1. Soils

The soil which lies on the surface of the ground has been created by the synthetic effect of numerous soil-forming factors (parent material, climate, vegetation, landform, ground water, etc.) over a long period and will continue to change in the future. The process of soil formation is reflected in the form, composition and features of soil profiles.

In Japan, the brown forest soils found in mountain areas throughout the country cover the largest area. Reddish and yellowish brown forest soils are distributed on low mountain areas or hills. Podzols are distributed on the ridgelines of high mountains in the Tyūbu District and northward. On mountains in the region facing the Seto-Naikai, residual regosols are fairly widely distributed. Ando soils, whose parent material is mainly volcanic ash, are widely distributed on tablelands and other such areas. Brown lowland soils, gray lowland soils and gley soils are distributed on lowlands. Red and yellow soils, which are sparsely found on tablelands in various districts, are considered to be Paleosols created during warm periods in the Pleistocene.

[Salient Points of the Legend and Map Compilation]

Lithosols: soils distributed on steep mountaintops or mountainsides, of (A) C type. They generally consist of gravel with shallow, poor development of the (A) horizon. Bare rocks are included in lithosols on this map.

Volcanogenous regosols: soils with relatively new volcanic ejecta as a parent material, of the (A) C type. Development of the (A) horizon is shallow and poor.

Residual regosols: soils affected by surface erosion and of the (A) C type. They are distributed on mountaintops formed of granites or rhyolites.

Sand dune regosols: coarse soils distributed on sandy areas with good drainage such as coastal sand dunes, of (A) C type.

Podzols: soils formed under forests in a humid cold climate. They are of the A B C type and have a thick humic horizon with leaching of iron and aluminum in the A horizon and an accumulation of iron and humus in the B horizon.

Brown forest soils: soils of the A (B) C type developed under forests in a humid temperate or humid warm-temperate climate. They gradually turn from a blackish brown A horizon into a brown or dark brown (B) horizon.

Brown forests soils (reddish, yellowish): brown forest soils having a hue relatively close to reddish brown or yellowish brown.

Red and yellow soils: soils formed under forests mainly in a humid subtropical climate. They are widely, though sporadically, distributed on hills and tablelands with an elevation less than 200m in littoral areas of Japan.

Dark red soils: soils with limestone or ultrabasic rock as their parent material. This map indicates only those in Okinawa Prefecture, those in other areas being included in red and yellow soils.

Ando soils: soils whose parent material is mainly volcanic ash and with thickly-developed black surface soils. They generally have a high humus content.

Pseudogley soils: soils found on tablelands in Hokkaidō, whose parent material is mainly Pleistocene sediments or Tertiary siltstone and mudstone. The humus content of the surface soil is low but the clay content is high. They are gray in color and are known as "heavy clay soils".

Brown lowland soils: soils distributed on alluvial plains, particularly on natural levees, with a yellowish-brown coarse-or intermediate-grained (B) horizon below the relatively underdeveloped A horizon. They are mainly used as fields.

Gray lowland soils: used mainly as paddy fields. The soils have a color which is relatively close to gray below the plow layer; soils with various mottles distributed on alluvial plains. No gley layer appears within 50cm of the surface.

Gley soils: soils distributed on alluvial plains with high groundwater tables, having the gley layer within 50cm from the surface. Almost used as paddy fields.

Peat soils: soils with a peat or muck layer of more than 50cm in thickness 1m from the surface.

Explanation of the Horizons

A horizon: the horizon of the uppermost surface, generally showing such features as accumulation of humus, leaching or eluviation of material. Those which are low in humus content or are thin are called the (A) horizon.

B horizon: the horizon which generally lies just below the A horizon and usually shows features such as the accumulation of iron, humus, clay, etc. Those lacking an accumulation of material but showing advanced weathering and isolation of iron are called the (B) horizon.

C horizon: the horizon which generally lies just below the A and B horizons and is not altered by present soil-forming processes.

Gley layer: the layer below the groundwater table throughout or for most of the year and which shows a blue-gray color due to deoxidization.

2. Volcanoes

The Japanese Islands lie on the Circum-Pacific Volcanic Belt and are a district of very energetic volcanic activity. There are about 250 Quaternary volcanoes and groups of volcanoes in Japan, 82 of which are active volcanoes (including those with records of volcanic activity or with solfataric activity).

When violent submarine volcanic activity occurred during the Miocene, a large quantity of volcanic rock was discharged. Most of this rock altered to a green color and is generally called the Green Tuff. As volcanic activity in the Pliocene was relatively calm, the distribution of volcanic rocks was limited.

Considering the distribution of Quaternary volcanoes, a belt-like region lying from the Kurile Islands and Northeast Japan to the Izu islands, and another group lying in a row from the Tyūgoku District to the Kyūsyū District and the Southwest Islands can be easily recognized. The former is called the East Japan Volcanic Belt and the latter the West Japan Volcanic Belt. A clear boundary (volcanic front) can be drawn between the East Japan Volcanic Belt and regions without volcanoes on the Pacific side, such as the Kitakami Highland and the Abukuma Highland. A less clear boundary can be drawn on the east side of the West Japan Volcanic Belt. In particular, as the volcanic front in East Japan parallels the Japan trench, it can be seen that these volcanoes were formed in close connection with the subduction of ocean plate.

The density of volcanoes is high just inside the volcanic front, decreasing as one moves further away. Volcanoes formed from basaltic magma, rich in silica (SiO_2) and low in alkali (Na_2O, K_2O), stand in a row near the volcanic front, whereas those formed from basaltic magma, rich in alkali and low in silica are scattered further away.

In the Hokkaidō, Tōhoku and Kyūsyū Districts, there are large-scale calderas with a large quantity of pyroclastic flow sediment. Tephra (pyroclastic sediment) consisting of volcanic ash carried by westerlies is also widely distributed on the east side of The volcanoes.

[Salient Points of the Legend and Map Compilation]

This map was formed by the partial modification of 1:2,000,000 scale *Volcanoes of Japan* (Second Edition) published by the Geological Survey of Japan.

3. Thermal Springs

There are a great many thermal springs in Japan. According to prefectural data as of March 31, 1987. There were about 18,000 principal thermal springs (with temperature measured) used for bathing and drinking; principal springs with a temperature of more than 42℃ (including steam and gas) accounted for nearly two thirds of the total. The total discharge of thermal springs in Japan amounted to approximately 1,600,000ℓ/m. The number of thermal spring resorts was around 3,700, of which 1,800 discharge more than 100ℓ/m each. The greatest discharge was that of Beppu (Ōita Prefecture) with 80,000ℓ/m, followed by Kusatu (Gunma Prefecture), Yuhuin (Ōita Prefecture), Itō (Sizuoka Prefecture) and Ibusuki (Kagosima Prefecture), each discharging more than 20,000ℓ/m.

In the case of most thermal springs, guound water is heated at depth, resulting in the water containing various chemical components corresponding to the surrounding rocks. Though Japanese thermal springs are generally associated with Quaternary volcanoes and Neogene volcanic rocks, some thermal springs are found in areas of Tertiary plutonic rocks and hypabyssal rocks, and Mesozoic granite. Many of the latter are saline springs showing high radioactivity.

The medical benefits obtained by the drinking of thermal spring water or bathing in thermal springs are proven and thus thermal spring water is defined in terms of those diseases which it may benefit. The Japanese, however, use thermal springs mainly for recreation, and many sightseers gather at thermal spring resorts with good facilities.

[Salient Points of the Legend and the Map Compilation]

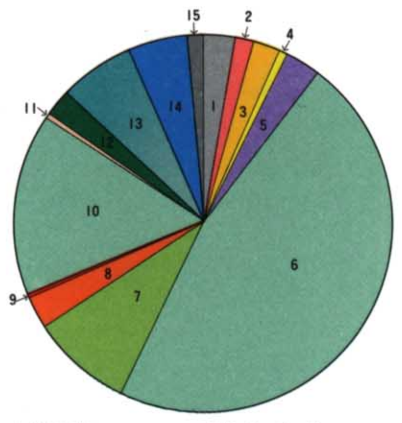
The Hot Spring Law states that thermal springs should be springs whose temperature exceeds 25℃, or those containing a larger amount of prescribed materials than normal.

This map shows the characteristics, discharge and temperature of thermal springs with yields of 100ℓ/m and over, including pumped thermal spring water. However, thermal spring resorts generally have many principal springs and their characteristics and temperatures often vary. Thus, the map shows the representative characteristic and highest temperature of each thermal spring resort.

[Source]

1. Land Planning Agency, 1:200,000 scale Land Classification Map (Soil Map), 1970—1977
2. Ono K., Soya T. and Mimura K., 1:2,000,000 scale *Volcanoes of Japan* (Second Edition), Geological Survey of Japan, 1981
3. Kaizuka S. and Machida H., *Distribution Map of Quaternary Pyroclastic Deposits*, 1976
4. Japan Association of Quaternary Research, *Quaternary Maps of Japan*, 1987
5. Data from the Environmental Agency and Prefectures

RATIOS OF AREAS OF DIFFERENT SOILS



1. Lithosols
2. Volcanogenous regosols
3. Residual regosols
4. Sand dune regosols
5. Podzols
6. Brown forest soils
7. Brown forest soils (reddish, yellowish)
8. Red and yellow soils
9. Dark red soils
10. Ando soils
11. Pseudoglay soils (Heavy clay soils)
12. Brown lowland soils
13. Gray lowland soils
14. Gley soils
15. Peat soils

(Compiled from *1:200,000 scale Land Classification Maps*)

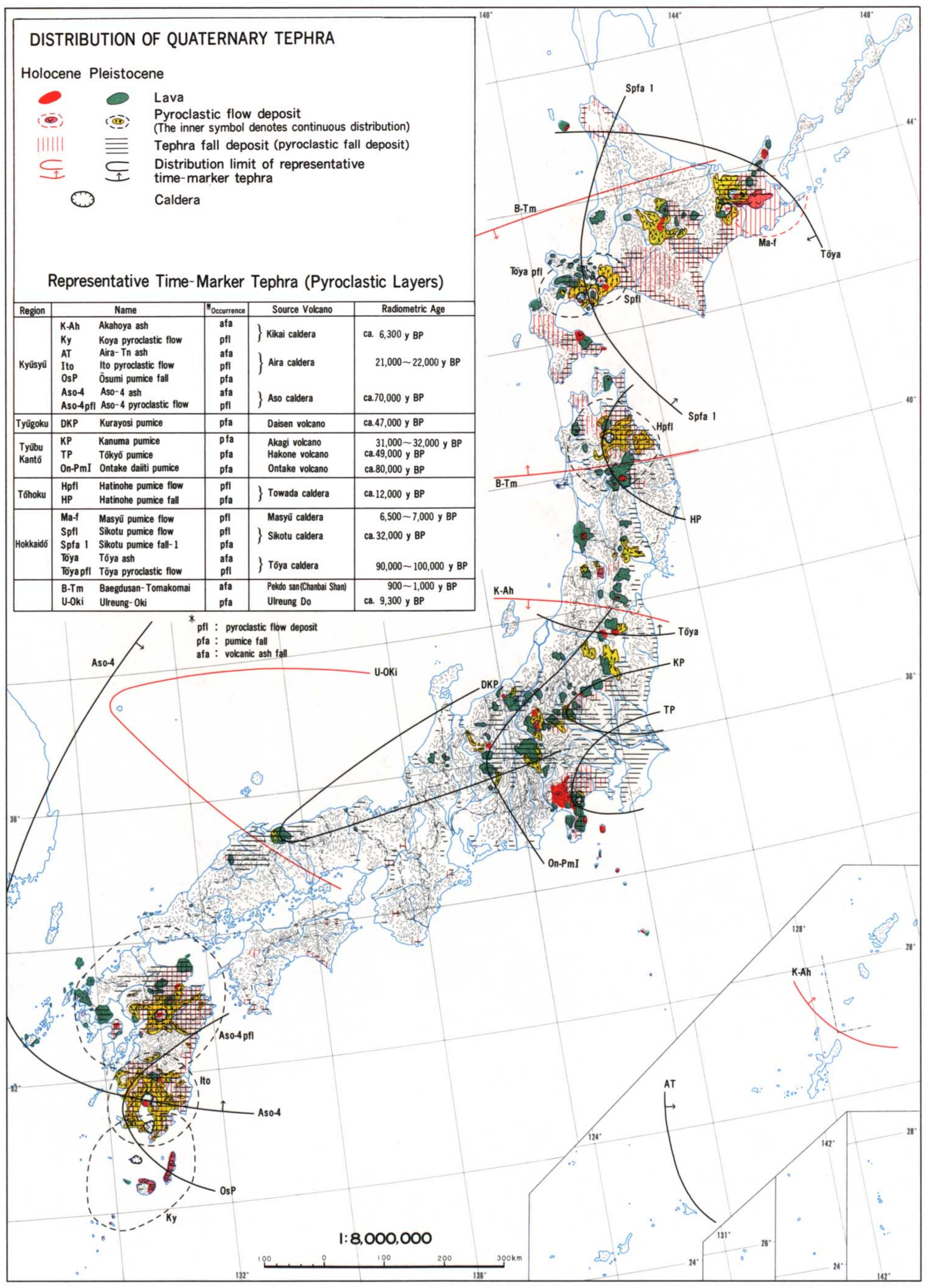
DEFINITION OF THERMAL SPRINGS BY APPLICABLE THERMAL SPRING LAW

Of the thermal waters, mineral waters, aqueous vapors and other gases discharging from the ground (excluding natural gas, the main component of which is hydrocarbon), those which have the following temperature or solutes are regarded as thermal springs.

1. Water temperature: higher than 25°C
2. Solutes (any one of those listed below)

Soluble	Content (per 1kg)
Soluble elements (excluding gases)	Total 1,000mg and over
CO_2	250mg and over
Li^+	1mg and over
Sr^{2+}	10mg and over
Ba^{2+}	5mg and over
Fe^{2+}, Fe^{3+}	10mg and over
Mn^{2+}	10mg and over
H^+	1mg and over
Br^-	5mg and over
I^-	1mg and over
F^-	2mg and over
$HAsO_4^{2-}$	1.3mg and over
$HAsO_2$	1mg and over
Total sulfur corresponding to $HS^- + S_2O_3^{2-} + H_2S$	1mg and over
HBO_2	5mg and over
H_2SiO_3	50mg and over
$NaHCO_3$	340mg and over
Rn	2×10^{-9} curie and over
Ra	1×10^{-8} 1mg and over

DISTRIBUTION OF QUATERNARY TEPHRA



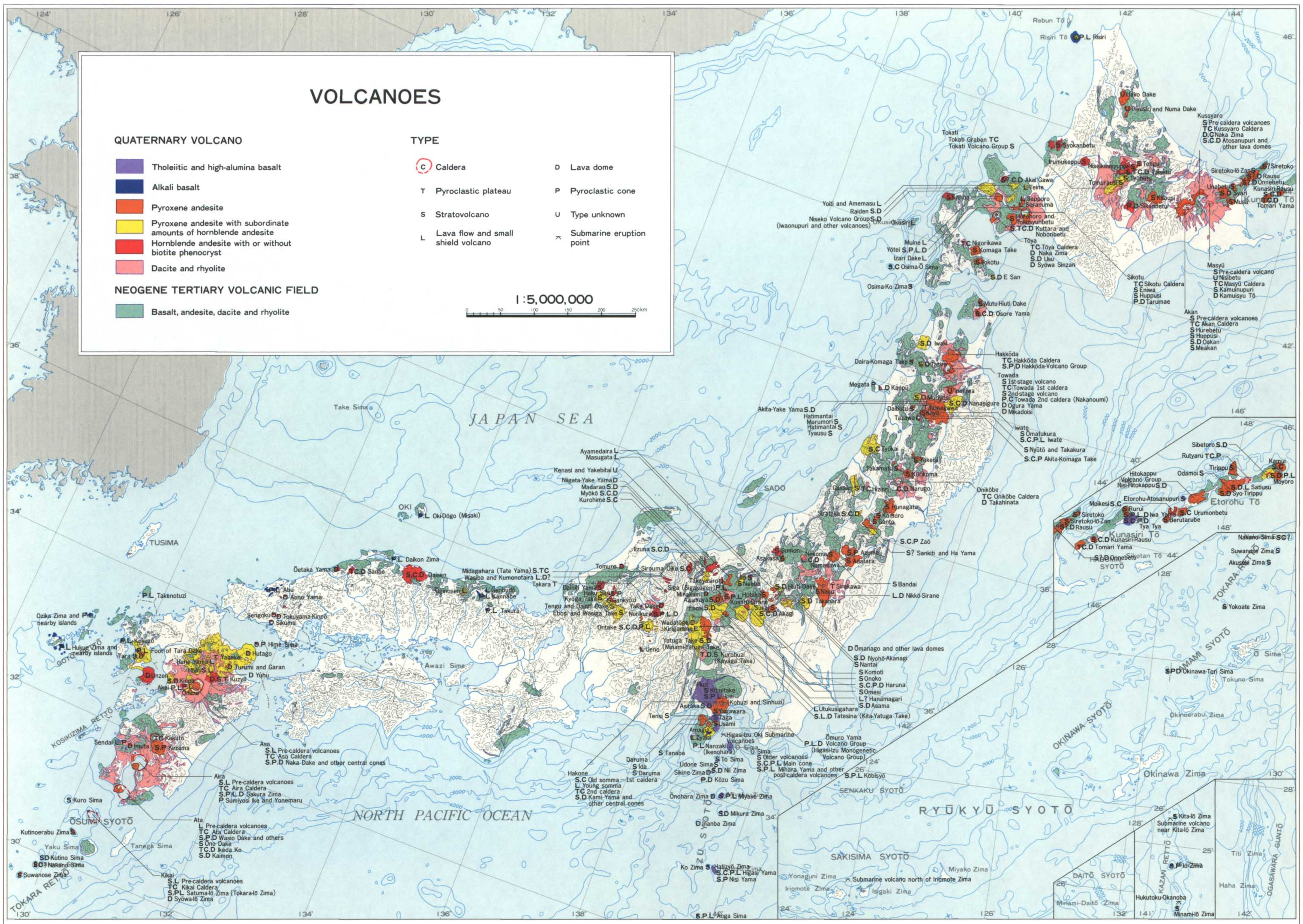
Representative Time-Marker Tephra (Pyroclastic Layers)

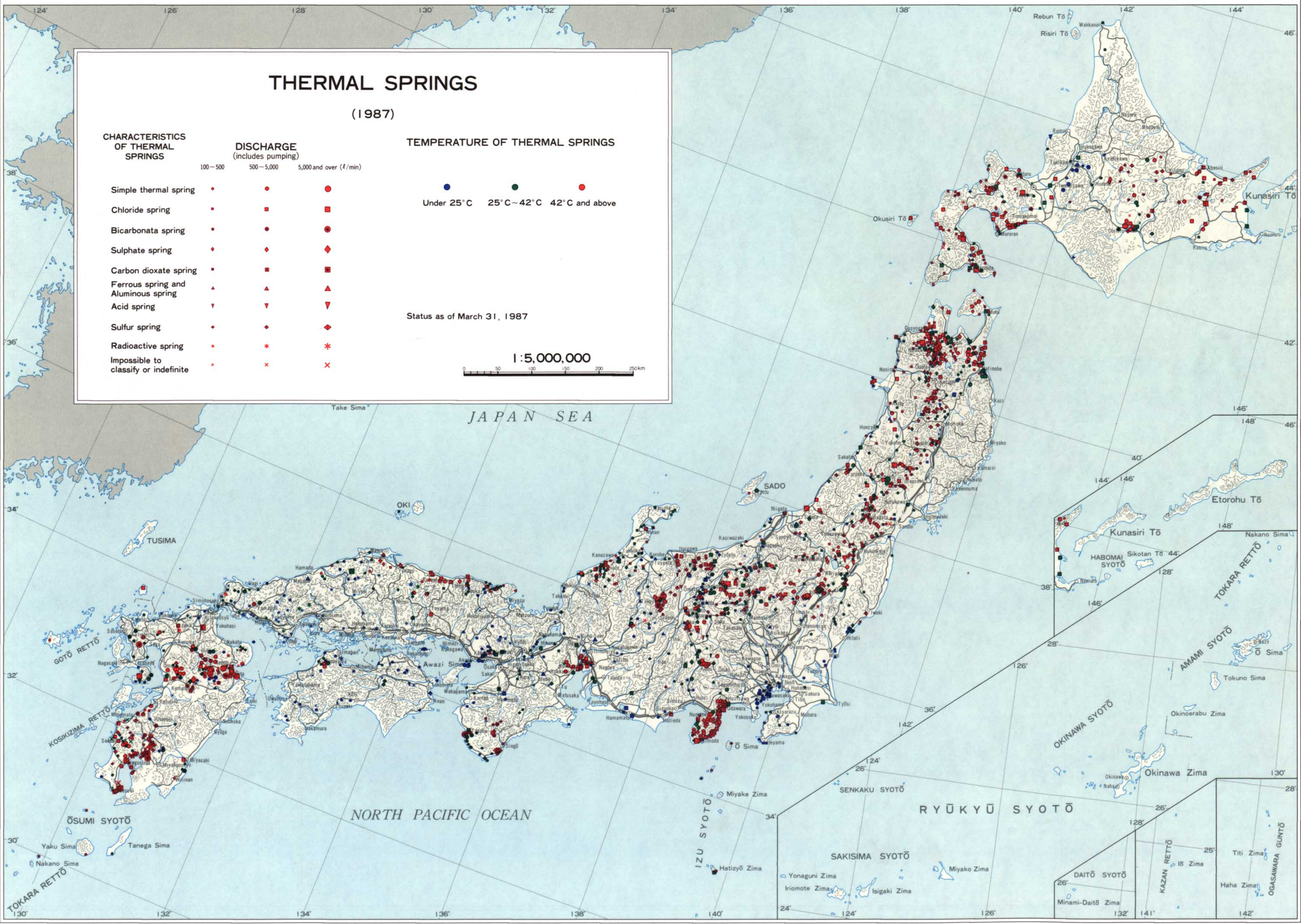
Region	Name		*Occurrence	Source Volcano	Radiometric Age
Kyūsyū	K-Ah	Akahoya ash	afa	Kikai caldera	ca. 6,300 y BP
	Ky	Koya pyroclastic flow	pfl		
	AT	Aira-Tn ash	afa	Aira caldera	21,000～22,000 y BP
	Ito	Ito pyroclastic flow	pfl		
	OsP	Ōsumi pumice fall	pfa		
	Aso-4	Aso-4 ash	afa	Aso caldera	ca.70,000 y BP
	Aso-4pfl	Aso-4 pyroclastic flow	pfl		
Tyūgoku	DKP	Kurayosi pumice	pfa	Daisen volcano	ca.47,000 y BP
Tyūbu Kantō	KP	Kanuma pumice	pfa	Akagi volcano	31,000～32,000 y BP
	TP	Tōkyō pumice	pfa	Hakone volcano	ca.49,000 y BP
	On-PmI	Ontake daiiti pumice	pfa	Ontake volcano	ca.80,000 y BP
Tōhoku	Hpfl	Hatinohe pumice flow	pfl	Towada caldera	ca.12,000 y BP
	HP	Hatinohe pumice fall	pfa		
Hokkaidō	Ma-f	Masyū pumice flow	pfl	Masyū caldera	6,500～7,000 y BP
	Spfl	Sikotu pumice flow	pfl	Sikotu caldera	ca.32,000 y BP
	Spfa 1	Sikotu pumice fall-1	pfa		
	Tōya	Tōya ash	afa	Tōya caldera	90,000～100,000 y BP
	Tōya pfl	Tōya pyroclastic flow	pfl		
	B-Tm	Baegdusan-Tomakomai	afa	Pekdo san (Chanbai Shan)	900～1,000 y BP
	U-Oki	Ulreung-Oki	pfa	Ulreung Do	ca. 9,300 y BP

*pfl : pyroclastic flow deposit
pfa : pumice fall
afa : volcanic ash fall

(Compiled from Kaizuka and Machida (1976) and Japan Association for Quaternary Research (1987) supplemented by Machida.)

4.2


VOLCANOES
QUATERNARY VOLCANO
Tholeiitic and high-alumina basalt
Alkali basalt
Pyroxene andesite
Pyroxene andesite with subordinate amounts of hornblende andesite
Hornblende andesite with or without biotite phenocryst
Dacite and rhyolite
NEOGENE TERTIARY VOLCANIC FIELD
Basalt, andesite, dacite and rhyolite
TYPE
C Caldera
T Pyroclastic plateau
S Stratovolcano
L Lava flow and small shield volcano
D Lava dome
P Pyroclastic cone
U Type unknown
Submarine eruption point
1:5,000,000
JAPAN SEA
NORTH PACIFIC OCEAN
RYŪKYŪ SYOTŌ
SAKISIMA SYOTŌ
ŌSUMI SYOTŌ
TOKARA RETTŌ
KOSIKIZIMA RETTŌ
OKINAWA SYOTŌ
AMAMI SYOTŌ
DAITŌ SYOTŌ
SENKAKU SYOTŌ
IZU SYOTŌ
TUSIMA
OKI
SADO
Take Sima
Awazi Sima
Tanega Sima
Yaku Sima
Okinawa Zima
Miyako Zima
Kunasiri Tō
Etorohu Tō
Rebun Tō
Risiri Tō


THERMAL SPRINGS
(1987)
CHARACTERISTICS OF THERMAL SPRINGS
DISCHARGE (includes pumping)
100—500
500—5,000
5,000 and over (ℓ/min)
Simple thermal spring
Chloride spring
Bicarbonata spring
Sulphate spring
Carbon dioxate spring
Ferrous spring and Aluminous spring
Acid spring
Sulfur spring
Radioactive spring
Impossible to classify or indefinite
TEMPERATURE OF THERMAL SPRINGS
Under 25°C
25°C~42°C
42°C and above
Status as of March 31, 1987
1:5,000,000
JAPAN SEA
NORTH PACIFIC OCEAN
RYŪKYŪ SYOTŌ
SAKISIMA SYOTŌ
ŌSUMI SYOTŌ
TOKARA RETTŌ
KOSIKIZIMA RETTŌ
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