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Characterisation of Clays from South Indian Soils - III Titration Curves (Electrometric method) *

by

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Synopsis: Eight soil samples representing the four major soil types of South India were studied for their electrochemical properties (titration curves) and from the available data it could be concluded that the black and laterite soils contain montmorillonite and kaolinite as dominant clay minerals, respectively, and the alluvial soil a mixture of clay minerals. The red soil from Semmanguliyur may contain kaolinite as the dominant clay mineral and the red soil from Peelamedu a mixture of clay minerals.

Introduction: The role played by the clays and the clay minerals in influencing various aspects of physics, chemistry, fertility, microbiology, pedology and technology of soils is vital and it is evident that there is hardly a chemical, physical or morphological property of the soil body that is not influenced by the clays. Thus there is not a problem of soil science that is in one way or other associated with the reactions involving the clay minerals. Out of the many methods available for the characterisation and identification of clays, the chemical methods and dehydration analysis have been discussed elsewhere (Manickam and Durairaj, 1963). In this, the method of Titration curves is used for the characterisation of clays.

Review of Literature: Mitra (1940) and Mukherjee *et al.* (1942) investigated the fundamental acid character of hydrogen clays and with these pioneering work, attempts were made to characterise the clay minerals by the electrometric method. Marshall (1949) and Grim (1953) indicated the usefulness of the same. Mukherjee *et al.* (1951) investigated the titration curves of hydrogen-montmorillonite and reported that they behaved as monobasic acids with only one inflexion point. The electro-chemical properties of hydrogen-kaolinite were studied by Chakravarti (1958) and Adhikari (1958) who reported a dibasic acid character with two inflection points. Illite was investigated by Roy and Das (1953) who indicated a tribasic acid character for the mineral.

After satisfactory establishment of the method for pure clay minerals, the method was extended to soils also. Mukherjee *et al.* (1951) and Das *et al.* (1952) investigated the black and red soil clays and obtained characteristic curves for montmorillonite and kaolinite, respectively. Laterite and lateritic soils were also studied.

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Materials and Methods: The number of samples taken, their description and other details were given in the previous paper of this series (Manickam and Durairaj, 1963). The clays were separated by using 1% ammonia. For preparing hydrogen clays, the samples were treated with 6% hydrogen peroxide repeatedly to destroy the organic matter. The cations were removed by repeated leaching with 0·02N hydrochloric acid and washed free of chloride. The treated samples were suspended in water by shaking for 24 hours to get 1% suspension.

For the electrometric titrations the "Bottle Method" of titration was used (Mitra and Rajagopalan 1952). A fixed quantity of 1% suspension (50·0 ml) was taken in each one of several beakers and increasing amounts of alkali (NaOH, KOH and Ca (OH_2)) were added separately and sufficient time allowed (24 hours) for completion of reaction. The pH was recorded, using a Beckman pH meter with glass electrode.

Results: The data for the electrometric titrations of various hydrogen clays are given in the table and are graphically represented in figures 1 to 4.

TABLE

Electrometric Titrations of Hydrogen Clays—pH

Milliequivalents of base/100 gm. of clay	Sodium hydroxide	Potassium hydroxide	Calcium hydroxide	Sodium hydroxide	Potassium hydroxide	Calcium hydroxide
I *Black Soil Clay:*		COIMBATORE			KOILPATTI	
0·0	4·6	4·6	4·6	4·5	4·5	4·5
10·0	5·6	5·5	5·2	5·1	5·4	4·7
20·0	6·3	6·0	5·4	5·6	5·8	4·9
30·0	6·6	6·3	5·6	5·9	6·1	5·2
40·0	6·8	6·5	5·7	6·2	6·3	5·5
50·0	7·0	6·8	5·9	6·5	6·6	5·8
60·0	7·3	7·3	6·1	6·8	6·8	6·1
70·0	7·6	7·9	6·4	7·6	7·3	6·6
80·0	8·1	8 5	6·8	8·3	8·1	8·2
90·0	8·4	8·6	7·6	8·7	8·6	8·6
100·0	8·7	8·8	8·1	9·0	8·9	8·8
110·0	8·8	8·9	8·2	9·3	9·2	9·1
120·0	9·0	9·0	8·3	9·6	9·6	9·4
130·0	9·2	9·1	8·4	9·9	10·0	9·7
140·0	9·3	9·2	8·5	10·1	10·3	10·0
II *Red Soil Clay:*		PEELAMEDU			SEMMANGULIYUR	
0·0	5·1	5·1	5·1	5·1	5·1	5·1
10·0	5·7	5·8	5·8	6·2	6·1	5·9
20·0	6·8	6·5	6·8	7·2	7·2	7·1
30·0	7·9	7·1	7·8	7·6	7·6	7·3

TABLE (*Contd.*)

Milliequivalents of base/100 gm. of clay	Sodium hydroxide	Potassium hydroxide	Calcium hydroxide	Sodium hydroxide	Potassium hydroxide	Calcium hydroxide
40·0	8·4	7·6	8·2	7·8	7·7	7·4
50·0	8·5	8·0	8·3	8·4	8·3	8·3
60·0	8·6	8·4	8·3	8·8	8·8	8·7
70·0	8·7	8·7	8·4	8·9	9·2	9·0
80·0	8·7	8·8	8·4	9·4	9·5	9·3
90·0	8·9	9·0	8·6	9·6	9·7	9·5
100·0	9·1	9·1	8·7	9·8	9·9	9·9
110·0	9·2	9·2	8·8	...	...	...
120·0	9·3	9·4	8·9	...	...	...
III *Alluvial Soil:*		KATTUPUTHUR			CUDDALORE	
0·0	5·5	5·5	5·5	4·8	4·8	4·8
10·0	6·0	6·1	5·7	5·2	5·1	4·9
20·0	6·5	6·7	6·2	5·6	5·5	5·2
30·0	7·5	7·6	7·3	6·2	6·1	5·5
40·0	8·1	8·0	7·6	7·4	7·3	7·1
50·0	8·2	8·1	7·7	8·4	8·3	8·0
60·0	8·9	8·7	8·4	9·0	9·0	8·8
70·0	9·2	9·2	8·9	9·2	9·1	9·3
80·0	9·3	9·4	9·3	9·3	9·2	9·5
90·0	9·4	9·5	9·7	9·5	9·7	9·6
100·0	9·6	9·6	9·8	9·9	10·0	10·1
110·0	9·7	9·9	9·9	10·2	10·1	10·2
120·0	9·7	10·0	10·0	10·3	10·2	10·3
IV *Laterite Soil Clay:*		NANJANAD			PATTAMBI	
0·0	5·1	5·1	5·1	5·0	5·0	5·0
10·0	6·8	6·7	6·4	6·0	6·1	4·8
20·0	7·5	7·5	7·3	7·7	7·5	7·3
30·0	8·1	8·0	7·5	7·8	7·8	7·6
40·0	8·9	8·8	8·7	8·4	8·3	8·4
50·0	9·0	9·1	8·9	8·8	8·7	8·7
60·0	9·3	9·2	9·0	9·1	9·0	8·9
70·0	9·4	9·5	9·4	9·4	9·3	9·1
80·0	...	...	...	9·6	9·5	9·3
90·0	...	...	...	9·8	9·8	9·5
100·0	...	...	...	9·9	10·1	9·8

The black soil clays showed a monobasic acid character with only one inflexion point (around pH 7·5 and 8·2) in each case, though variations were observed for different alkalies used. A buffering was noticed in each curve

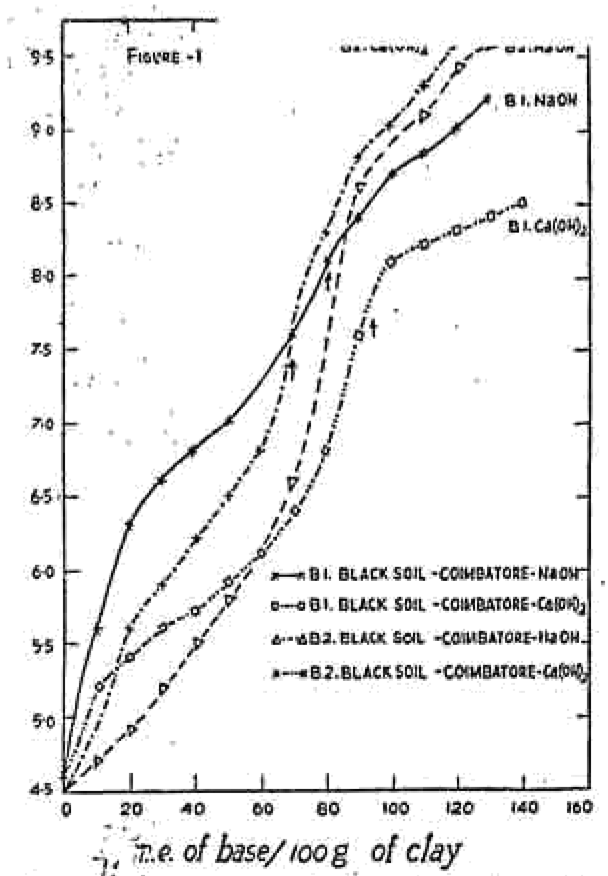
FIGURE - 1
B1. NaOH
B1. Ca(OH)2
B1. BLACK SOIL - COIMBATORE - NaOH
B1. BLACK SOIL - COIMBATORE - Ca(OH)2
B2. BLACK SOIL - COIMBATORE - NaOH
B2. BLACK SOIL - COIMBATORE - Ca(OH)2
m.e. of base/100g of clay

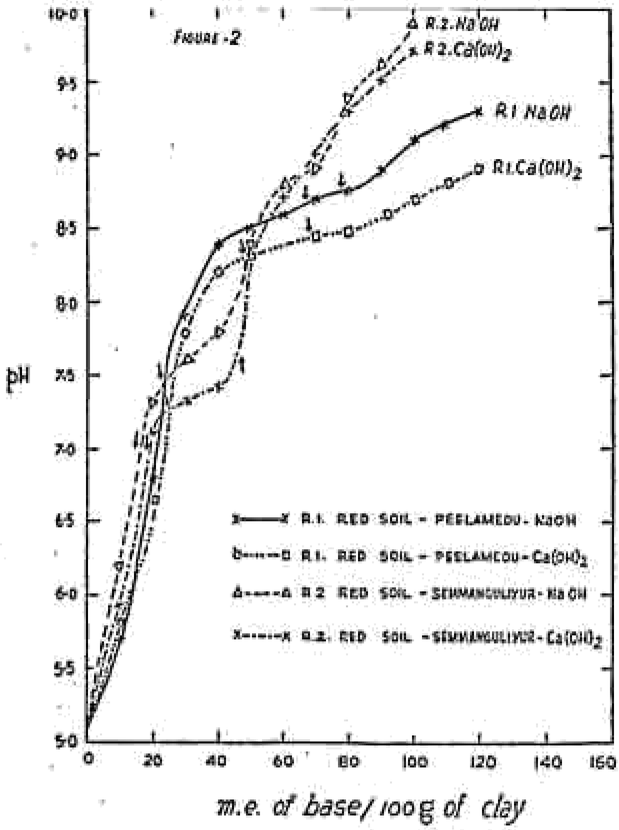
FIGURE - 2
R.2. NaOH
R 2. Ca(OH)2
R1 NaOH
R1. Ca(OH)2
pH
R.1. RED SOIL - PEELAMEDU - NaOH
R.1. RED SOIL - PEELAMEDU - Ca(OH)2
R 2 RED SOIL - SEMMANGULIYUR - NaOH
R.2. RED SOIL - SEMMANGULIYUR - Ca(OH)2
m.e. of base/100g of clay

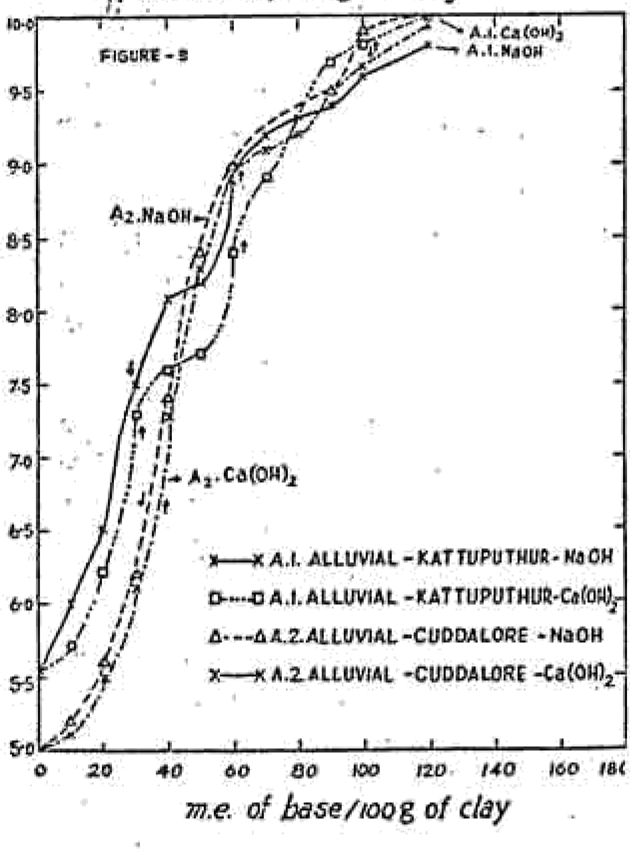
FIGURE - 3
A.1. Ca(OH)2
A.1. NaOH
A2. NaOH
A2. Ca(OH)2
A.1. ALLUVIAL - KATTUPUTHUR - NaOH
A.1. ALLUVIAL - KATTUPUTHUR - Ca(OH)2
A.2. ALLUVIAL - CUDDALORE - NaOH
A.2. ALLUVIAL - CUDDALORE - Ca(OH)2
m.e. of base/100g of clay

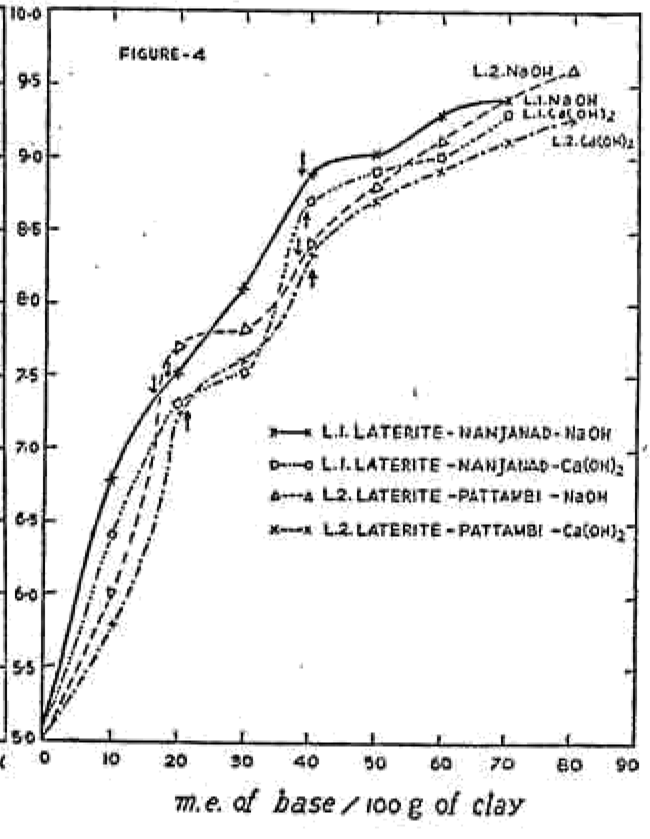
FIGURE - 4
L.2. NaOH
L.1. NaOH
L.1. Ca(OH)2
L.2. Ca(OH)2
L.1. LATERITE - NANJANAD - NaOH
L.1. LATERITE - NANJANAD - Ca(OH)2
L2. LATERITE - PATTAMBI - NaOH
L.2. LATERITE - PATTAMBI - Ca(OH)2
m.e. of base / 100 g of clay

beyond the inflexion point and also at the initial stages. In the case of red soil clay from Semmanguliyur and the two laterite samples the curves showed a dibasic acid character with two inflexion in each case, the first one occurring between pH 6·9 and 7·6 and the second between pH 7·8 and 8·7. The ratio of milliequivalents of base between the two inflexion points was found to be approximately two. For red soil sample from Peelamedu the second inflexion point was not so pronounced. The hydrogen clays from alluvial soils revealed a dibasic acid character, first inflexion occurring between pH 6·8 and 7·5 and second between pH 7·7 and 9·0. The ratio of milliequivalents of base at the two inflexion points was found to be more than two and no buffering action was noticed.

Discussion: The titration curves of both the black soil revealed a monobasic acid character and this feature was attributed to the presence of montmorillonite by Mukherjee *et al.* (1951). Hence the black soils may contain montmorillonite as the dominant clay mineral and this corroborates with the present authors' findings published elsewhere. The red soil clay from Semmangliyur and the two laterite samples exhibited a dibasic acid character and the ratio of milli-equivalents of base at the two inflextion points was found to be two. Mukherjee *et al.* (1951) attributed similar results for the presence of kaolinite. Thus it may be concluded that these samples contain kaolinite as the major mineral. But in the case of Peelamedu red soil sample the clay did not exhibit features for kaolinite, though a dibasic acid character was revealed. Considering the results obtained by other methods, the soil may be said to contain a mixture of illite and kaolinite because similar results were reported elsewhere for a mixture of kaolinite and illite. With regard to alluvial samples distinct characters were not seen for a single clay mineral and hence it may be said that these soils contain a mixture of clay minerals and this was found to be supported by the data obtained by other methods.

Summary and Conclusion: The method of electrometric titration has been used for the characterisation of clays. The method of preparation of hydrogen clays and titrations has been explained. The data obtained are graphically represented to study the various features.

From the data available, it may be concluded that black soils contain montmorillonite, red soil of Semmanguliyur and the laterite soils contain kaolinite as the predominant mineral. The other soils may contain a mixture of clay minerals and these were found to be supported by data obtained by chemical methods and dehydration analysis.

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RETIREMENT

Sri T. K. Thangavelu, B. Sc. (Ag.), retired from service as Joint Director of Agriculture, Madras. From the rank of an Agricultural demonstrator, he rose to the high position of Joint Director of Agriculture to be in charge of Inspection and General policies in the Extension wing of the Madras Agricultural department. He was for a number of years deputed for important items of work outside the Department of Agriculture. The M. A. S. U. wishes him a long, happy and enjoyable life of retirement.