^{14}C Age of Humus of Ando Soils in Japan

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Introduction

Japan is one of the famous volcanic countries of the world, and is widely covered with Ando Soils developed from volcanic ejecta as the parent material. Total area distributed with the Ando Soils is estimated to be about six million ha and one half of which, three million ha, possesses a very important role in Japanese agriculture being utilized as arable land.

Though the parent material of the Ando Soils seems to be erupted in late Pleistocene to recent, its chronology is not yet much advanced except Hokkaido and one part of Kanto and southern Kyushu.

Recently, the radiocarbon dating with ^{14}C is used to determine the age of volcanic ejecta. Most of the subjects in this determination are the buried materials from deep strata, but volcanic ash and humic material in the surface horizon are treated very rarely. It may be considered from the forming process of humus that the chronology of humus has been obtained seldom because of the impossibility in the determination of the absolute age of parent material.

Even though the absolute age is unknown, if a certain value, which can suggest the age of parent material or the ages concerning to the soil genesis, is obtainable, it may be used as an effective criterion to promote the study on the genesis of Ando Soils.

Though results are not yet sufficient at present and more determination of many soils should be performed urgently, the author would like to discuss on some results.

Distribution of ^{14}C age of Ando Soils in Japan

Table 1 shows the ^{14}C age of 23 samples of humus horizon collected from 13 places. Sampling locations were shown in Fig. 1. The humus of Ando Soils in Table 1 shows a wide distribution extending from modern to about 25,000 years B.P.*

Here, all the Ando Soils of the age of more than 6,000 years B.P. were derived from buried humus horizon, and the ages of surface humus horizon (All, A12, Ap) were less than about 6,000 years B.P., namely, they belong to the younger ages after the Early Jomon Age.

As to the relation between the age and position of humus horizon, the deeper the position, the higher the age in the soil contained with the buried humus horizon, and also the age of surface horizon is younger in the thick Ando Soils (Ando Soils contained with the humus horizon of which thickness is more than 60 cm) and the age becomes higher according to the increase of depth. Similar inclination was found in the horizon sequence of ^{14}C age of some European chernozems investigated by Scharpenseel et al.

Scharpenseel considered that the decrease of ^{14}C age in surface horizon might be due to rejuvenation by root or other modern C.[10] This consideration may also be applicable on the Ando Soils in the root sphere of modern plant, but the ^{14}C age inclination in the humus horizon of thick Ando Soils cannot be explained

* The abbreviation of "Before Present" which indicates the number of years counted backward from 1950.

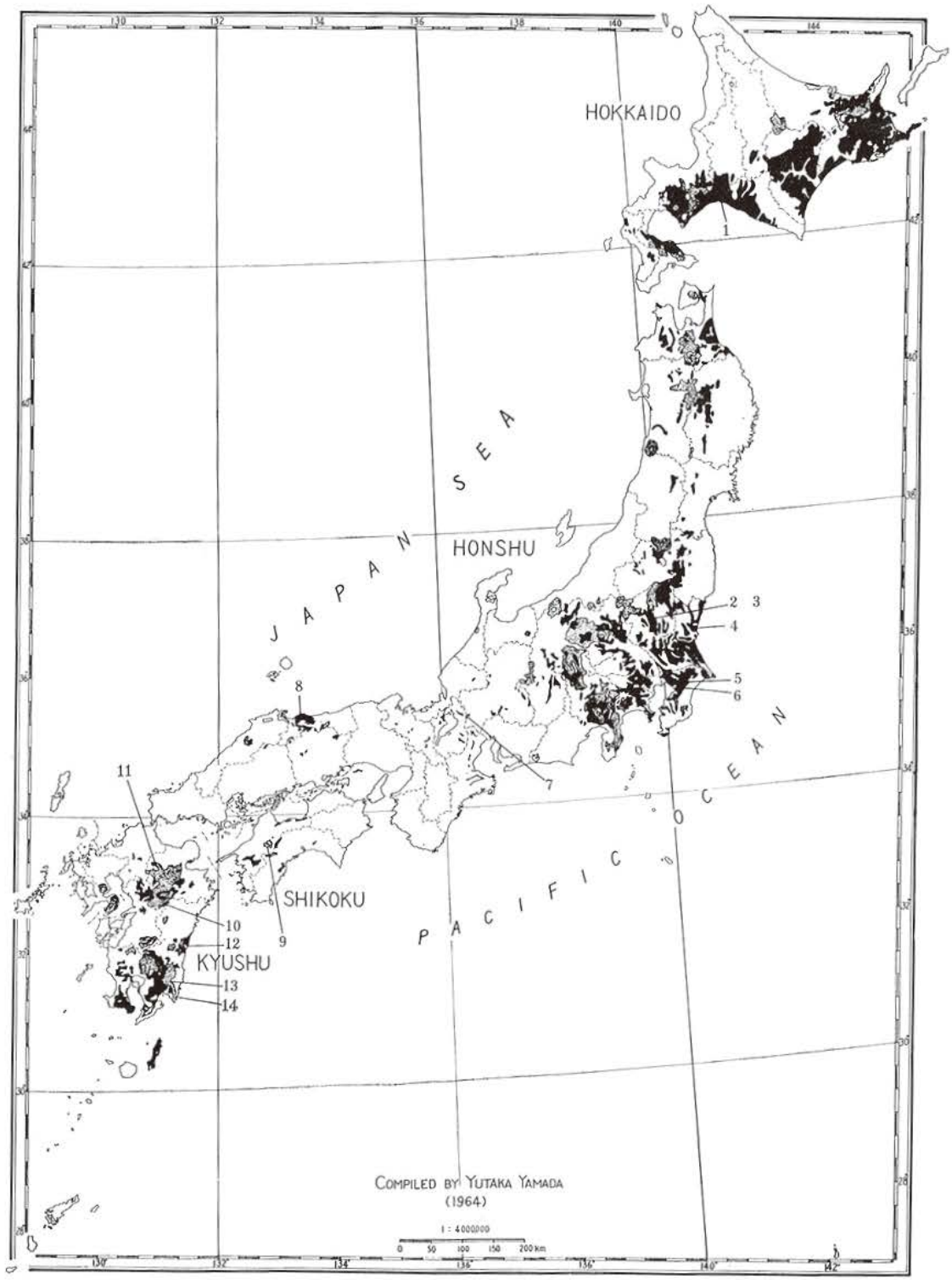

Fig. 1. Distribution map of Ando Soils

Table 1. ^{14}C age of some Ando Soils in Japan

Soil	Location		Horizon	Depth (cm)	Code No.	^{14}C Age
	Lat.	Lon.				
1. Hayakita, Hokkaido[2]	42°46′	141°50′	A1	0– 8	Gak. 732	Modern<200
			IVA	25– 53	〃 733	1640± 90
			VA	68– 83	〃 734 a	3420± 90
2. Imaichi, Tochigi[3]	36°42′	139°46′	Ap	0– 28	N 1184	1690±100
			A12	28– 46	〃 1185	4290±120
			A13	46– 60	〃 1186	5900±125
3. Dozawa, Tochigi[2]	36°41′	139°44′	A12	12– 28	Gak. 726	3950± 90
4. Kanuma, Tochigi[4]	36°30′	139°45′	A12	18– 31	〃 1076	2140± 80
			IIA	97–107	〃 1077	9950±300
5. Kokubunji, Tokyo[2]	35°42′	139°29′	Ap	0– 15	〃 731	2620±100
6. Seijo, Tokyo[5]	35°38′	139°37′	IIIA	150–180	〃 1129	17000±400
			IVA	200–290	〃 1130	24900±900
7. Akasaka, Gifu[6]	35°22′	136°35′	A	0– 10	〃 734 b	5200±110
8. Higashiyama, Tottori[7]	35°19′	133°34′	A11	0– 20	〃 1528	2690±100
			IIIA	60– 80	〃 1529	5200± 90
9. Okubo, Kumamoto[8]	32°56′	131° 0′	IIA	60– 90	N 1529	11800±220
			IVA	170–195	〃 1530	22100±415
10. Kuju, Oita[2]	33° 3′	131°16′	A12	20– 38	Gak. 729	3500±100
			IIIA	87–102	〃 728	4300±270
			VA11	122–158	〃 727	9060±100
11. Bannochi, Miyazaki[9]	32° 9′	131°31′	Ab	80–100	〃 339	4570±190
12. Arasa, Kagoshima[2]	31°30′	130°56′	A11	0– 7	〃 730	1040±100
13. Kanoya, Kagoshima[9]	31°23′	130°52′	Ab	130–150	〃 340	5450±160

completely by only the difference of the effect of modern C. It also seems necessary to consider the stratification of humus horizons of different ages of genesis which were caused by periodical addition of volcanic ash.

Even in the surface humus horizon which shows the most remarkable effect of modern C, the ages distribute widely from modern less than 200 years to 5,200 years B.P.

From this point, the fall of ^{14}C age in surface horizon seems to be caused not only by the difference of the effect of modern C, even in consideration of the environmental difference of each soil, but also by the difference of ages of fundamental geneses.

The soils shown in Table 1 are the soils of uncultivated land and of upland but not of paddy field. Though the data are not shown here, the direct influence of cultivation could not be seen in the Ando-Soils so much as Cambell et al. had reported. But when the land is cultivated into paddy field, remarkable fall of age is brought about in a comparatively short period.

Relation between the ^{14}C age of humus and the age of parent material

Hayakita soil is the stratified Ando Soils derived from the ejecta of Mt. Tarumae, and it is said that its A_1 horizon is derived from Ta series (erupted in 1739), IVA horizon from Tc series (1,500–2,000 years B.P.) and VA horizon from Td series (3,000–5,000 years B.P.)[11].

In A_1 horizon, the relation with parent material cannot be confirmed because modern is less than 200 years B.P., but the ^{14}C ages of

IVA and VA horizons are found to be in the extent of the presumed deposition age of parent materials.

From these points, it may be suggested that the genesis of humus began comparatively immediately after the falling and deposition of parent materials and much humus was accumulated in a short period, and that the stability of accumulated humus is very high. This soil is of coarse-textured and of the permeability moderate to excessive. Even the soils are under the conditions by which the soils seem easily be affected by the new humus moved from upper buried humus horizon or from the uppermost surface, the influence scarcely appears on ^{14}C age. Therefore in the buried humus horizon which contains more than 10 per cent of humus like IVA and VA horizons, the addition of new humus from upper horizon occurrs rarely or a little if any.

The humus in the buried humus horizon merely gives the minimum age to its parent material, but it gives the maximum age to its upper horizon. This latter fact is said to manifest the value of the humus in the buried humus horizon[12]. But Ando Soils seems also to give valuable age to the parent material which composes the humus horizon.

Relation between humification degree and ^{14}C age

It is reported that the color of humic acid solution gradually becomes dark, the content of methoxyl-C decreases and the ratio of humic acid to fluvic acid (Ch/Cf) increases according to the advance of humification. And these facts are used to determine humification degree of various soils.

When the color density of humic acid solution of Ando Soils was determined by the system of International Commission of Illumination (I.C.I.) and the dominant wave length $\lambda d(m\mu)$, brightness $Y(\%)$ and purity $P(\%)$ were calculated, a very high correlation between these color components and ^{14}C age was found with each sample of which age is less than about 6,000 years B.P.

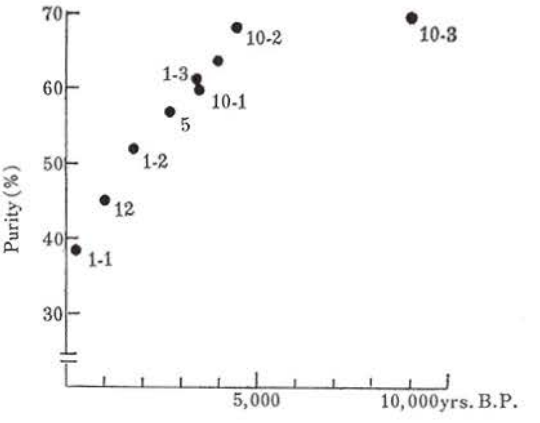

Fig. 2. Relationship between color purity of humic acid solution and ^{14}C age

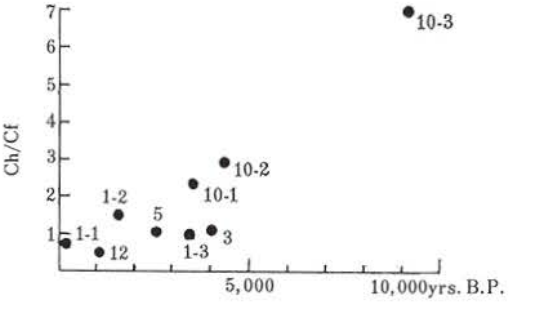

Fig. 3. Relationship between Ch/Cf and ^{14}C age

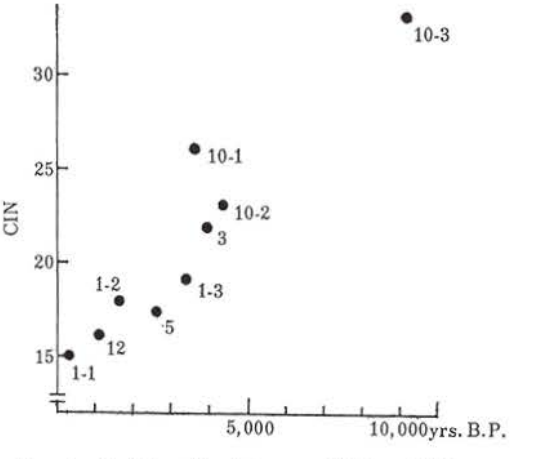

Fig. 4. Relationship between C/N and ^{14}C age

Namely, apart from the climate and other factors, the color which shows the polymerization degree of humic acid is apparently

closely related to the age of humus genesis. Some relations are also found between ^{14}C age and C/N, Ch/Cf. With the old sample of more than about 6,000 years B.P., the color of humic acid solution becomes almost indifferent, while Ch/Cf and C/N show clearly high values corresponding to ages.

As the result, it seems possible to presume the age of humus reversely by putting the color of humic acid, Ch/Cf, C/N and some other characters of humus together.

Conclusion

The age of major humus horizon in the Ando Soils of Japan is comparatively young belonging to the early Jomon Age in the Alluvial Epoch, namely less than 6,000 years B.P., although the age of buried humus horizon is fairly old, for example, those of southern Kanto and Kyushu districts are more 10,000 years and some of them are of nearly 30,000 years B.P. Among buried humus horizons, and even among thick humus horizons, ^{14}C ages are very high.

This difference of ages among each subhumus horizon may be caused by the difference of effect of modern C, but as to the Ando Soils of Japan, it may be caused mainly by the stratification of humus horizons of different ages of geneses.

Generally, the humus in soils can be regarded as a mixture of various kinds of humus of different ages which were deposited and accumulated for a long time from the beginning of soil genesis up to present. Therefore its availability, unlike that of buried material, seems to be much limited as a sample for the determination of age. But the ^{14}C age of the humus in Ando soils showed a high value unexpectedly, and it may be much available not only as a relative measure for understanding of the age concerning to soil gensis but also as a material to presume the age of volcanic ash falling in buried humus horizon.

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