STUDIES ON THE RED SOIL DEVELOPED ON THE LIMESTONE PLATEAU OF AKIYOSHIDAI, YAMAGUCHI PREFECTURE

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Résumé

A problem concerning the soil type of the red-colored soils derived from limestone in Japan has not yet been dissolved. For instance, Kawashima has recognized that neither terra rossa nor rendzina is found on the limestone plateau of Hiraodai, northern Kyushu, whereas Kamoshita has considered the red-colored soil derived from limestone in Central Japan to be the terra rossa. Kawamura has suggested from field studies in the several limestone plateaux that there may be no terra rossa in Japan. Lee has recently described that the red-colored soil found on Akiyoshidai belongs to the red podzolic soil.

This paper deals with the morphological and chemical characteristics of the red soil of Akiyoshidai.

Akiyoshidai lies at about 20 *km* northwest of Yamaguchi City, and is the most prominent limestone plateau in Japan, showing a typical karst topography. The parent rock from which the red soil has developed is *Fusulina* limestone of the Permo-Carboniferous which is hard and gray in color. In most places of the plateau a dominant vegetation consists of several kinds of coarse grasses and shrubs.

Data of 60 years from the Shimonoseki Meteorological Station, are as follows:

Rainfall *mm*	*Mean Temperature* *C°*	*Mean Relative Humidity* *%*	*Rain Factor (Lang)*	*NS-Quotient (Meyer)*	*P-E Index (Thornthwaite)*	*T-E Index (Thornthwaite)*
1,615.2	15.2	74.8	103	499	165	82

From the above data it is obvious that the area belongs to the warm and temperate region with mesothermal and superhumid climate, and that the climate of Akiyoshidai offers a marked contrast to that of the Mediterranean region which is characterized by a rainy winter season alternating with a dry season in the summer.

A typical profile taken from the hill side, has a following feature:

A_1 (516301-1) 0～4 *cm*. Dark brown silty clay with some humus and many rootlets, granular structure (4～5 *mm* in diameter), and friable. Some white mycelia occur around the roots. Burnt black remnants of grasses and shrubs have remained on the surface.

A_2 (516301-2) 4～22 *cm*. Brown clay with some humus and many rootlets, granular structure (5～10 *mm* in diameter), friable and slightly compact.

B_1 (516301-3) 22～32 *cm*. A transitional horizon. Brown clay, coarse granular structure (above 10 *mm* in diameter) or nuciform structure, friable and compact. It has been impregnated with humus. Some white mycelia are seen around the roots.

B_2 (516301-4) 32～82+*cm*. Reddish brown clay with nuciform structure and very compact. Lumps are friable when moist and plastic when wet. It contains some unweathered sandy materials. Roots have penetrated to about 60 *cm*. Moisture content and compactness increase with the depth. The soil shows a slightly developed profile.

The soil is characterized by a heavy texture throughout the profile and a red color in the B_2 horizon. From the mechanical composition given in Table 1, it is indicated that the colloidal clays accumulated, to a great extent, in the B horizon. There is no marked development of acid humus layer, nor is there any evidence of bleaching or fading in the A_2 horizon which is common in podzols or podzolic soils.

It is noticed from Table 1 that the soil is characterized by a strongly acid reaction and an extremely low degree of base saturation throughout the profile, except for the B_2 horizon. The relation between the actual *p*H (pH_0) and the ultimate *p*H (pH_u) of the various horizons is obviously different from that of podzols, in which the pH_0 is generally lower than the pH_u in the C and B horizons. The exchange reactions (pH_u in water minus pH_u in $n/100$ Na_2SO_4) show neutral or alkaline. Judging from the properties obtained here, the soil of Akiyoshidai is subjected to the anionic solvation and eluviation, as Mattson stated, and consequently, it is not a product of podzolization.

The silica-alumina and silica-sesquioxide ratios of the colloidal clay fractions become wider with the depth, and are fairly siliceous.

In consideration of its morphology and chemical properties the soil of Akiyoshidai should be regarded as the non-podzolic red soil, and generally speaking, under the humid condition such as Japan, limestone parent material gives rise to a subtropical type of soil which is quite different from the terra rossa, rendzina and brown forest soils with high base status, and from the podzolic soil groups with a bleached horizon. Although soils derived from limestone are generally considered to be fertile in the temperate region, the red soil of Akiyoshidai is not so, because of its strongly acid reaction and extremely low base status.

Table 1. Mechanical and Chemical Characteristics of the Red Soil Developed on the Limestone Plateau of Akiyoshidai

Sample No	516301-1	516301-2	516301-3	516301-4
Horizon	A_1	A_2	B_1	B_2
Depth (*cm*)	0～4	4～22	22～32	32～82+
Mechanical Composition (Per cent on oven-dry basis)*:				
Gravel (above 2 *mm*)**	tr	0.01	tr	tr
CS (2～0.2 *mm*)	3.55	4.01	4.13	1.61
FS (0.2～0.02 *mm*)	4.29	8.57	3.26	0.91
Silt (20～2 μ)	50.75	43.44	42.31	18.15
Clay (below 2 μ)	41.41	43.98	50.30	79.33
Texture of Fine Earth	Silty Clay	Clay	Clay	Clay
* USAD's sodium hexametaphosphate method. ** Air-dry basis.				
Reactions:				
pH_o in Water (w)	5.00	4.87	5.12	5.00
pH_o in n KCl (s')	4.32	4.35	4.45	4.45
pH_o in n/100 Na_2SO_4 (s'')	5.11	4.86	5.12	5.15
Ultimate pH_u:				
in Water (w)	4.15	4.08	4.25	4.45
in n/100 Na_2SO_4 (s'')	4.58	4.59	4.35	4.61
Titrative Acidities (y_1):				
in n KCl	22.0	23.3	20.7	24.3
in n CH_3COONH_4	95.9	61.0	32.3	32.0
Humus Content & C/N Ratio (Oven-dry basis):				
Organic Carbon	3.45	1.76	1.25	0.29
Humus	5.95	3.03	2.16	0.50
Total Nitrogen	0.197	0.106	0.049	0.031
C/N Ratio	17.5	16.6	25.6	9.4
Exchangeable Capacity & Bases (*m.e.*/100 *g* oven-dry material):				
Capacity *	35.53	27.15	23.46	29.02
Al *	0.31	0.20	0.15	0.52
Ca *	2.69	0.55	1.05	3.94
Mg*	1.40	0.25	0.52	2.00
Mn*	0.63	0.16	0.12	0.03
K *	0.007	0.006	0.006	0.008
Na *	0.05	0.04	0.08	0.10
Total Bases *	5.087	1.206	1.926	6.598
H**	29.83	24.56	23.46	29.02
Degree of Base Saturation (%)	14.32	4.44	8.21	22.74
Ca ***	3.10	0.77	1.36	3.53
* Schollenberger's n CH_3COONH_4 (pH 7.0) method. ** Mehlich's Triethanolamine method. *** n KCl extracted.				
Electrodialysable Anions & Bases (*m.e.*/100 *g* oven-dry material):				
Anions	1.80	0.39	0.53	1.79
Ca	4.00	1.49	1.97	4.67
Mg	3.96	1.36	1.63	2.89
R_2O_3 (%)	0.12	0.02	0.04	0.02
Colloidal Clay Fraction (below 0.002 *mm*) (Oven-dry basis):				
Loss on Ignition	34.11	21.72	18.65	11.62
SiO_2	32.93	39.35	39.58	41.78
Al_2O_3	24.89	28.11	23.00	23.51
Fe_2O_3	9.83	12.71	22.07	24.60
Silica/Alumina	2.24	2.38	2.92	3.02
Silica/Sesquioxide	1.79	1.84	1.81	1.81