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Forms and Amounts of Soil Phosphorus - An Indication of Chemical Weathering *

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The formation and transportation of the various phosphate species according to the chemical principle of solubility product, following the order, calcium, aluminium and occluded phosphates, corresponding to the increasing stages in a weathering sequence, are due to differences in stability. As the soils of Nilgiris district are found under a wide range of rainfall and elevations, a study of the various stages of chemical weathering was undertaken. It showed that weathering has been hindered at one stage of chemical weathering or the other in many places. Some soils were in advanced stages of chemical weathering.

The distribution of soil inorganic phosphorus was reported to measure the degree of chemical weathering, the sequence being phosphates of calcium, aluminium, iron and occluded phosphates of aluminium and iron (Chang and Jackson, 1958). Godfrey and Reicken (1954) observed a definite relationship between the amount and distribution of phosphorus and the stage of soil development in genetically related loess-derived soils. The total phosphorus was found to decrease in the profile along the traverse in relation to the degree of profile development Paul (1954) also found the same trend as above in peat soils of British Guinea. He observed that more than 70 per cent of the total phosphorus of these soils was present as organic and inorganic alkali-soluble forms. Comparison with virgin soils of high productivity indicated that both total and organic phosphorus diminished on cropping. Godfrey and Reicken (1957) observed that in acid or near neutral soils, alkaline soluble phosphorus was a function of the position of the sample in the profile and to be further related to the degree of profile development. They indicated that soil weathering tended to change the inorganic phosphorus from calcium forms to iron, aluminium and adsorbed forms.

Carbonell and Valenein (1957) recognised degree of chemical weathering as one of the soil factors in the formation of various discrete chemical forms of phosphorus in the soil. Chang and Jackson (1957) stated that in the initial stages of weathering, calcium and aluminium phosphates were more likely to be formed than iron phosphate. As time elapsed,

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TABLE-1. Fractions of Soil Phosphorus (as percentage of total phosphorus)

	P as Aluminium phosphate	P as Iron phosphate	P as Calcium phosphate	P as Occluded phosphate	P as Organic phosphate
Nadgani	20.6	1.2	0.4	56.7	21.0
Sreemadur	24.5	12.4	2.0	61.2	—
Cherambdi	6.8	3.8	1.4	25.9	62.2
Devala	8.8	11.0	1.4	22.3	57.4
Theppakadu	29.1	—	5.3	63.7	1.9
Masanigudi	11.7	5.0	3.7	31.6	49.3
Mudumalai	5.2	40.0	7.2	22.0	25.0
Pandalur	25.6	—	1.3	68.2	5.1
Nellakottai	37.8	—	2.0	61.3	—
Gudalur	6.8	4.2	0.8	14.6	73.7
Tharapalli	20.8	4.0	2.9	31.1	41.7
Asanhaba Estate	9.9	6.9	0.4	16.0	66.8
Rangaswamy Hills (B)	3.9	5.4	0.3	9.1	72.5
Kengarai	5.8	8.0	0.4	12.7	69.4
Aravenu	9.9	16.5	0.7	15.8	57.1
Kundha	4.1	1.6	0.2	7.1	87.0
Ebbanad	6.3	4.3	0.3	10.8	77.9
Sholurmattam	14.2	—	0.8	30.8	54.3
Rangaswamy Hills (Top)	4.7	6.9	1.1	10.8	76.4
Kockal	8.0	13.1	0.1	13.2	65.7
Coonoor	12.6	10.9	12.6	40.5	23.5
Kateri	5.3	3.5	0.2	10.9	80.2
Katery Valley	7.5	11.5	1.1	19.6	60.4
Naduvattam	8.9	9.9	0.8	16.5	64.5
Melur	5.9	10.9	0.8	1.5	7.2
Sholur	10.5	18.9	0.5	14.6	55.4
Kodanad	3.7	—	0.8	9.6	85.9
Dimbatti	11.2	18.1	—	23.1	47.5
Kotagiri	9.6	12.0	2.3	19.8	56.2
Bikkatti	7.9	8.8	0.6	11.0	71.1
Thunceri	20.8	34.2	1.7	43.1	—
Enerald	15.2	13.2	1.3	31.0	39.3
Hullathi	8.9	0.2	1.1	18.6	71.2
Kattabettu	4.2	7.7	0.7	8.1	79.4
Devarsholu	4.3	2.6	0.2	7.4	85.6
A. R. S. Nanjand	13.0	4.3	0.1	23.8	58.9
Ithaler	8.1	10.8	1.0	10.7	69.3
Ootacamund	17.9	32.7	3.1	45.2	1.2
Parson's Valley	18.6	7.6	0.3	37.3	36.2
Doddabetta	7.7	14.1	0.7	13.8	63.8

calcium and aluminium phosphate gave place gradually into iron phosphate which was the least soluble among the phosphate forms. Goel and Agarwal (1960) in a study of the Kanpur soils in the Indo-Gangetic plants found that phosphorus content of the soil decreased with maturity.

The present study was, therefore, undertaken with the object of finding the relationship of the different discrete chemical forms of soil phosphorus present in the soils of Nilgiris district with the stages of chemical weathering.

MATERIAL AND METHODS

Forty virgin surface soil samples (0.22 cm) were collected from various parts of the district so as to represent the wide range of rainfall and elevation. The samples were analysed for total phosphoric acid and the different forms of soil phosphorus by the fractionation procedure described by Jackson (1957).

RESULTS AND DISCUSSION

Phosphorus as calcium phosphate ranged from traces to 67.8 ppm with a mean of 12.3 ppm. This formed 1.48 per cent of the total phosphoric acid content. Phosphorus in aluminium phosphate was between 49.4 ppm and 163.5 ppm with a mean value of 116.9 ppm. This fraction formed 11.6 per cent of total phosphoric acid content of the soil on an average. Phosphorus as iron phosphate ranged from traces to 277.0 ppm with a mean of 119.2 ppm This was 9.7 per cent of the total phosphoric acid content of the soil. Phosphorus in occluded aluminium ranged from 30.6 ppm to 190.6 ppm with a mean of 101.7 ppm. This formed 9.67 per cent of the total phosphoric acid. Phosphorus on occluded iron phosphate ranged from 59.7 ppm to 164.3 ppm. This fraction formed 15.33 per cent of the total phosphoric acid content of the soil. Organic phosphorus formed 51.6 per cent of the total phosphoric acid.

The above values showed that in general the soils of the Nilgiris were in an advanced stage of chemical weathering indicated by about 52.4 per cent of the inorganic phosphorus in the occluded forms and only 2.9 per cent of the inorganic phosphorus in the calcium phosphate fraction. The percentage of the various fractions of soil phosphorus of the total phosphorus are furnished in Table I. The formation of various discrete forms of phosphates followed the order, calcium phosphate, aluminium phosphate, iron phosphate and occluded phosphates of iron and alumina, representing increasing stability, corresponding to the advancing stages of the chemical weathering sequence. An attempt was made to study the stages of chemical weathering in the Nilgiris soils, based on the work of Chang and Jackson (1958). Such a study showed that in some places the chemical weathering was in progress, in some other places they reached

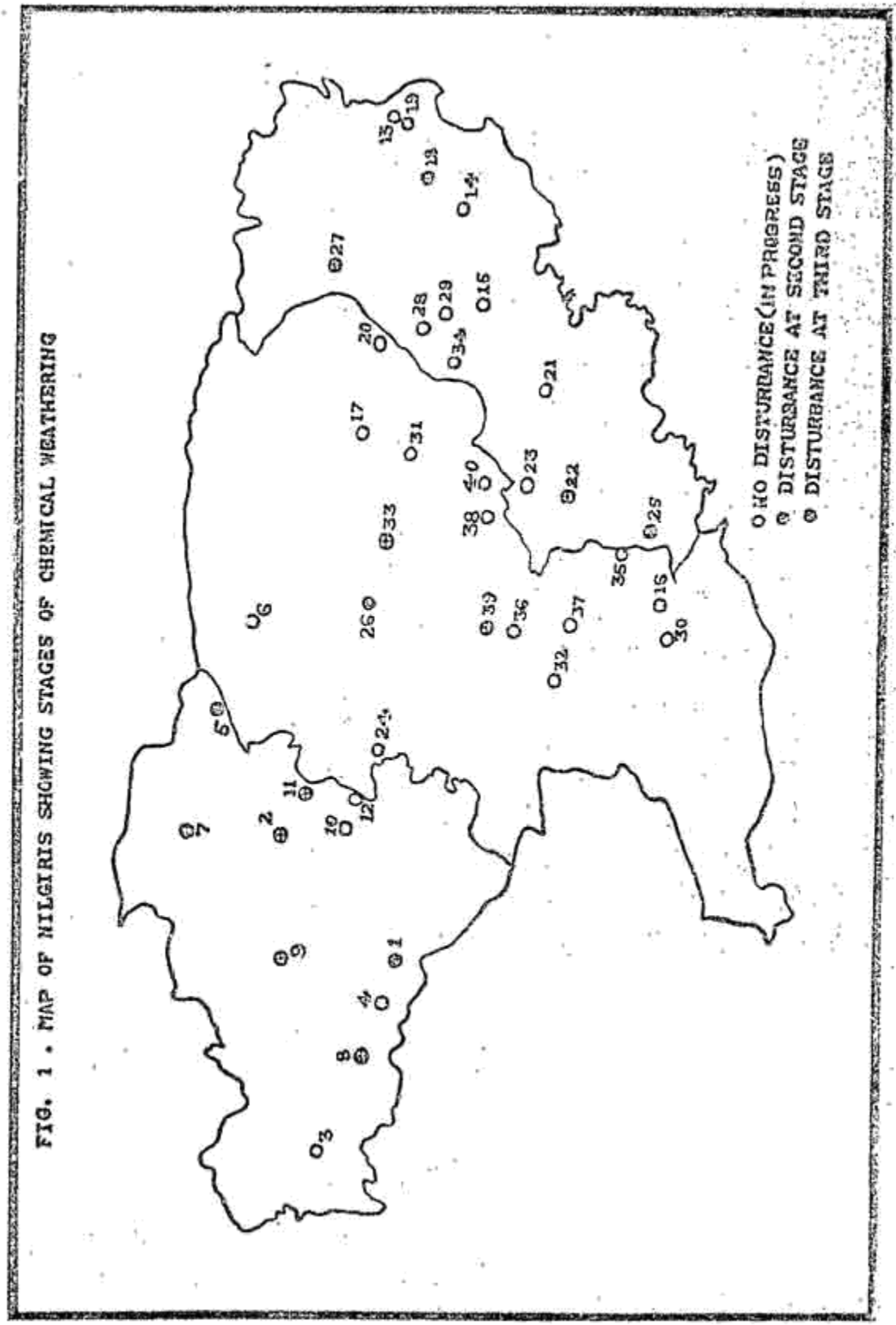

FIG. 1 . MAP OF NILGIRIS SHOWING STAGES OF CHEMICAL WEATHERING

the advanced stage of chemical weathering and in the rest of the places there had been some disturbance in the chemical weathering as could be seen py accumlation of a particular fraction of phosphorus at a certain stage and an abrupt decrease at the succeeding stages. This index gave not only the stage of chemical weathering but also the rate of chemical weathering indicated by a smooth progressively upward increase in the quantity of the fractions.

The overall picture of the various stages of weathering are noted in Fig. I.

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