis of the clay fraction. It appears that no previous work regarding the chemical composition of the clay fraction of these soils had been undertaken. Since the clay fraction of a soil is the seat of chemical activity, primary importance should be given to its study with a view to assess the the fertility status. Hence in the present investigation, the chemical composition of clays and their base exchange capacities have been determined.

EXPERIMENTAL

Soils from four depths viz. 0—4', 4—9"—9—25" and 25" and below, were collected from three localities, one from Kumarakari, Alleppey District (Upper Kuttanad Region), one from Porakkadu (Thottppally) Alleppey District (Kari region) and the third one from Paddy Breeding Station, Moncompu, Alleppey District (Central Kuttanad region). The above localities were selected as sampling sites because they represent broadly the different regions of these tracts. The hydrogen clay was prepared by adopting the "Segregation method" of Jackson, Whitting et (1949). Sodium Carbonate fusion method of Bear (1955) was followed for the preparation of clay fusion extract. Silica and sesquioxide were estimated as per details given by jBear (1955). Iron and Potassium were estimated colorimetrically, and by Flame Photometer respectively using the hydrochloric acid extract of clay. Total cation exchange capacity of clay was determined by leaching the clay with neutral normal ammonium acetate as described by Schollen, berger and Dreibelbis (1930.) For other determinations, methods given in A. O. A. C. (1950) and Piper's Soil and Plant Analysis" (1920) were followed.

RESULTS AND DISCUSSION

Chemical Properties

Table 1. Gives the percentages of clay, in the soil samples, moisture, loss on ignition,

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silica sesquioxides and CaO, MgO and K_2O in the clay fractions.

The abnormal variation of the clay content in the Kumaramkari profile in the last layer–25" below–suggests, the presence of an illuviated compact clay layer at that depth. The clay contents of Thottapally surface soil and deep subsoil are comparatively low. The distribution of clay in this profile is peculiar and it may be due to the alternate deposition of peaty sand and clay by tidal waters. The clay content of the Monkompu profile increases upto 25" but below that depth, it diminishes. The moisture content of clays from all soils from Kuttanad are high and may be explained as due to the presence of mixed clay minerals. The variation of loss on ignition percentages in the clay may be due to the occurence of unoxidised organic matter. An irregular variation of silica percentages of the clays is met with in profiles from Kumaramkari and Moncompu. Thottapally profile contains comparatively more silica than the other two showing that the clays of that profile are of silicious nature.

Generally the percentages of alumina in all the profiles are very high compared to the percentages of Fe_2O_3 in the clay fraction. The virgin peat profile from Thottapally shows less Fe_2O_3 in the clay fraction. The clays of Moncompu profile show an appreciable amount of alumina. As to be expected, CaO exists only in traces in the clay fraction of almost all soils. The percentages of MgO and K_2O are also appreciable. The Calcium. Magnesium and Potassium in the clays of soils under study were estimated after complete removal of exchangeable bases. Therefore the presence of these elements in the clays indicates that they are the structural elements in the clay minerals.

The appreciable percentages of MgO and K_2O in the clay fractions can be explained by the existence of Magnesium and Potassium in the soil solution, the origin of which is mostly from the sea, river or from underground water. These soils therefore contain inherently a reserve of Potassium and Potash fertilization is not likely to give any response in such soils. Further there is an unbalanced proportion of calcium to magnesium in the soil, to correct which, the addition of lime to such soils is desirable. Clays of most of the soils of these profiles have high content of non-exchageable Potassium indicating the presence of illitic as well as montmorillonitic minerals. Originally the clay might have been dominantly montmorillonitic in nature which under marine and back water influence might have changed to illite as observed by Nagelschmidt (1944.)

The molar ratios and base exchange capacities of clay fractions are given in Table II. These analyses throw more light on the nature of clay minerals present. In Kumaramkari profile no regular variation of the molar ratios with respect to depth is noticeable. In the Thottapally profile the SiO_2, Al_2O_3 ratios are some what higher than that of Kumaramkari profile. The higher values for Al_2O_3/Fe_2O_3 indicate the relatively low content of iron in the clays. The Base exchange capacities of clays are more or less uniform varying from 30 to 35.8 m. e./100 g.

The Silica/Alumina ratios of the clay fraction of the soils under study vary generally between 1.9 to 3.8 suggesting that there is a good proportion of montmorillonitic clay associated with some illitic material as indicated by the high proportion of potassium in the clay fraction. This suggestion is also corroborated by the base exchange capacity figures for clays.

SUMMARY

Chemical composition with allied determinations and base exchange capacities of

TABLE - I.

Analysis of clay fraction of soils on oven-dry basis.

Kuttanad Soils, Kerala.

Sample No.	Depth in inches	Clay %	Moisture %	Loss on ignition	SiO_2 %	R_2O_3 %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %	K_2O %
Profile I. **Kumaramkari.**											
1	0- 4"	36.3	3.76	11.69	48.75	42.89	7.75	35.14	tr	1.10	1.46
2	4- 9"	37.4	4.39	11.32	47.53	30.07	6.17	23.90	tr	1.00	1.63
3	9-25"	38.4	4.82	13.03	49.10	37.74	7.23	30.51	.01	1.20	1.44
4	25-below	54.5	5.42	9.24	48.78	32.71	7.34	25.37	.04	2.02	1.41
Profile II Near **Thottappally Sillway.**											
5	0- 4"	4.4	2,92	13.74	55.11	33.11	2.42	30.69	tr	1.03	1.76
6	4- 9"	32.8	3.38	14.69	42.26	36.79	3.65	33.14	tr	0.80	1.39
7	9-25"	26.3	3.08	14.88	51.74	32.68	3.49	29.19	tr	0.85	1.66
8	25-below	3.0	3.11	10.89	57.82	26.53	2.30	24.23	tr	1.50	2.18
Profile **III Monkompu** (Paddy Breeding Station)											
9	0- 4"	33.6	3.26	12.40	41.68	42.01	6.53	35.48	tr	1.20	2.05
10	4- 9"	39.2	4.34	12.50	45.91	41.94	5.12	36.82	.03	1.00	1.79
11	9-25"	40.2	3.90	12.80	45.45	42.23	4.68	37.55	.12	1.41	1.47
12	25-below	22.9	4.07	12.30	46.66	45.22	4.10	41.06	.14	1.50	1.94

TABLE n

Molar Ratios and Base Exchange Capacities of Clay,

FRACTIONS

Kuttanad Soils. Kerala

Sample No,	Depth in inches	SiO_2 / Al_2O_3	SiO_2 / R_2O_3	Al_2O_3 ,/Fe_2O_3	B. E. C. m e/100 g.
Profile I Kumaramkari					
1	0- 4"	2.37	2·07	7.07	38.8
2	4- 9"	3.25	2.75	6.32	42.5
3	9-25"	2.80	2.42	6.47	42.8
4	25-below	3.18	2.71	5.52	47.2
Profile II Near Thottappally Spillway					
5	0- 4"	3.03	2.90	20.00	35.5
6	4- 9"	2.17	2.03	14.23	35.2
7	9-25"	3.01	2.80	13.11	37.8
8	25-below	3.79	3.67	16.24	38.2
Profile III Monkompu (Paddy Breeding Station)					
9	0- 4"	1.95	1.77	8.52	35.8
10	4- 9"	2.12	1.96	11.25	30.0
11	9-25"	2.05	1.91	12.60	30.5
12	25-below	1.92	1.81	15.53	32.0

hydrogen clays from the three representative profiles of Kuttanad, Kerala,- were studied with a view to assessing the fertility status and the nature of clay minerals present, The constituents of clays and the nature of clay minerals present are discussed. It is suggested that a mixture of hydrous mica, montmorillonitic and illitic clays are present. The results have to be confirmed by adopting X-ray diffraction, dehydration curves and thermal analysis methods.

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