

Electrochemical Properties of Red Soil Clays

BY

D. AUGUSTINE SELVASEELAN¹, D. RAJ² AND T. S. MANICKAM³

ABSTRACT

Nine red soil clays were subjected to potentiometric titration studies to identify the possible clay mineral make up. The qualitative evidence based upon the number of inflection points of potentiometric titration curves was found to be unreliable, instead, the ratio of buffer capacities below and beyond the first demarcation point has been established as a parameter for the identification of the possible clay minerals which decreased with the increase in the proportion of montmorillonite like minerals.

INTRODUCTION

The identification of clay mineral assemblage in a soil is considered as one of the most important aspect of soil research as the clay, qualitatively and quantitatively influences the various physical, physico-chemical and chemical properties. Many methods have been proposed for the clay mineral characterisation as no single method is found to be accurate enough for the purpose. The soils invariably contain a mixture of clay minerals. Use of electrochemical properties of the acid clays (titration curves) is one of the methods which has been found useful for the identification of soil clay minerals. Hence with the objective of identifying the clay minerals present in the red soils of Tamil Nadu, the titration curves have been used. The pattern of curves and other related properties have been made use of and discussed here.

MATERIALS AND METHODS

The clay fraction (<0.002 mm) of 9 representative red soils was separated

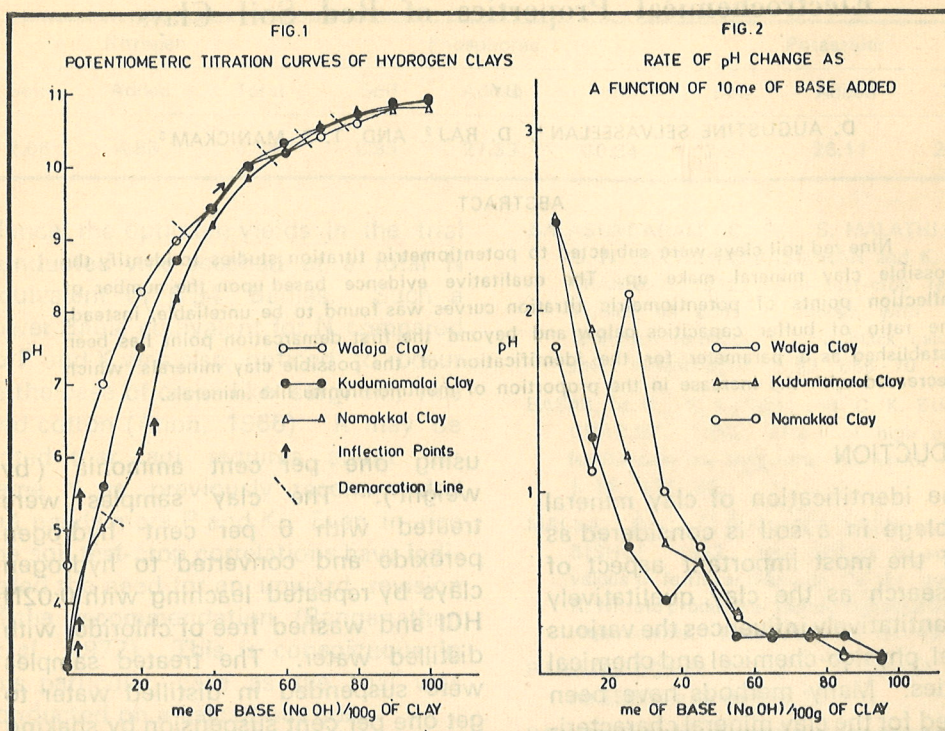
using one per cent ammonia (by weight). The clay samples were treated with 6 per cent hydrogen peroxide and converted to hydrogen clays by repeated leaching with 0.02N HCl and washed free of chloride with distilled water. The treated samples were suspended in distilled water to get one per cent suspension by shaking for 24 hours. The "Continuous method" of titration (Mitra and Rajagopalan, 1952) was adopted.

RESULTS AND DISCUSSION

The pH change due to the addition of NaOH was traced in the patterns of titration curves (Fig. 1) and more informations were gathered from the titration curves on the following lines:

- i. The inflection points were fixed on the titration curves (curves showing rate of change of pH) as a function of 10 m. e. of base added were useful in fixing the inflection points (Fig. 2).
- ii. After fixing the inflection points, the portion covered by two successive

1. Instructor, 3. Assistant Professor, Department of Soil Science and Agricultural Chemistry and 2. Professor of Biochemistry, Tamil Nadu Agricultural University, Coimbatore - 641003.



inflection points (inflection sequence) was taken as a unit and divided into a steep and relatively flat portions by a demarcation point. iii. Total acidities at pH 7 for each inflection and demarcation points were calculated.

iv. Buffer capacity for steep and flat portions of all inflection points, gross buffer capacity for the entire pH range, and buffer capacity below and beyond the first demarcation point were also calculated (Table 1).

TABLE 1. Buffer capacity for different portions of titration curves
(Milli equivalents of base NaOH/100 g/unit change in pH)

Locality	Buffer capacity			Buffer capacity ratios	
	Below first demarcation point (a)	Beyond first demarcation point (b)	Gross buffer capacity (c)	$\frac{b}{a}$	$\frac{c}{a}$
Namakkal	6.0	15.8	13.2	2.6	2.2
Reddiyarchatram	9.1	70.0	13.2	7.7	1.5
Oddenchatram	8.8	120.0	13.1	13.6	1.5
Sawyerpuram	6.1	112.0	13.2	18.4	2.1
Sundapalayam	4.4	17.6	13.2	4.0	3.0
Wallajah	6.5	16.0	15.1	2.5	1.6
Kudumiamalai	9.6	90.0	13.3	2.5	1.6
Ponneri	4.8	54.2	13.3	11.3	2.8
Krishnagiri	4.9	17.0	13.2	3.5	2.7

The Namakkal, Sundapalayam, Wallajah, Ponneri and Krishnagiri red soil clays revealed a di-basic acid nature with two inflection points. Mukerjee *et al.* (1942) and Adhikari (1958) established a di-basic acid character for hydrogen kaolinite. Accordingly it can be concluded that the above five soil clays are dominant in kaolinite mineral. The remaining four clay samples, showing a single inflection point (around 4.0 m. e.) in the titration curve, may be having a mixture of montmorillonite and kaolinite. It was observed that the evidences from the potentiometric titration curves and cation exchange capacity which have been earlier established as a parameter for characterisation of clay (Augustine *et al.*, 1973) was not well concordant. The plausible reason for this may be that acid clays contain both H and Al simultaneously in association (Coleman and Craig, 1961). Hence the form of the titration curve and other related properties are to be considered due to a combined system of H and Al, and hence much variations are observed in the present investigation also. Further recent works have shown that H-montmorillonite can be monobasic, di-basic and tri-basic depending upon the method of preparation, dissociation of aluminium from the clay system and similar properties. Hence the variations observed in the present investigation can also be attributed to similar reasons recorded recently by Mitra *et al.* (1963) and Mitra and Kapoor (1969).

The total acidities at pH 7, at first inflection point, first demarcation point, buffer capacities beyond first inflection

(flat portion) and below and beyond first demarcation point, gross buffer capacity and the ratio among these above buffer capacities were all compared individually with the cation exchange capacity for the existence of possible relationships. Only in the case of the total acidity at pH 7 ($r=0.771^*$) and the ratio between the buffer capacities below and beyond the first inflection point ($r=-0.716^*$) close correlations were observed with cation exchange capacity, suggesting the utility of these parameters.

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