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Characterisation of Clays from South Indian Soils
II. Dehydration Method *

by

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Synopsis: Eight soil samples representing the four major soil types of South India were studied by dehydration analysis and from the available data it could be concluded that black soils and laterite soils contain montmorillonite and kaolinite as dominant clay minerals, respectively, and the alluvial soil and red soil from Peelamedu contain a mixture of clay minerals. The conclusion was found to agree with the data obtained by other methods.

Introduction: The importance of soil clays has been discussed in full in the previous paper. As it is evident, a thorough knowledge of the nature and the properties of clay minerals helps one to understand the soil forming processes of the past, for an interpretation of physical properties and chemical composition of different soils, and for a prediction as to the reaction of any soil to any particular treatment. Thus a better knowledge of the clays and clay minerals will undoubtedly contribute to a better understanding of the soil properties. Several methods are used for characterising the clay minerals. The use of chemical methods and data obtained are fully discussed in the previous paper. Results of dehydration analysis are presented in this paper

Review of Literature: Dehydration of clay minerals involves loss of water, adsorbed or crystal lattice water, held by them and the pattern of loss is a characteristic feature of each clay mineral. Taking advantage of this, it would be possible to identify the clay minerals of the soil by comparing the dehydration curves obtained with those of pure clay minerals. Kelley (1935) conducted dehydration analysis for pure clay minerals and classified them into kaolinitic and bentonitic clays according to the shape of curves. Kelley *et al.* (1936) constructed dehydration curves for pure clay minerals and soil colloids and reported that water loss was characteristic of each mineral. Kelley *et al.* (1939) indicated the presence of montmorillonite in soil colloids by the wave shaped curve obtained by using dehydration technique. Dehydration analysis was employed to characterise the clays of Indian Black soil by Raychaudhuri *et al.* (1943), Bagchi (1951), Sinha (1957) and Menon and Sankaranarayanan (1957). They obtained wave-shaped curves with a higher percentage of adsorbed water than crystal lattice water. Bagchi (1951) studied the clays of Indian red lateritic and laterite soils by dehydration analysis and observed a higher percentage of crystal lattice water than the adsorbed water and indicated the presence of kaolinite as the clay mineral.

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Materials and Methods: The number of samples taken and their description are given in the previous paper of this series (Manickam and John Durairaj 1963). The methods of preliminary analysis and clay separation from the whole soil were also given in that paper.

Dehydration analysis was conducted according to the method described by Kelley *et al.* (1936). The clay samples were brought to uniform humidity level (50 per cent) by keeping over dilute sulphuric acid. The samples were heated in an electric muffle furnace and loss in weight due to moisture was recorded at every hundred degrees interval upto 900°C. Graphs were constructed and the amounts of crystal lattice and adsorbed water were calculated.

Results: The percentage losses of moisture at various temperatures are given in table 1 and the content of adsorbed, crystal lattice water, total water and inflexion temperature are reported in table 2. The data have been graphically represented in figures 1 and 2.

TABLE 1

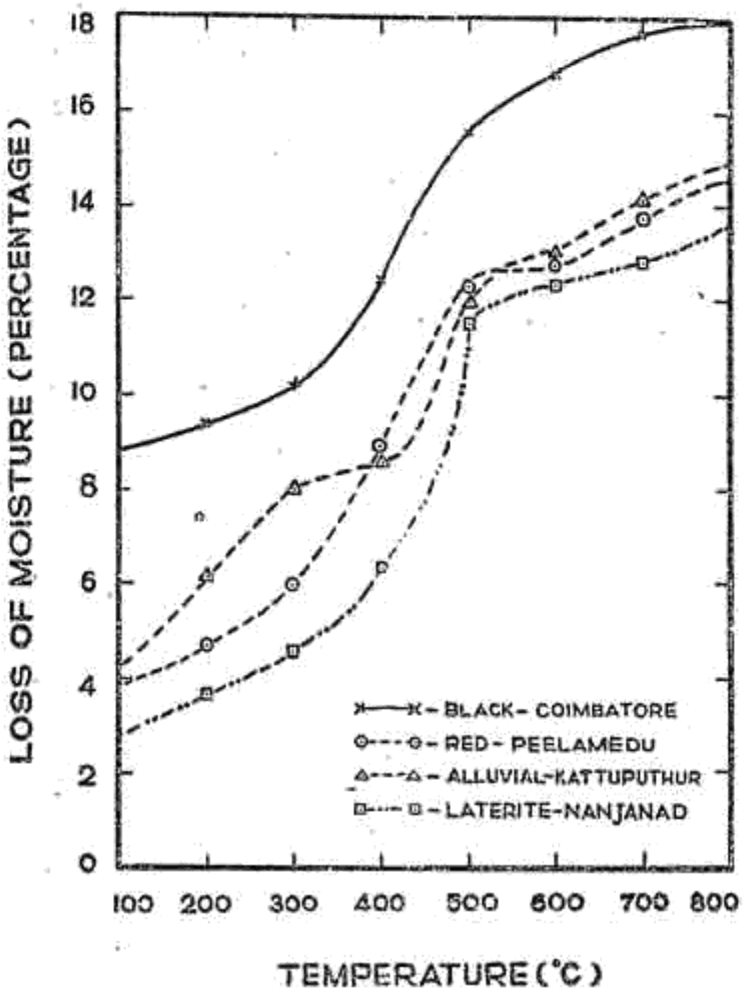
Dehydration Data for Clays (Percentage Loss of Water)

Soil type and locality	100°C	200°C	300°C	400°C	500°C	600°C	700°C	800°C
Black—Coimbatore ...	8·8	9·4	10·3	12·5	15·6	16·8	17·7	18·0
Black—Koilpatti ...	8·2	10·8	12·0	13·6	15·1	15·9	17·0	17·9
Red—Peelamedu ...	3·9	4·7	6·0	8·9	12·2	12·8	13·8	14·6
Red—Semmanguliyur ...	3·3	4·8	5·5	6·6	12·8	13·7	14·6	15·4
Alluvial—Kattuputhur ...	4·1	7·1	8·1	8·6	11·9	13·0	14·2	14·9
Alluvial—Cuddalore ...	4·7	6·3	7·2	8·4	13·4	15·0	15·7	16·0
Laterite—Nanjanad ...	2·8	3·7	4·6	6·4	11·6	12·4	12·8	13·6
Laterite—Pattambi ...	2·4	3·4	4·0	4·9	12·1	13·3	14·0	14·4

TABLE 2

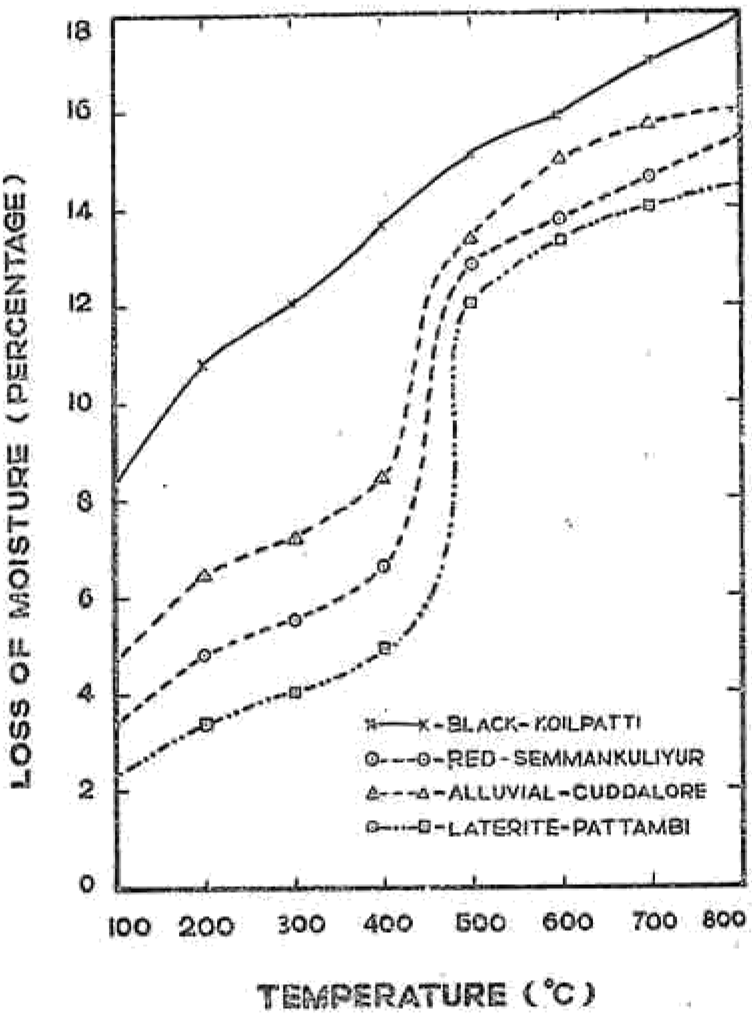
Percentage Loss of Water

Soil type and locality	Adsorbed water	Crystal lattice water	Total water	Inflexion temperature
Black—Coimbatore ...	12·5	5·5	18·0	450
Black—Koilpatti ...	13·6	4·3	17·9	340
Red—Peelamedu ...	8·9	5·7	14·6	530
Red—Semmanguliyur ...	6·6	8·8	15·4	490
Alluvial—Kattputhur ...	8·6	6·3	14·9	440
Alluvial Cuddalore ...	8·4	7·6	16·0	460
Laterite—Nanjanad ...	6·4	7·2	13·6	490
Laterite—Pattambi ...	4·9	9·5	14·4	460



The two black soil clays were found to have a higher percentage of adsorbed water (12·6 and 13·6 respectively) than crystal lattice water, the inflexion temperatures being around 450°C. The Peelamedu sample was found to have a slightly higher percentage of adsorbed water but the inflexion was found to occur at 530°C. Both the alluvial samples were noted to contain slightly higher content of adsorbed water and inflexion occurred around 440°C. The other samples were observed to have a higher percentage of crystal lattice water than the adsorbed water.

Discussion: The two black soil clays from Coimbatore and Koilpatti were found to have a higher percentage of adsorbed water than the crystal lattice water, this being a characteristic feature of montmorillonite. Kelley *et al.* (1936) observed similar features for pure montmorillonite which produced a wave-shape dehydration curve. In the case of Peelamedu red soil the dehydration curve revealed some intermediate properties, with only a slightly higher percentage of adsorbed water, and with an inflexion point at 530°C. These features were found to be not for any single clay mineral but for a mixture. The Semmanguliyur sample and the two laterite samples were found to contain a higher percentage of crystal lattice water than adsorbed water. This was found to be characteristic of kaolinite (Kelley *et al.* 1936). Similar results were reported for red



and laterite soil clays by Bagchi (1951) who concluded that these soils contained kaolinite as the predominant clay mineral. The curves for the two alluvial soil samples showed slightly higher percentage of adsorbed water than crystal lattice water, but they were not found to be characteristic of any one single clay mineral. This suggests that the clays may contain a mixture of clay minerals due to alluvial origin of the soils.

Summary and Conclusions: Dehydration analysis was conducted for eight clay samples separated from four typical soils of South India and the data are presented in the previous paragraphs.

The data suggest that the black soils may contain montmorillonite as the predominant clay mineral, red soil of Semmanguliyur and laterite samples may contain kaolinite as the dominant mineral and the red soil of Peelamedu and the two alluvial soils a mixture of clay minerals. This is found to agree with the results obtained by other methods.

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