A PEDOLOGICAL INVESTIGATION OF THE JAPANESE VOLCANIC ASH SOILS IN JAPAN

II. On the Yellowish Brown Type of Kuroishibara, Kumamoto Prefecture, Central Kyushu.

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Résumé

In the previous paper the senior writer has classified the Japanese volcanic ash soils in Japan into the four subtypes, i. e., Brown, Yellowish Brown, Light Yellowish Brown, and Onji types, owing to their morphological characteristics, origins, and reactions. In this paper it is intended to show the morphological and chemical characteristics of Yellowish Brown type of Kuroishibara, Kumamoto Prefecture, Central Kyushu.

Kuroishibara lies on the northeastern diluvial land of Kumamoto City. Data of 60 years from the meteorological station of Kumamoto are as follows:

Rainfall mm	*Mean Temperature* C°	*Mean Relative Humidity* %	*Rain Factor (Lang)*	*NS-Quotient (Meyer)*	*P-E Index (Thornthwaite)*	*T-E Index*
1,704.7	15.5	77.4	110	576	153	33

From the above data it is indicated that the area belongs to the warm and temperate region with mesothermal and superhumid climate.

The parent material of the soil in the area is the volcanic ash and detritus erupted from Volcano Aso, and it is underlain by gravelly and loamy beds of the Pleistocene. The following profile is found at a new road cutting in the well-drained woodland with smooth relief.

A_1 (518401-1) 0～15 *cm*. Soil materials with very thin leaf litters slightly decomposed, are heavily matted with many rootlets of bamboo-grass, and are characterized by dark brown to brownish black loam to clay loam, weakly developed fine granular structure, and loose and soft consistence. Rich in humus.

A_2 (518401-2) 15～95 *cm*. Brownish black silt loam to clay loam with many fragments of volcanic glasses. Rich in humus. Blocky or nuciform structure, blocks crush easily into many coarse granules. Friable, porous, and very slightly compact. Firm in places (porphyritic matrix). It gradually merges into thel ower horizon.

B_1 (518401-3) 95～120 *cm*. A transitional horizon. Dark yellowish brown clay, impregnated with humus. Blocky structure, porous and more compact. Sticky when wet and friable when moist. Roots penetrate into this horizon.

B_2 (518401-4) 120～180 *cm*. Yellowish brown clay with blocky structure, and contains volcanic glasses and pumices. Consistence resembles that of the upper horizon. It is underlain by a gravelly bed consisting largely of andesite stones which are round in shape.

The profile closely resembles the appearance of Prairie soils. The soil is characterized by a thick and dark surface horizon followed by a yellowish brown subsoil, and has a slightly well-developed profile.

Mechanical and chemical characteristics of the soil are shown in Table 1. The soil is clayey in texture throughout the profile. The humus content decreases with the depth, that is, it amounts to about 30 per cent in the upper-most horizon, while it falls about 1 per cent in the B_2 horizon. The carbon-nitrogen ratio of the surface layer is higher than those of the corresponding horizons of Prairie soils and Chernozems.

The *p*H of the soil is strongly acidic, and the relation between the actual *p*H (pH_0) and the ultimate *p*H (pH_u) of the various horizons differs from that of podzols. The exchange reactions (pH_u in water minus pH_u in $n/100$ Na_2SO_4) show neutral or alkaline throughout the profile. Judging from these properties mentioned above, it seems that the soil of Kuroishibara is subjected to the anionic solvation and eluviation during which negatively charged acidoids (mostly silica) in association with bases are washed out of the profile.

One of the most striking properties of the soil is a low base status, that is, the degrees of base unsaturation amount to about 90 per cent or more throughout the profile. Although the fresh ashes erupted from Volcano Aso contain originally about 10 per cent of calcium, a large portion of the calcium had been washed out of the ash deposit owing to intense leaching process. The molecular ratios of the clay fractions in the various horizons show extraordinarily allitic in composition. This fact, on the one hand, may be attributed to the original compositions of the fresh ashes. For example, the silica-alumina ratios of the fresh ashes erupted from Volcano Aso have been reported to be 2.80 (average of 9 samples), 4.78 (average of 12 samples), and 4.54 (one sample with 0.002～0.003 *mm* in diameter). These values are remarkably lower as compared with the value of 6.99 which is calculated from the average composition of igneous rocks shown by Clarke. On the other hand, the low molecular ratio of the clay fractions indicates a tendency of strongly desilicification. This fact is also supported by the dissolved silica in river water. For example, it is found that the dissolved silica in the river water of

Shirakawa which flows from Volcano Aso, amounts to about 50 *mg/l.*

The pedogenic process of the Japanese volcanic ash soils is neither podzolization nor laterization, but it is an independent one, subjecting to the anionic solvation and eluviation, which has not yet been established universally. The soil of Kuroishibara may be considered to be infertile because of its strong acidity and extremely low base status.

Table 1. Mechanical and Chemical Characteristics of the Yellowish Brown Type of the Japanese Volcanic Ash Soils, Kuroishibara.

Sample No	518401-1	518401-2	518401-3	518401-4
Horizon	A_1	A_2	B_1	B_2
Depth (*cm*)	0～15	15～95	95～120	120～180
Mechanical Composition (Per cent on oven-dry basis)*:				
Gravel (above 2 *mm*)**	0.23	0.01	0.18	0.18
Coarse Sand (2～0.2 *mm*)	3.21	4.40	0.81	1.06
Fine Sand (0.2～0.02 *mm*)	29.41	14.98	5.11	16.91
Silt (20～2 μ)	30.67	37.25	38.33	44.52***
Clay (below 2 μ)	36.71	43.37	35.76	37.51***
Texture of Fine Earth (USDA)	Clay	Clay	Clay	Clay
* Robinson's provisional method (HCl). ** Air-dry basis. *** Robinson's method (NaOH).				
Reactions:				
pH_0 in Water (*w*)	5.48	5.49	5.18	4.76
pH_0 in *n* KCl (*s'*)	4.61	5.11	4.71	4.76
pH_0 in 0.01 *n* Na_2SO_4 (*s''*)	5.59	5.94	5.51	5.79
Ultimate pH_0:				
in Water (*w*)	5.39	5.18	4.89	3.89
in 0.01 *n* Na_2SO_4 (*s''*)	5.49	5.58	5.20	5.29
Titrative Acidities (y_1):				
in *n* KCl	6.5	1.3	3.9	2.6
in *n* CH_3COONH_4	59.7	52.7	17.0	13.4
Humus Content (Oven-dry basis) & C/N Ratio:				
Organic Carbon	15.80	5.71	2.65	0.79
Humus	27.24	9.85	4.58	1.36
Total Nitrogen	0.666	0.293	0.157	0.097
C/N Ratio	23.6	10.4	16.7	7.9
Exchangeable Capacity & Bases (*m.e.*/100 *g* oven-dry material)*:				
Capacity	61.29	50.58	50.06	36.09
Al	2.73	0.58	None	None
Ca	0.97	0.20	0.47	0.95
Mg	0.62	0.19	0.33	0.71
Mn	0.043	0.007	0.010	0.033
K	0.018	0.011	0.013	0.055
Na	0.19	0.14	0.32	0.63
Total Bases	4.571	1.128	1.143	2.378
H**	59.36	47.70	46.32	32.00
Ca***	1.09	0.34	0.64	1.04
Degree of Base Saturation (%)	7.46	2.23	2.28	6.59
* *n* CH_3COONH_4 (*p*H 7.0) method. ** Mehlich's Triethanolamine method. *** *n* KCl extracted.				
Electrodialysable Anions & Bases (*m.e.*/100 *g* oven-dry material):				
Anions	2.26	2.84	3.71	2.29
Ca	1.84	0.86	1.01	1.37
Mg	0.72	0.61	0.75	1.15
R_2O_3 (%)	0.05	0.03	0.04	0.03
Free Silica & Free Alumina (Oven-dry basis)*:				
Silica	1.88	0.86	1.19	0.66
R_2O_3 (mainly Al_2O_3)	0.12**	2.23	2.29	1.59**
* Truog & Drosdoff's method. ** Include the minor content of Fe_2O_3.				
Colloidal Clay Fraction (below 0.002 *mm*) (Oven-dry basis):				
Loss on Ignition	39.87	49.04	24.97	16.05
Silica	19.44	22.84	30.18	40.23
Alumina	33.59	22.14	35.96	35.48
Iron	7.81	2.99	7.05	10.30
Silica/Alumina	0.98	1.75	1.42	1.92
Silica/Sesquioxide	0.86	1.61	1.27	1.62