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Study of Alluvial Soils of Madras State
III. Clay Examination*

by

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Synopsis: Twelve representative alluvial soils from five major river alluviums of the State were taken and the clays were separated out. They were examined for their chemical make-up and dehydration pattern. The study revealed that the dominant clay mineral was of the 2:1 type in these soils.

Introduction: The importance of alluvial soils and the physical and chemical properties have been discussed in the previous papers (Premanathan and Durairaj, 1963 and 1965). In the present paper, study on the clays from twelve representative alluvial soils is presented. As the clay forms the most reactive part of the soil, the study will help to understand the several properties.

Review of Literature: Martin and Doyne (1927) pointed out the usefulness of silica-alumina ratios for the identification of clay minerals. The use of silica-sesquioxide and silica-alumina ratios for pure clay minerals was indicated by Marshall (1935). The work of Menon and Sankaranarayanan (1957) and Parthasarathi (1959) on silica-alumina and silica-sesquioxide ratios of various Indian soils indicated roughly the type of clay minerals.

Raychaudhuri *et al* (1943) and Parthasarathy (1959) indicated the application of base-exchange data for characterising clays of Indian soils. Total base-exchange capacity is a function of both quality and quantity of clay minerals.

Dehydration of clay minerals results in loss of water, either adsorbed or crystal lattice water, held by them and the pattern of loss is a characteristic feature of each clay mineral. Based on this principle, it is feasible to identify the clay minerals of the soil by comparing the dehydration curves obtained with those of pure clay minerals. Kelley *et al* (1936) constructed dehydration curves for pure clay minerals and soil colloids and reported that water loss was characteristic of each mineral. Raychaudhuri *et al* (1943), Bagchi (1951), Sinha (1943), Bagchi (1951), Sinha (1957) and

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Menon and Sankaranarayanan (1957) employed dehydration analysis to characterise the clays of Indian black soil and obtained wave-shaped curves with higher percentage of adsorbed water than crystal lattice water. Bagchi (1951) used this technique to study the clays of Indian red, lateritic soils and found that higher percentage of crystal lattice water than the adsorbed water thereby indicating the presence of Kaolinite as the clay mineral.

Materials and Methods: Twelve representative alluvial soils (0—9") from the five major river alluviums, namely Palar, Ponnaiyar, Cauvery, Vaigai, and Tambraparni were used in the study. The clays from these samples were separated by shaking with one per cent ammonia by weight for six hours. The clays were then analysed for their chemical composition, Silica-alumina and silica-sesquioxide ratios were worked out.

Base exchange capacity for the above 12 soil samples was estimated by ammonium acetate method. Then the base exchange capacity was calculated on clay basis. Dehydration studies were conducted for these soils in the method described by Kelly *et al* (1936). The soils were heated in an electric muffle furnace and the loss in weight due to moisture was recorded at every 100°C interval upto 1000°C. The moisture losses were then recalculated on the clay basis of these soils. The loss of moisture upto 400°C was taken as adsorbed water and the loss from 400°C to 1000°C was taken as crystal lattice water. The sum of the adsorbed water and crystal lattice water was the total moisture loss.

Results and Discussion: The results of the clay examination and the base exchange capacity are presented in Table I. The results of dehydration status are presented in Table II. The dehydration data have been graphically represented in Figures I and II.

TABLE I.

Clay Examination.

Chemical Composition of Clay.

S. No.	Soluble Silica SiO_2	Iron (Fe_2O_3)	Alumina Al_2O_3	Silica/ Al_2O_3 ratio	Silica/ R_2O_3 ratio	Base Exchange capacity on clay basis m. e. / 100g of clay
1.	37·20	12·80	17·80	3·54	2·43	83·3
2.	37·10	12·80	22·05	2·85	2·00	83·7
3.	37·12	12·00	19·45	3·24	2·32	119·2
4.	36·09	12·00	20·75	2·95	2·15	70·7

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TABLE I (*Contd.*)

S. No.	Soluble Silica SiO_2	Iron (Fe_2O_3)	Alumina Al_2O_3	Silica/ Al_2O_3 ratio	Silica/ R_2O_3 ratio	Base Exchange capacity on clay basis m. e. / 100g of clay
5.	38·23	12·00	19·10	3·39	2·42	84·7
6.	38·16	12·00	19·35	3·34	2·40	88·8
7.	38·48	12·80	21·25	3·07	2·22	62·7
8.	41·58	12·80	19·85	3·55	2·52	64·4
9.	38·14	10·40	24·00	2·70	2·11	61·0
10.	39·31	12·00	18·45	3·61	2·56	120·6
11.	34·17	16·00	26·65	2·17	1·57	49·9
12.	44·03	9·60	23·20	3·22	2·55	70·6

S. No. 1 and 2–Palar alluvium; 3 and 4–Ponnaiyar alluvium; 5 to 8 Cauvery alluvium; 9 and 10—Vaigai alluvium; 11 and 12–Tambraparni alluvium.

TABLE II.

Dehydration Data.

(percentage loss on basis of moisture-free clay).

S. No.	Name of alluvium		Adsorbed water	Crystal lattice water	Total water
1.	Palar alluvium	...	18·74	10·50	29·24
2.	Palar alluvium	...	18·92	9·30	28·22
3.	Ponnaiyar alluvium	...	17·70	9·79	27·49
4.	Ponnaiyar alluvium	...	14·38	8·06	22·44
5.	Cauvery alluvium	...	18·60	10·80	29·40
6.	Cauvery alluvium	...	20·61	6·77	27·38
7.	Cauvery alluvium	...	19·51	7·83	27·34
8.	Cauvery alluvium	...	19·17	10·08	29·25
9.	Vaigai alluvium	...	19·31	7·87	27·18
10.	Vaigai alluvium	...	18·46	7·66	26·12
11.	Tambraparni alluvium	...	23·81	8·90	32·71
12.	Tambraparni alluvium	...	19·66	8·41	28·07

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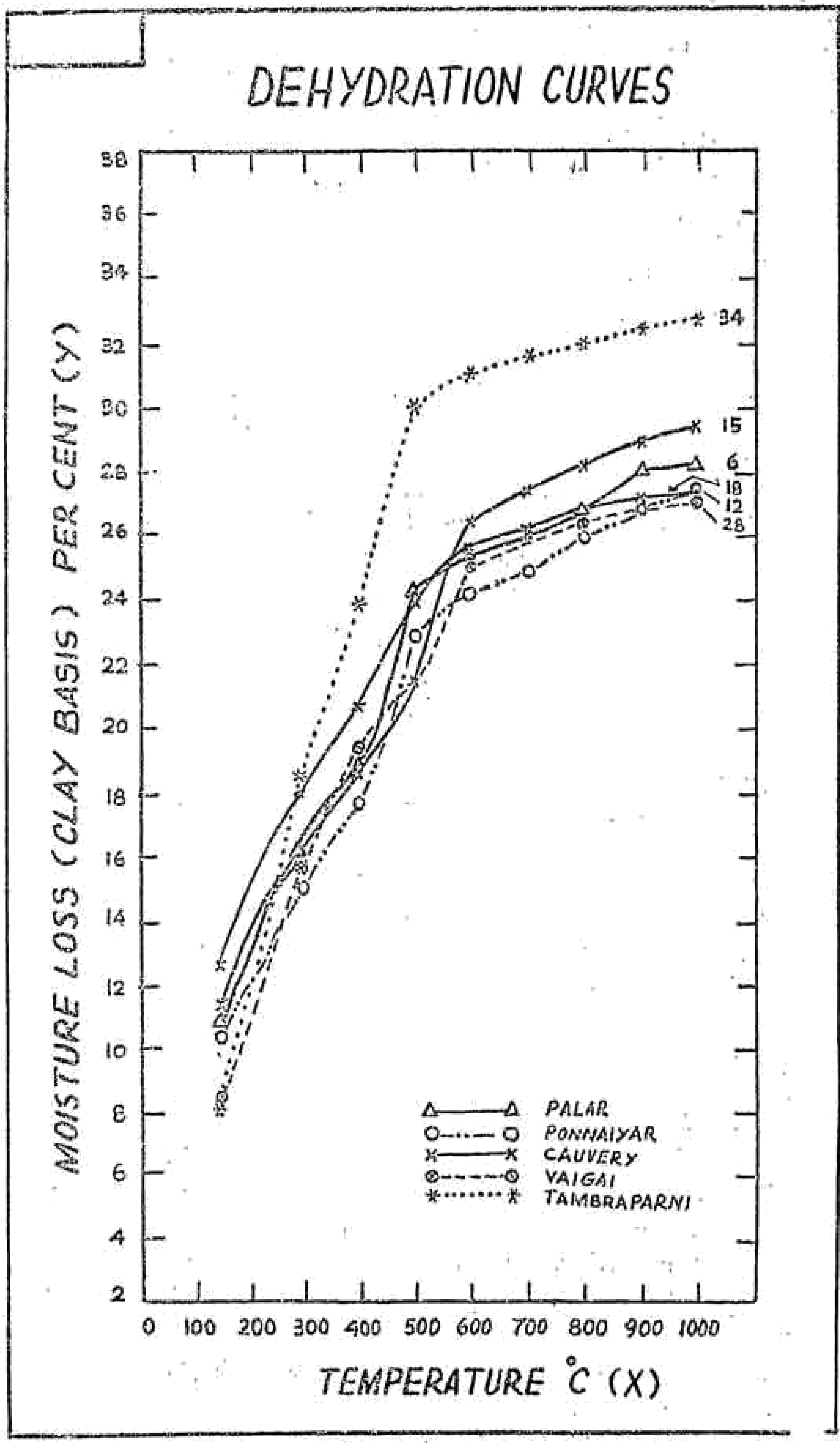
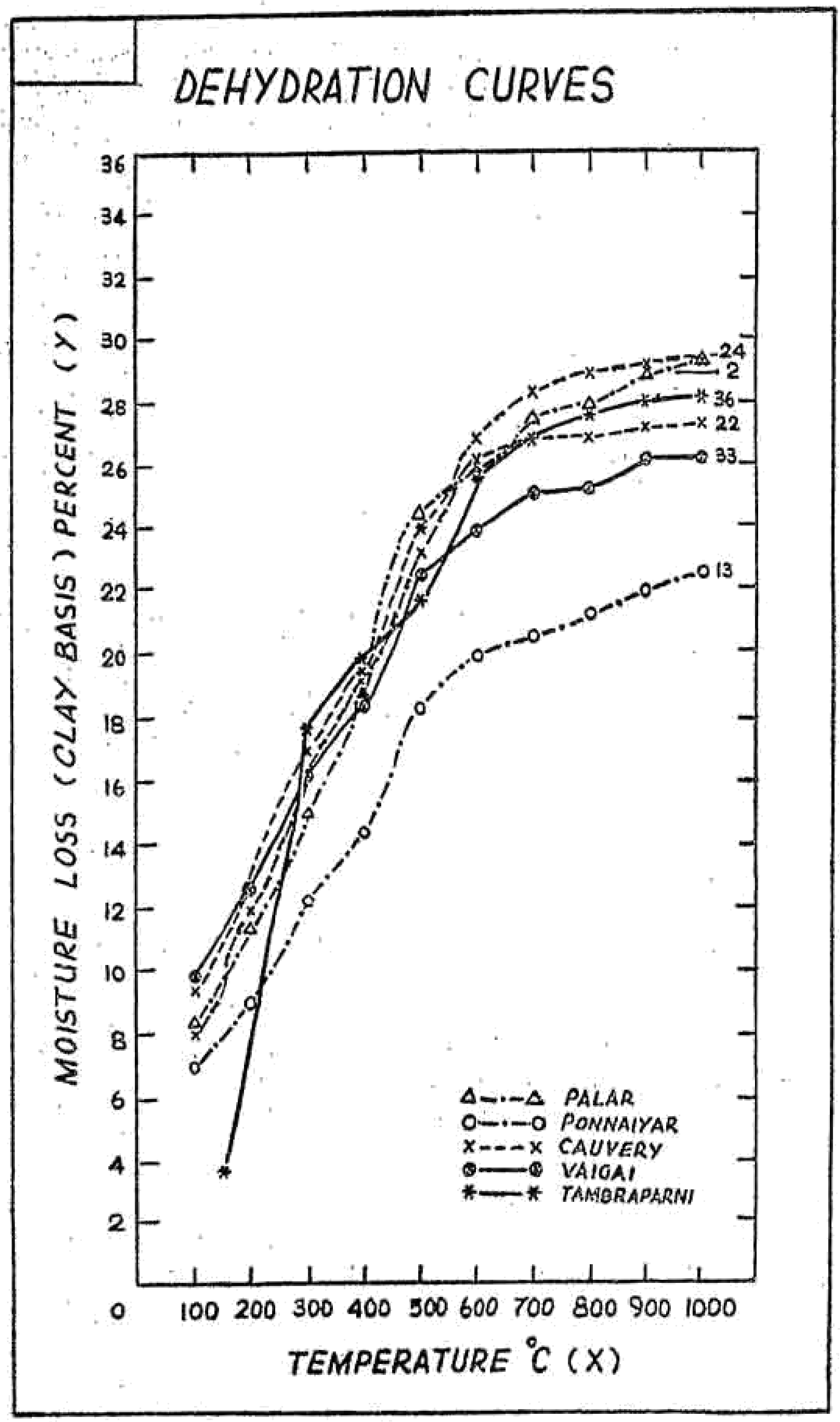
From the examination of [illegible] contents, it appeared that the clays were ve[illegible] reference to iron content. The SiO_2/R_2O_3 rati[illegible] about 2·8 and



DEHYDRATION CURVES
MOISTURE LOSS (CLAY BASIS) PER CENT (Y)
TEMPERATURE °C (X)
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
0
100
200
300
400
500
600
700
800
900
1000
34
15
6
18
12
28
PALAR
PONNAIYAR
CAUVERY
VAIGAI
TAMBRAPARNI


DEHYDRATION CURVES
MOISTURE LOSS (CLAY BASIS) PERCENT (Y)
TEMPERATURE °C (X)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
100 200 300 400 500 600 700 800 900 1000
24
2
36
22
33
13
PALAR
PONNAIYAR
CAUVERY
VAIGAI
TAMBRAPARNI

3·1 respectively for all the samples studied generally. These results are in agreement with the results of Ravi Kumar (1957) and Manickam and Durairaj (1963). The trend of these ratios indicated that the clay minerals in these soils are of 2 : 1 type.

The base exchange capacity of these soils on clay basis ranged from 49·9 to 120 m. e. with an average of about 80 m. e. This also indicates the dominance of 2 : 1 type of clay mineral.

The dehydration curves of the alluvial soils indicated that the percentage of adsorbed water, crystal lattice water and total water was closely similar in all the twelve soils studied. The adsorbed water was greater than the crystal lattice water in all the cases, indicating thereby the dominance of 2 : 1 type of clay minerals. The curves obtained were similar to those obtained by Venkataramanan (1962).

Corraborative evidence for the homogeneity of the clay is provided by the high correlation coefficient values obtained by the authors, for many of the relationships, even when all the alluviums of the five different rivers were considered together. Thus it appears that the alluvial soils contain basically an identical clay, the quality of the clay remaining the same. The differences in many of the properties were brought about by the variation in the quantity of clay.

Summary and Conclusions: Twelve samples of alluvial soils were studied for the chemical composition of clay and dehydration pattern. The base exchange capacity was estimated for these soils. The silica-sesquioxide and silica-alumina ratios were worked out. From the study, it was found that in the alluvial soils, the dominant clay mineral was of the 2 : 1 type. This is found to agree with the results obtained elsewhere. It appears, therefore, that the South Indian alluvial soils examined contain basically an identical clay, the quality of the clay remaining the same and the variation in physical and chemical properties was brought about by the variation in the quantity of clay.

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REFERENCES

Bagchi, S. N. 1951 Minerals present in H-clays from Indian soils. Kaolins and bentonites II. Thermal and optical studies. *Bull Indian Soc. Soil Sci.* **6** : 42–46.

Kelley, W. F., H. Jenny and S. M. Brown — 1936 Hydration of minerals and soil colloids in relation to crystal structure. *Soil Sci.* **3** : 85-91.

Manickam, T. S. and D. John Durairaj — 1963 Characterisation of clay from South Indian soils. I. Chemical methods. *Madras agric. J.* **50** : 326-31.

Martin, E J. and H. C. Doyne — 1927 Laterite and lateritic soils of Sierra Leone. *J. agric. Sci.* **17** : 530-46.

Marshall, C. E. — 1935 The chemical composition and crystal structure of clay minerals. *Trans. 3rd Inter. Congr. Soil Sci.* **3** : 95-97.

Menon, P. K. R. and M. P. Sankaranarayanan — 1957 General characteristics of Indian Blackslise-Black soils of the Tinnies tract. *Indian J. Agric Sci.* **27** : 259-65.

Parthasarathi, K. — 1959 Study on the genetic inter-relationship between black and red soils occurring in close proximity as affected by parent material Thesis submitted and approved for Assoc. I. A. R. I., by Indian Agricultural Research Institute, New Delhi.

Premanathan, S. and D. John Durairaj, — 1963 Study of the alluvial soils of Madras State. I. Physical properties. Paper presented at the Fourth Annual Session of the Academy of Agricultural Sciences, Coimbatore. Abstracts. *Madras agric. J.* **51** : (2), 82-83, 1964.

——— 1965 Study of the alluvial soils of Madras State. II. Chemical properties. *Madras agric. J.* **53** : (2), 49-54.

Ravi Kumar, V. — 1962 Genesis of alluvial soils in arid and semi-arid tracts. *Madras agric. J.* **49** : 71-76.

Raychaudhuri, S. P., M. Sulaiman and A. B. Bhuniyan — 1943 Physico-chemical and mineralogical studies of black and red soil profiles near Coimbatore. *Indian J. agric. Sci.* **13** : 264-74.

Sinha, S. D. — 1957 Studies on a black soil from Padegaon (Bombay). *J. Indian Soc. Soil Sci.* **5** : 91-102.

Venkataramanan, C. R. — 1962 Base exchange capacity of soil as an index for characterisation of certain South Indian Soils. M. Sc. (Ag.) Dissertation submitted to and approved by Madras University.