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Note on Some Chemical Aspects of the Soils of Viti Levu, Vanua Levu and Guadalcanal Islands

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The systematic soil surveys based on Soil Taxonomy (USDA, 1975) have been proceeding in Fiji by several workers (1).

Because almost all soil samples were taken from surface or top horizon, the classification attempt of the soils was nearly impossible in this study. Then some chemical properties such as soil pH , base status and P-retention were examined on the soils of Viti Levu and Vauna Levu of Fiji and those of Guadalcanl of Solomon.

From the obtained data, the authors attempted to make grouping of the characteristics of the soils in each Island.

Materials and Methods

Nineteen soil samples from Viti Levu, 7 from Vanua Levu and 6 from Guadalcanal were collected for analyses in this study. (Fig. 1 and Tab. 1)

The soil pH was measured in H_2O and 1 M KCI suspension with the soil:soluton ratio of 1:2.5. The pH of 1 g of the soil in 50 ml of 1 M NaF (2 minutes after the addition of NaF) was also measured.

The KCl and Ca $(CH_3COO)_2$-acidities were obtained as follows:the suspension of soil:H_2O or soil:1 M Ca $(CH_3COO)_2$ of pH 7.0 with the soil:solution ratio of 2.5:1 was shaken for 1 hour and filtered. The filtrate was titrated with 0.05 M NaOH and the acidity was expressed as me/100g.

The cation exchane capacity (CEC) was estimated as the sum of the exchangeable cations and the Ca $(CH_3COO)_2$-acidity, because the acidity was considered to be composed of exchangeable H and Al ions.

The exchangeable Ca, Mg, K and Na ions were extracted with 1 M NH_4CH_3COO of pH 7.0 and determined by atomic absorption spectroscopy.

The amount of P-retention was determined as follows:10 ml of 0.032 M KH_2PO_4 adjusted at pH 4.6 was added to 1.0 g of soil sample and shaked for 24 hours at 30°C. The amount of PO_4 ion in the supernatant was determined spectroscopically by

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Table 1. Description of the soil samples

Site No	Locality	Depth (cm)	Soil Color	Kind of Field and Crop	Remarks
2-1	Koronivia, Nausori (Viti Levu)	0-10	2.5YR 2/3 (Very dark reddish brown)	Pasture	
-2		40-50	5Y 5/3 (Grayish olive)		
4	Ngaloa, Nuku (Viti Levu)	0-10	7.5 YR 3/4 (Dark brown)	Pasture	Ill drained field
5-1		0-10	7.5YR 3/4 (Dark brown)	Shifting field Pineapple	
-2		10-20	7.5YR 3/4 (Dark brown)		
-3		20-30	10YR 3/4 (Dark brown)		
6-1	Nawamangl, Sigatoka (Viti Levu)	0-10	2.5Y 3/3 (Dark olive)	Upland field Sorghum	Very hard soil After harvesting
-2		0-10	10YR 5/4 (Brownish black)	Upland field Sorghum	Adjacent field to 6-1 After ploughing
-3		10-20	7.5YR 4/3 (Brownish black)		
-4		20-30	5YR 4/2 (Grayish brown)		
7-1	Nanduri, Sigatoka	0-10	7.5YR 4/3 (Very dark brown)	Upland field Yam	After harvest and ploghing
-2		10-20	2.5YR 3/3 (Dark olive)		Soft subsoil
8-1	Rawanga, Sigatoka	0-10	10YR 3/2 (Brownish black)	Upland field Passion fruit	2nd year after planting
-2		0-10	10YR 3/2 (Brownish black)	Upland field Passion fruit	1-st year after
-3					
-3		0-10	10YR 3/2 (Brownish black)		Plant was dying
9	Nakambuta, Sigatoka (Viti Levu)	0-20	5YR 2/2 (Dark reddish brown)	Upland field Cassava	Hillside farm
10	Nadi (Viti Levu)	0-30	7.5YR 3/3 (Dark brown)	Upland field Sugar cane	After harvest
11	Lautoka (Viti Levu)	0-20	2.5YR 3/4 (Dark reddish brown	Upland field Pulse	Experimental station

Site No	Locality	Depth (cm)	Soil Color	Kind of Field and Crop	Remarks
12-1	Mbatir, Macuata (Vanua Levu)	0-10	2.5YR 2/4 (Very dark reddish brown)	Shifting field Yam	Hillside farm just after burning
-2		10-20	2.5YR 3/6 (Dark reddish brown)		
13-1	Dreketi, Macuata (Vanua Levu)	0-10	2.5YR 2/2 (Very dark reddish brown)	Orchard Citrus	Growth was poor
-2		10-20	2.5YR 3/4 (Dark reddish brown)		
20 21	Dreketi, Macuata (Vanua Levu)	0-10	5YR 3/4 (Dark reddish Brown)	Farmyard field Maize	
21	Mutsolovu, Dreketi (Vanua Levu)	0-10	7.5YR 2/3 (Very dark reddish brown)	Cocoa field Cocoa	New plantation
23			10YR 3/6 (Dark red)		Soil of bank of the recently developed road
24-1	Ravangga, Sigatoka (Viti Levu)	0-10	7.5YR 2/3 (Very dark brown)	Upland field Tomato	
-2		0-10	10YR 3/2 (Brownish black)	Upland field Sweet potato	
29-1	Near, Mt. Austen (Solomon)	0-10	7.5YR 2/3 (Very dark brown)	Shifting field Sweet potato etc.	1st cropping after burning
-2		10-20	7.5YR 3/4 (Dark brown)		
30-1		0-10	7.5YR 2/3 (Very dark brown)	Shifting field Kindey bean, etc.	2nd cropping after burning
-2		10-20	5YR 2/4 (Very dark reddish brown)		
31-1		0-10	5YR 2/3 (Very dark reddish brown)	Shifting field Yam	3rd cropping after burning
-2		10-20	5YR 2/4 (Very dark reddish brown)		

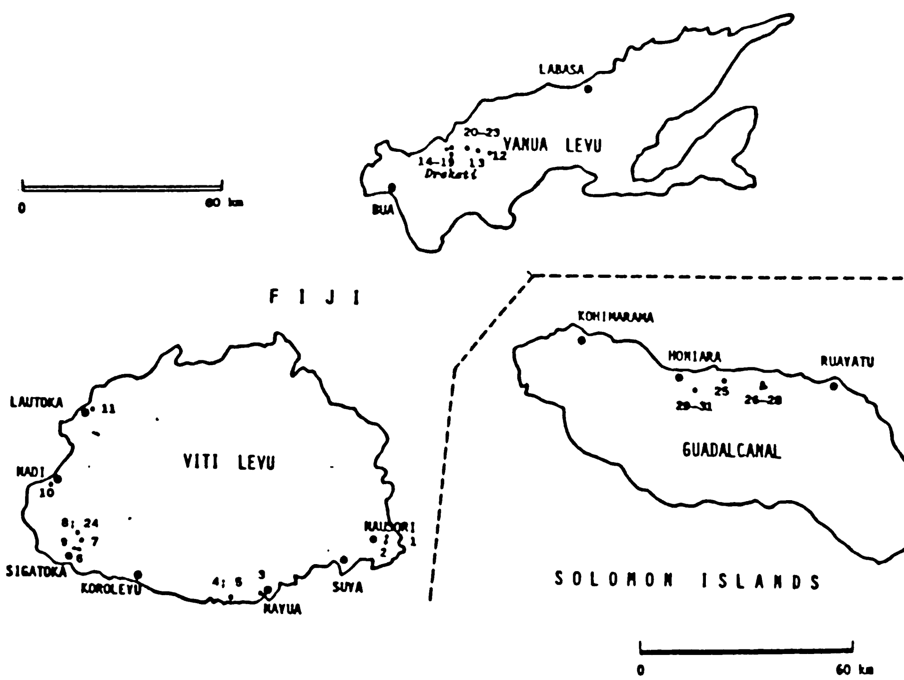

Figure 1. Sampling sites of soils

vandomolybdatic yellow at 470 nm. The difference between the P content of original solution and that of supernatant was taken as the amount of adsorbed phosphorus.

Results and Discussion

Table 2 shows the pHs and the acidities of the soil samples and Table 3 their amounts of exchangeable cations and base saturation degrees, respectively.

Some of these results are rearranged in Table 4 according to several analytical items.

Among samples used, the soil pH (H_2O) was higher in Guadalcanal (2 samples are higher than 7 and 4 between 6 and 7) and in Viti Levu (most soils between 6 and 7) than in Vanua Levu (5 of 7 samples are between 5 and 6). This tendency was in good accordance with that of base saturation degrees, as shown in Table 4. In Guadalcanal and Viti Levu soils, almost all samples exceeded 80% in base saturation, while, in Vanua Levu, all soils were lower than 80% in the saturation degree and 5 of 7 soils are lower than 60%.

The pH values were also correlated with the amounts of exchangeable Ca and/or Ca saturated degrees.

The differences between pH (H_2O) and pH (KCl) also show clear tendency. The differences of Viti Levu soils except 2-1 were rather high as 1.0, (1.14 – 2.30, m =

Table 2. The pHs and the acidities of the soil samples

Site No	pH			Acidity	
	H_2O	KCl	NaF	KCl	$Ca(CH_3COO)_2$
2-1	4.20	3.36	8.28	11.25	16.88
-2	5.05	3.66	9.00	3.88	5.03
4	6.17	4.93	8.48	0.13	2.60
5-1	6.35	4.89	8.44	0.13	3.40
-2	6.07	4.43	8.57	0.38	3.63
-3	6.43	4.13	8.64	0.40	3.75
6-1	6.10	4.90	8.52	0.13	2.03
-2	6.46	4.55	8.42	0.08	2.48
-3	6.70	4.52	8.57	0.26	1.88
-4	6.68	4.66	8.61	0.18	1.75
7-1	6.80	4.79	8.59	0.05	1.70
-2	6.90	5.04	8.66	0.08	1.38
8-1	6.66	4.93	8.57	0.13	2.13
-2	6.69	4.89	8.65	0.08	1.95
-3	6.57	5.06	8.57	0.13	2.40
9	6.10	4.84	8.31	0.15	2.78
10	7.18	5.39	8.54	0.06	1.00
11	6.01	4.87	8.87	0.05	1.00
12-1	5.02	4.05	9.47	0.13	1.08
-2	4.65	3.84	9.37	1.38	6.13
13-1	6.20	5.41	10.08	3.63	7.38
-2	5.40	4.87	9.73	0.08	3.53
20	5.20	4.35	8.65	0.25	4.93
21	5.82	5.16	8.54	0.20	4.15
23	5.30	3.84	9.56	4.95	6.20
24-1	6.46	4.90	8.67	0.25	2.13
-2	6.55	4.97	8.68	0.13	1.88
29-1	6.96	6.24	8.87	0.18	1.43
-2	6.83	6.01	9.25	0.13	1.33
30-1	7.24	6.60	9.06	0.20	0.88
-2	7.16	6.41	9.10	0.15	0.95
31-1	6.63	5.93	9.05	0.13	1.98
-2	6.32	5.57	9.13	0.20	2.58

Table 3. The Amounts of Exchangeable Cations, Cation Exchange Capacities and Base Saturation Degrees of the Soil Samples.

Site No	Exchangeable Cation (me/100 g)					CEC	Base Saturation
	Ca	Mg	K	Na	Total	(me/100 g)	Degree (%)
2-1	1.96	0.48	0.23	0.26	2.93	19.81	14.8
-2	6.46	2.39	0.31	0.27	9.43	14.46	65.2
4	12.0	3.59	0.43	2.22	18.24	20.84	87.5
5-1	11.2	5.63	1.07	0.54	18.44	21.84	84.4
-2	10.4	5.74	1.14	2.28	19.86	23.49	84.5
-3	10.7	5.87	1.27	4.47	22.31	26.06	85.6
6-1	14.7	3.65	1.12	0.27	19.74	21.77	90.9
-2	14.7	3.95	0.54	0.43	19.62	22.10	88.8
-3	16.5	4.43	0.40	0.37	21.70	23.58	92.0
-4	16.9	4.37	0.20	0.43	21.90	23.65	92.6
7-1	15.8	3.83	1.43	0.22	21.28	22.98	92.6
-2	15.5	3.83	0.88	0.29	20.50	21.88	93.7
8-1	16.9	3.89	1.29	0.17	22.25	24.38	91.3
-2	15.7	3.71	1.02	0.18	20.61	22.56	91.4
9	8.65	2.76	0.91	0.20	12.52	15.30	81.8
10	14.9	3.00	0.18	0.12	18.20	19.20	94.8
11	6.76	1.02	0.58	0.07	8.43	9.43	89.4
12-1	1.75	0.78	1.01	0.29	3.83	4.91	78.0
-2	1.31	0.42	0.94	0.25	2.92	9.05	32.3
13-1	8.36	0.36	0.31	0.17	9.20	16.58	55.5
-2	1.31	0.24	0.26	0.12	1.93	5.46	35.3
20	3.64	1.26	1.09	0.08	6.07	11.00	55.2
21	11.4	3.00	0.66	0.10	15.16	19.31	78.5
23	3.93	3.35	0.19	0.14	7.61	13.81	55.1
24-1	16.2	4.13	1.19	0.17	21.69	23.82	91.1
-2	15.3	4.07	1.15	0.17	20.69	22.57	91.7
29-1	15.1	1.68	0.74	0.10	17.62	19.05	92.5
-2	12.5	1.32	0.36	0.13	14.31	15.64	91.5
30-1	23.7	0.95	0.38	0.10	25.13	27.11	92.7
-2	16.6	0.84	0.33	0.10	17.87	18.82	95.0
31-1	13.8	1.44	0.38	0.12	15.74	17.72	88.8
-2	11.5	1.44	0.51	0.11	13.56	16.14	82.2

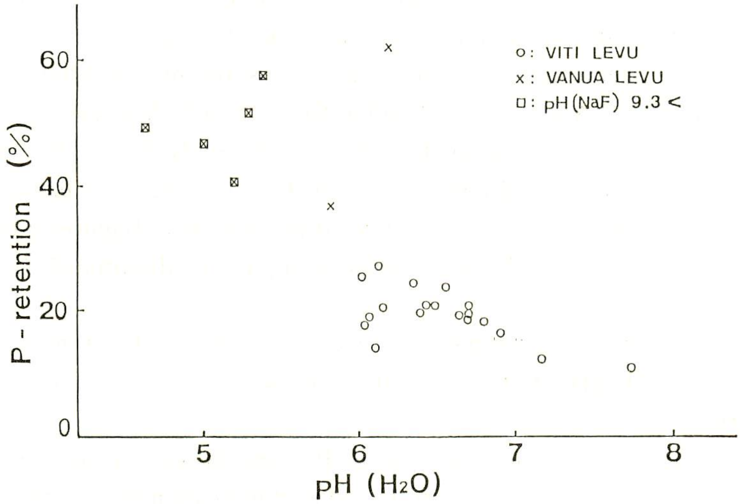

Figure 2. Correlation between pH (H_2O) and P-retention

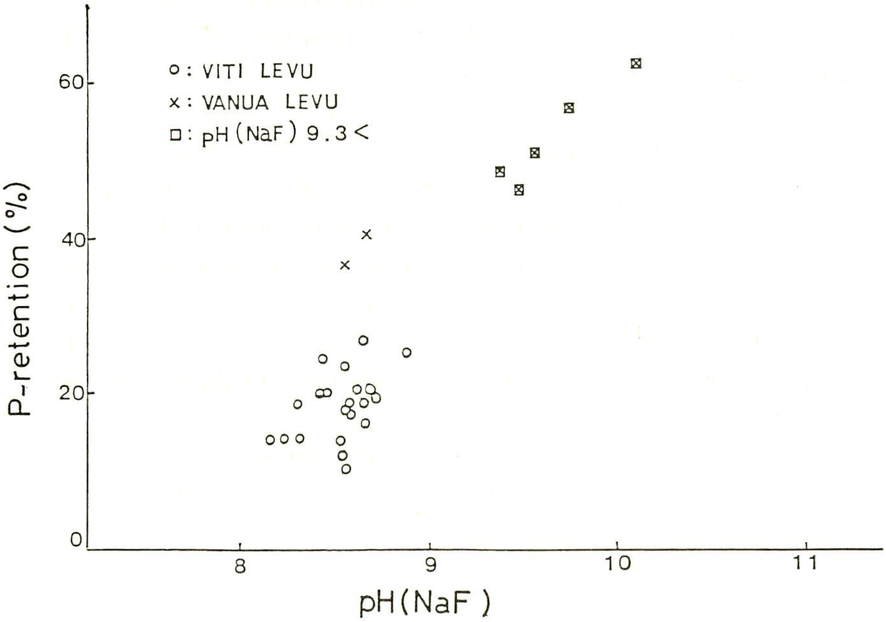

Figure 3. Correlation between pH (NaF) and P-retention

1.66). But those of Gudalcanal (0.65 – 0.82) and Vanua Levu except No.13 (0.57 – 0.97, m = 0.68) are less than 1.0.

The distinct lowering of pH in KCI usually indicates the existence of the crystalline clay minerals having rather strong acidic character retainable exchangeable Al. Thus Viti Levu soils seemed to contain some 2:1 type clay minerals as smectite and / or vermiculite.

The smaller lowering of pH in KCI, as the case of Vanua Levu, suggests that the negative charge of the soils are weaker and due to mainly amorphous colloidal constituents such as allophane and R_2O_3 and/or kaolin clays.

Because these chemical features of Vanua Levu soils are somewhat similar to those of volcanic ash soils ("Andosols" in FAO/UNESCO and "Andepts" or "Andisols (in proposal)" (2) in Soil Taxonomy/USDA), the pH in NaF and P-retention of the sample was also measured and compared with those of other two Islands.

The pH value of more than 9.2 or 9.4 (3) is taken as a diagnostic of Andepts or Andisols, respectively, of which exchange complex is dominated by amorphous materials.

As expected, among the samples analyzed, only in Vanua Levu there observed such soils as having high pH (NaF), indicating the larger presence of releasable surface exposed OH.

As shown in Table 5, their amounts of P-retention were in the range from 40 to 60% and were not so high as the diagnostic value of more than 90% in the classification. while the soils of other two Islands showed much lower P-retention values.

Though the P-retention were not so high, nearly good correlations between the pH (NaF) and P-retention (%) and that between pH (H_2O) and P-retention were observed: the lower the pH (H_2O), the higher the P-retention and the higher the pH (NaF), the higher the P-retention, as shown in Figures 2 and 3.

These data suggest that the Vanua Levu soils in this study are not included in Andepts or Andisols category though they are very similar in their chemical features except P-retention values and that the reclaim of their acidities by liming, the addtion of organic matter and the much application of P are recommended.

Further studies studies especially on the mineralogical analyses are needed.
As to Ca/Mg ratio (Table 4), many soils showed lower values than 4 in Viti Levu and Vanua Levu:the former resulted from the high contents of Mg compared with Ca and the latter mainly from the low Ca contents themselves. In these two Islands much liming are desirable.

The Mg/K ratios were mostly adequate except some soils of Vanua Levu which showed the ratios less than 2 and are needed the application of Mg fertilyzer together with liming.

Table 4. *Comparison of some base status with each island*
Value : numbers of samples
(　　) : desirable value

Saturation degree (40-80)

me/100 g	40	40-60	60-80	80-90	90
Viti Levu	1	0	0	8	10
Vanua Levu	2	3	2	0	0
Solomon	0	0	0	2	4

Exchangeable Ca (8.0)

me/100 g		4-8	8-12	12
Viti Levu	1	2	5	11
Vauna Levu	5	0	2	0
Solomon	0	0	1	5

Ca/Mg ratio (4-10)

	4	4-10	10
Viti Levu	11	8	0
Vanua Levu	5	1	1
Solomon	0	4	2

Mg/K ratio (2)

	2	2-10	10
Viti Levu	1	15	3
Vauna Levu	5	1	1
Solomon	0	4	2

Table 5. The P-retention of the soil samples

Site No	P-retention (%)	Site No	P-retention (%)
2-1	31.6	11	25.1
-2	33.0	12-1	46.1
4	20.2	-2	48.9
5-1	24.6	13-1	62.6
-2	17.9	-2	57.0
-3	26.8	20	40.8
6-1	14.0	21	36.9
-2	20.4	23	51.4
-3	19.3	24-1	20.7
-4	20.7	-2	19.6
7-1	17.6	29-1	31.0
-2	16.2	-2	35.5
8-1	19.0	30-1	32.4
-2	18.7	-2	34.1
-3	23.7	31-1	31.3
9	14.2	-2	42.2
10	12.3		

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