

Geological and Petrological Studies on the "Shirasu" in South Kyushu, Japan Part I. Preliminary Note

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Geological and Petrological Studies on the "Shirasu" in South Kyushu, Japan Part I. Preliminary Note

By

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As the detailed report on the "Shirasu" will be published serially in collaboration with helpers, according as the progress of the investigation, only introductory brief account is given in this paper (Part I).

In the Volcanic District of South Kyushu (The greater part of Kagoshima prefecture and the southern part of Miyazaki prefecture), the so called "*Shirasu*" (White sand), very often accompanied with the underlying "*Hai-ishi*" (Ash stone), is wide spread, forming a vast tableland, almost always covered by the thin pumice-loam bed (perhaps erupted from the Kirishima Volcano). These younger formations of volcanic origin with some interbedded sedimentaries lie on the eroded surface of the older land which consists largely of Mesozoic sedimentaries, late Mesozoic or Miocene granitic rocks, and Cainozoic volcanic rocks and sedimentaries (perhaps Pliocene~Pliopleistocene), stratigraphic descriptions on which will be given in future.

The so called "*Hai-ishi*" (Ash stone) (NAKASHIMA, K. (1895), INOUE, K. (1909), MATSUMOTO, Tad. (1933), YAMAGUCHI, K. (1937), TANEDA, S. (1950)) is another name of the volcanic substance known as the "mud lava" (NAKASHIMA, K. (1895), INOUE, K. (1909), MATSUMOTO, Tad. (1943)), the "Hypersthene Trachyandesite" (KOTO, B. (1916), IHARA, K. (1930, 1931, 1934)), the "Anzangan Hari" (andesite glass) (SATO, D. (1925, 1940)) or the "Hujigan Hari" (andesite glass) (ODA, R. (1917)). It consists of several beds and varies in petrographic feature apparently ranging from tuff breccia (unwelded or slightly-welded tuff) to well-welded tuff or lava. From mineral components and chemical composition (SiO_2 66-77% YAMAGUCHI, K., 1937), the "*Hai-ishi*" belongs to Hypersthene-andesite, -trachyandesite; Hornblende two-pyroxene-andesite, -trachyandesite; (Hornblende) hypersthene-rhyodacite, -trachyandesite; Biotite-bearing hypersthene-rhyodacite.

The microphotographs of thin sections are shown in Fig. 3.

Dr. Tad. MATSUMOTO (1943) summarized the result of his geological (especially topographical, and structural) studies on the districts of the "*Hai-ishi*" and "*Shirasu*."

As to the origin of the "Hai-ishi" he thought that it had erupted from the trench Bay of Kagoshima in manner similar to that of a fissure eruption and that they erupted from the blind head of the Bay of Kagoshima and also from the entrance to the same Bay. The former he named Aira and the latter Ata. At the other hand Dr. K. YAMAGUCHI (1933, 1937) stated his opinion that at least a part of the "Hai-ishi" may be intrusive sheet.

At the present I have a vague view that, if not all, the most part of the "Hai-ishi" may be welded tuff derived from the products of such abnormal volcanic eruption as *nuées ardentes* (eruptions similar to that of Mount Pelée) (LACROIX, A. (1902), ANDERSON, T. & FLETT, J. S. (1903), PERRET, F. A. (1937)), though still awaiting endurable studies in future. The centre of such volcanic activities may be two or three, whereas the very points of extrusion or eruption not so few. More over the eruption must be repeated during Pliopleistocene (or Pliocene)~Pleistocene. The data will be shown later.

The "*Shirasu*" consists mainly of volcanic ash, coarse ash, pumice, accompanied with some rock fragments. In short it is loose lapilli tuff-, tuff breccia-, volcanic breccia-like deposits, characterized with glassy or pumiceous fragments.

The thickness of the "*Shirasu*" bed varies greatly not only because of the erosion since its deposition, but mostly because of irregularities of the base on which it deposited. At the plateau southwest of Kagoshima city the "*Shirasu*" bed is as much as 150 m thick. North of the city of Kagoshima, there develops the tableland of Yoshino-dai, 200 to 500 m high, consists of a thick (at least 100 m) "*Shirasu*" bed. In the northern part of Kagoshima Bay, we find a tableland of the "*Shirasu*" bed, less than 250 m high, along the Sendai River, it is as much as 50 to 70 m in thickness.

On the eastern side of Kagoshima Bay, the water-shed, 400 to 800 m high, runs NNE-SSW, parallel with and close to the coast line. In contrast with the steepness of the side of the Bay, the eastern and southeastern slope is quite gentle, going down to a fossil-like around the City of Miyakonozyo (144 m) as well as to the Bay of Shibushi. The "*Shirasu*" is wide spread forming a vast tableland, to some extent dissected, sometimes excessively. In the Southern part of Miyazaki prefecture also it occupies the wide area less than 300 m high. Generally saying where the



Fig. 1. Generalized map showing the distribution of the "Shirasu" in South Kyushu

DISTRIBUTION OF SHIRASU AND HAI-ISHI
IN KAGOSHIMA PREFECTURE

S. TANEDA (1953)
Chiefly based on S. TANEDA & T. ARITA's
Geological Map of Kagoshima Pref.

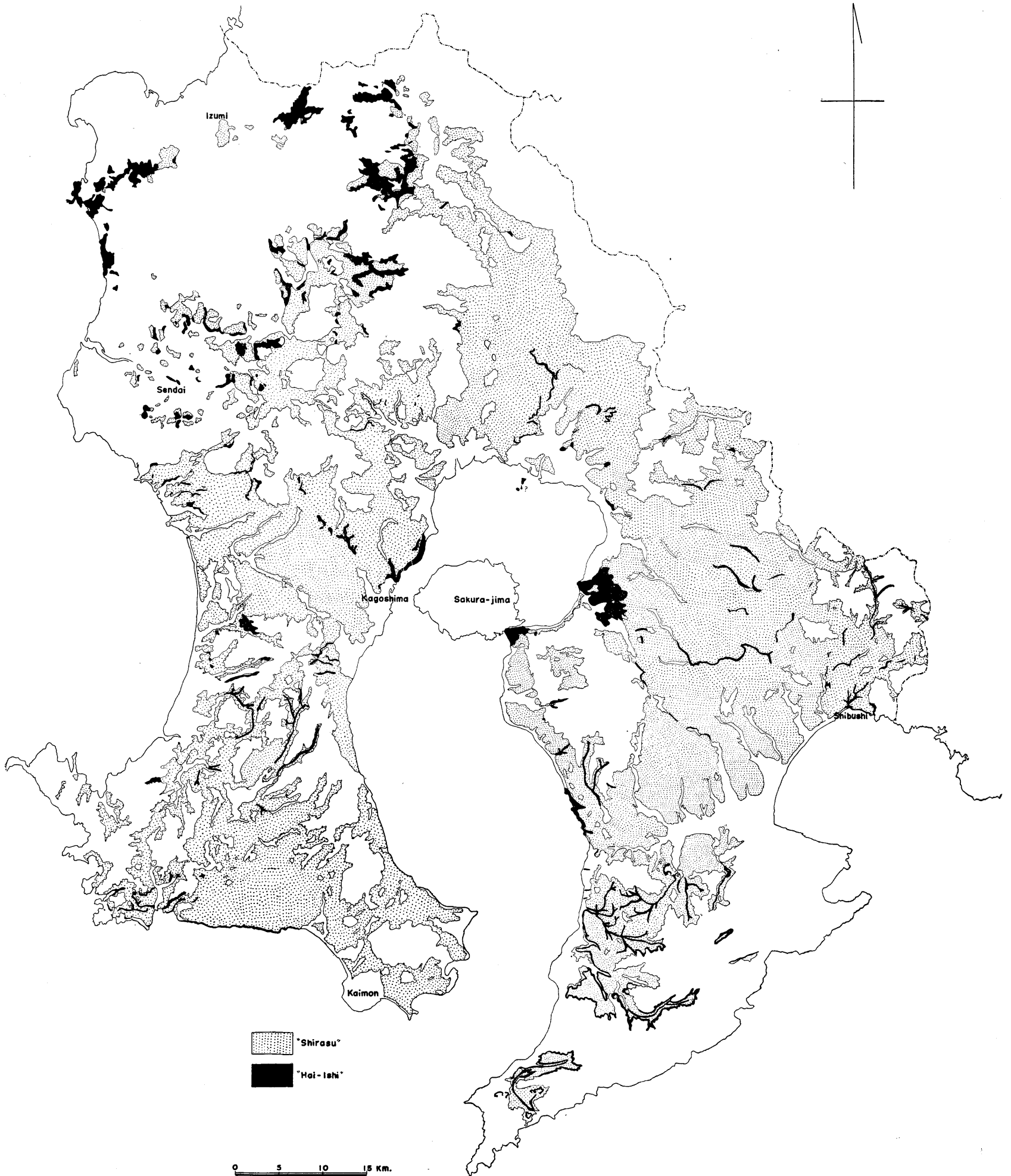


Fig. 2.

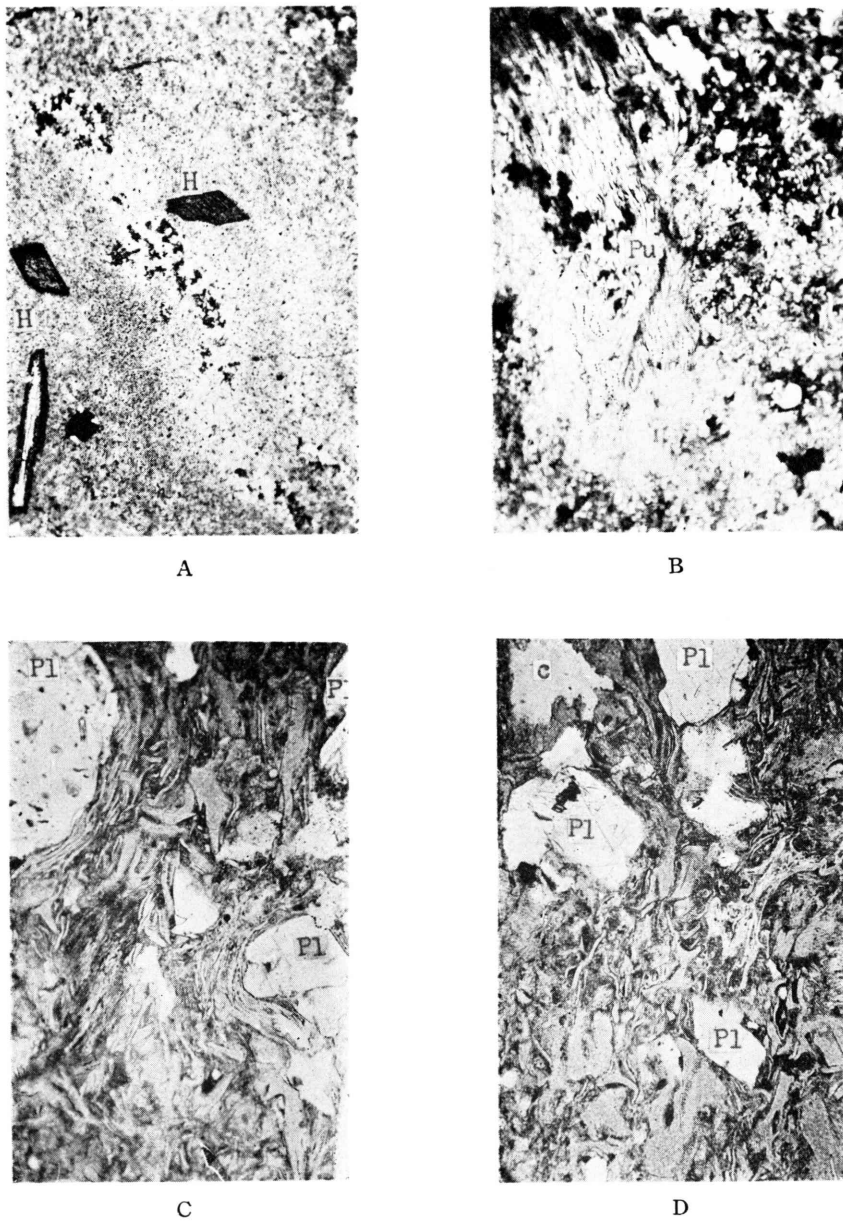


Fig. 3. Microphotographs of the "Hai-ishi" $\times 37$

Pl-Plagioclase H-Hornblende C-Cavity Pu-Pumice

A: Lava type. Loc. Kuwakino, Higashi-ichiki town

B, C, D: Welded lapilli-bearing tuff

Numerous tiny pieces of glass stretched and bent in every possible manner, shards squeezed between comparatively large crystals. Pumice in B stretched into bands of threads.

Loc. B—S of Kurano, Hiwaki village C and D—Mizuto, Hiwaki village

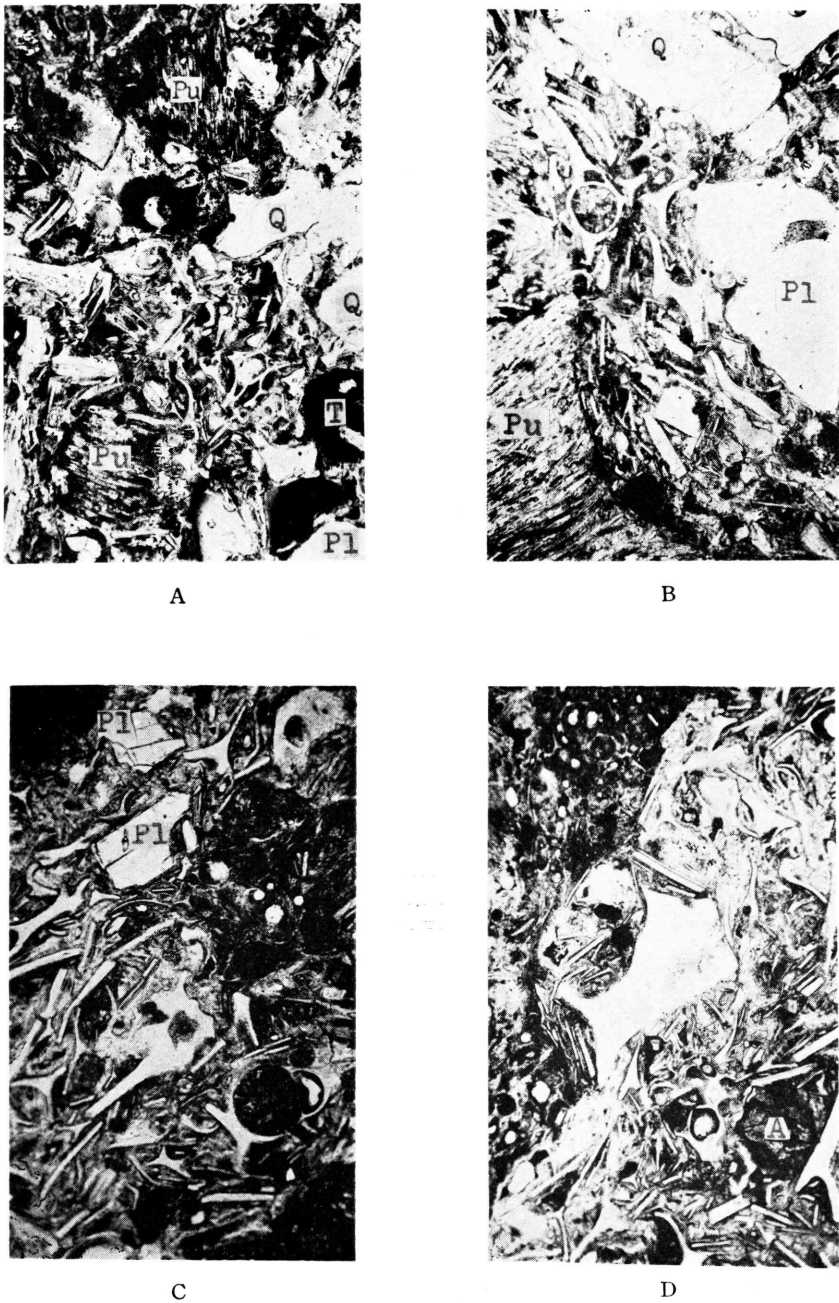


Fig. 4. Microphotographs of the "Shirasu" and "Hai-ishi" (unwelded or scarcely welded)" $\times 37$
 Pl-Plagioclase Q-Quartz A-Augite Pu-Pumice G-older tuff
 A, B; "Shirasu", vitroclastic, in a part scarcely welded. Loc. Uto, Hiwaki village
 C, D; "Hai-ishi", vitroclastic, in a part scarcely welded. Loc. S of Soeda, Iriki town

"Hai-ishi" exist under the "Shirasu", the latter's thickness is small, average less than 50 m, although where the "Hai-ishi" does not exist, the "Shirasu" is thick up to 150 m.

The top of the "Shirasu" is often stratified, composed of pumiceous sand, gravel and clay, which seem to be the secondary materials derived from the "Shirasu" itself, in a pre-pumice-loam age.

The "Shirasu" bed proper is almost non-bedding, and the bottom sometimes changes to sandy, clayey, gravel beds, less than 1 m in thickness.

In the "Shirasu", the pumice fragments as well as accidental ones varies irregularly in amount and in dimension, and is hardly found recognizable sorting in any of the localities studied, and still more striking is generally saying the lack of regularity in the horizontal variation of coarseness sometimes are found the lenticular accumulation of pumice lumps, the size of which (lense), for example, at a cutting road of north of Soeda Hot Spring, Iriki town, is 2 m in thickness and 5 m in length.

As to the matrix of the "Shirasu" no difference is found between the pumice-accumulated part and pumice-not-accumulated part through the "Shirasu" bed.

The pumice itself is composed mainly of finely vesicular or fibrous glass. A small percentage of phenocrysts of plagioclase (andesine~labradorite), hypersthene ((-) $2V = 59^{\circ}$ - 50°) and magnetite is present, with occasional grains of quartz. Its chemical composition, analysed by K. YAMAGUCHI (1938) are similar to those of the Hypersthene-plagioliparite belonging to the "Hai-ishi".

Table 1.

	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	TiO ₂	P ₂ O ₅	MnO	Total
1	74.53	13.67	0.53	1.69	0.46	2.26	3.70	2.79	0.16	0.15	0.03	100.00
2	74.06	13.94	0.61	1.66	0.61	2.68	3.63	2.47	0.16	0.14	0.04	100.00

1. Average chemical composition of the pumice of the "Shirasu"
 2. Average chemical composition of Hypersthene plagioliparite belonging to the "Hai-ishi"
- K. YAMAGUCHI (1938)

The accessory and accidental materials are the fragments of the "Hai-ishi", pyroxene andesites, granite, and sedimentary rocks, being distributed in the "Shirasu" sparsely. Carbonized vegetable remains are also found rarely.

The finer particles are glass (n=1.495~1.505) and grains of the minerals mentioned as forming phenocrysts in the pumice and compact fragments.

Dr. B. KORO (1916), in his work "The great eruption of Sakurajima, in 1914", wrote that it is "the glassy lava (the "Hai-ishi")" around the Bay of Kagoshima that gave birth to the lapilli formation (the "Shirasu"). Dr. Tad. MATSUMOTO's opinion (1943) is that all the glassy mud lava and its derivatives (the "Hai-ishi")

and the "Shirasu") had erupted from the blind head of the Bay Kagoshima and also from the entrance to the same Bay. As to the mechanism of deposition, Dr. K. YAMAGUCHI (1938) thought that the "Shirasu" constructing the tableland was not an aeolian but aqueous deposits of volcanic materials, on the basis that: (1) the "Shirasu" bed is bedding partially; (2) sometimes it contains somewhat rounded pumice fragments; (3) marine fossils are found in the underlying shale and tuffaceous clay. And then he said (1952) that the "Shirasu" had been formed by submarine fissures eruptions.

As to the "Shirasu" bed, at the present no one may be able to give a definite view, but it may be pointed that facts as above mentioned are not always advantageous to the "aqueous deposition" of ejecta hurled high far above the vents. In order to clarify the problems we must study the microscopic texture or structure, as well as the geological mode of occurrence. At this standpoint I intended to observe the *thin section* of the "Shirasu" bed, cemented in the natural state, at the field, by URIX and BAKEPOND (the commercial name of a kind of bakelite).

The *microphotographs* of the thin section of the "Shirasu" bed are shown in Fig. 4, together with those of some "Hai-ishi" (slightly welded or unwelded tuff type). It is remarkable that under the microscope we can hardly find a difference between the "Shirasu" and the unwelded or slightly welded type of the "Hai-ishi", the both showing the similar vitroclastic texture, in a part scarcely welded.

Here I recollect that at some localities the "Hai-ishi" varies gradually to show the "Shirasu"-like appearance, especially often by the weathering.

Mechanical analysis of the "Shirasu" may be also available for the research of the mechanism of "Shirasu" deposition. The data obtained about some samples are listed into Table 2 and shown in Figs. 5 and 7. In this experiment the large fragments over 4 mm in diameter were excluded, and the analyses have not been carried out for materials finer than 1/16 mm in diameter.

Table 2. Size distribution of the "Shirasu"

No.	4-2	2-1	1-1/2	1/2-1/4	1/4-1/8	1/8-1/16	Below 1/16 mm
1.	2	3	5	22	25	27	16
2.	5	13	16	10	17	19	20
3.	3	11	26	14	15	13	18
4.	1	5	20	17	23	22	12
5.	2	7	20	14	23	21	13
6.	2	4	11	12	23	23	25
7.	1	4	10	19	23	25	18
8.	2	6	16	15	22	21	18
9.	2	6	16	10	22	24	20
10.	4	10	25	14	17	17	13

analyst, M. NISHIHARA

Localities:

- | | |
|---|--|
| No. 1 Southeast of Uke-ai, Turuda village | No. 2 East of Mizuto, Hiwaki village |
| No. 3 South of Ichihino, Hiwaki village | No. 4 East of Ichihino, Hiwaki village |
| No. 5 Ditto | No. 6 Uesako, Turuda village |
| No. 7 North of Iwamoto, Hiwaki village | No. 8 Taneda, Turuda village |
| No. 9 East of Mizuto, Hiwaki village | No. 10 Shiroyama, Kagoshima city |

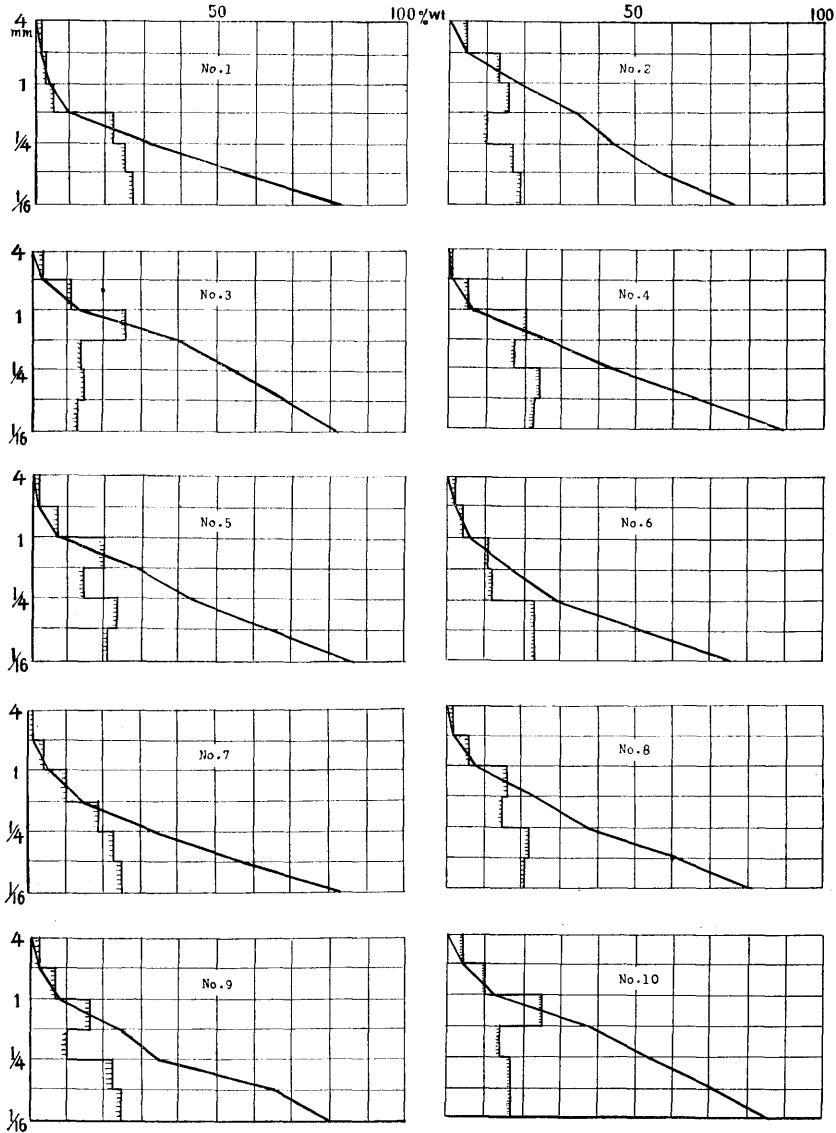


Fig. 5. Size-distribution diagrams of the "Shirasu" Fragments larger than 4mm in diameter are excluded. The curves are "cumulative curves" and show the percentage of the total sample retained on screens of any particular fineness. The histograms show the percentages of material passed by one screen and retained on the next finer. Here are abbreviated the part of finer materials less 1/16 mm in diameter. Nos. 1-10 refer to Table 2.

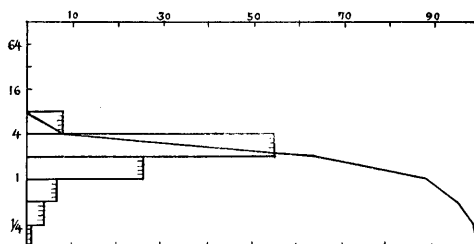


Fig. 6. Idealized composition of some Hawaiian ash (after Wentworth)

The size distribution diagrams of the "Shirasu" show that its grade of sorting is too bad to be correlated with tuff or ash, loess, etc., sorted well by aircurrent, namely Hawaiian Ash (WENTWORTH, C. K., 1926), Sanborn loess (SWINEFORD, A. and FRYE, J. C., 1945), the "Younger pumice" in the Crater Lake Region (MOORE, B. N., 1934), Kirishima loam covering the "Shirasu", etc. The "Older pumice" in the Crater Lake Region (MOORE, B. N., 1934) is fairly comparable to the "Shirasu" (Fig. 7). When the proportion of the fragments larger than 4 mm in diameter, which were omitted in Table 2 (or Figs. 5 and 7), is taken in consideration, the similarity of the "Shirasu" to the "Older pumice" of Crater Lake Region in bad sorting and great size range of the particles may be more reliable. The "Older pumice" has been interpreted as the products erupted in a manner of *nuée ardente* type.

Now, we are introduced to the presumption that the "Shirasu" proper also, is regarded as the product of a series of abnormal eruptions perhaps fairly or at least somewhat similar to *nuées ardentes* or pumice flows. The amounts of material carried by the eruptions indicate that they were of tremendous size and force.

Here we must, however, give particular attention to the size distribution, because the "Shirasu" is composed of two materials—one crystalline fragments, and other pumice or glassy materials, and because there is possibility that each of which had been separately ejected and brecciated or (and) sorted during the eruption and deposition. It is realized that probably more data should be accumulated before the origin of the "Shirasu" similar to that described above can be determined with any degree of certainty.

Regarding to the mechanism and circumstance in which the "Shirasu" beds have been formed, we must promote further geological and lithological investigation more carefully. I am very glad to intend to clarify the detail in cooperation with earnest collaborators, under the kind guidance and encouragement of many senior investigators.

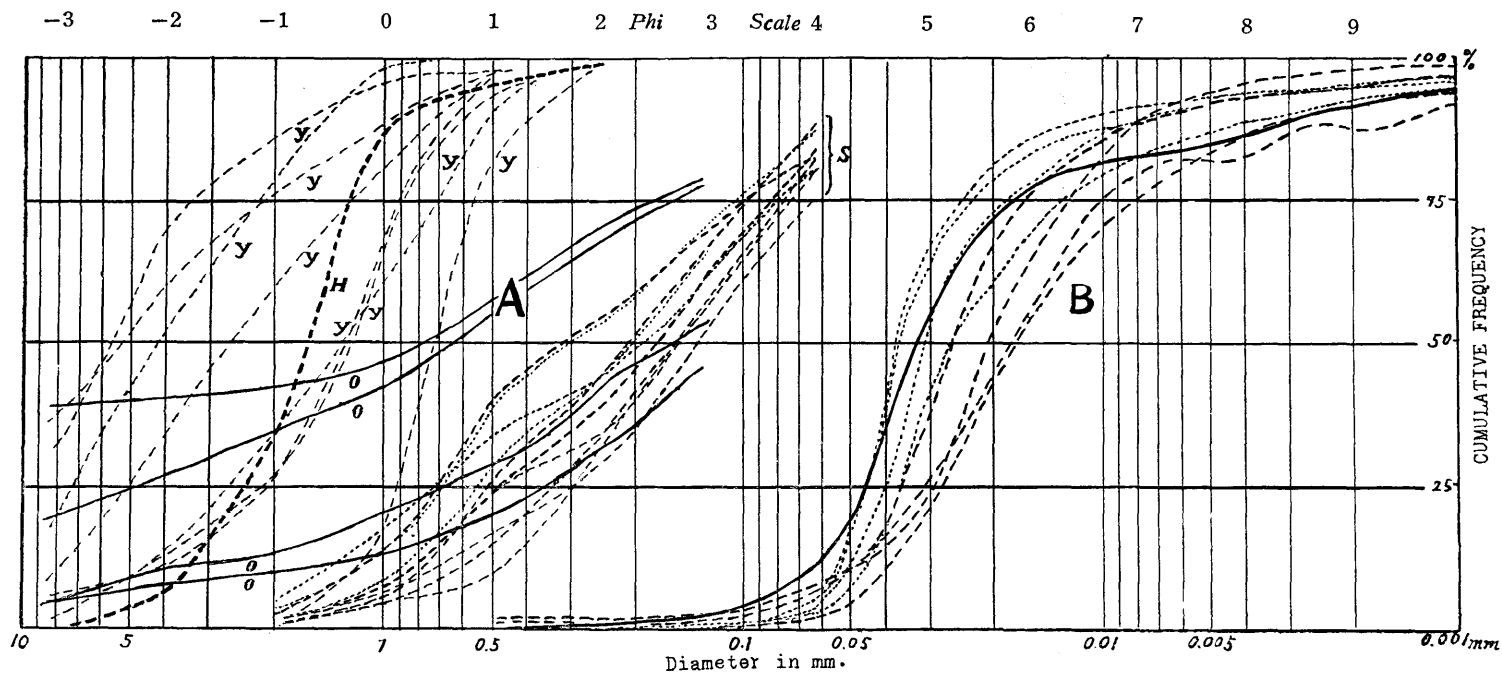


Fig. 7. Cumulative curve of the "Shirasu", pumice, ash, loess, and dust

- A. Dotted lines (S) } —The "Shirasu". Fragments larger than 4 mm in diameter are excluded
 Broken lines (S) }
 Broken lines (Y)—The "Younger pumice" of Crater Lake Region (Moor, B. N.)
 Broken thick line (H)—Hawaiian ash (Wentworth)
 Full lines (O)—The "Older pumice" of Crater Lake Region (Moor, B. N.)
- B. Dotted lines—Lower Mississippi Valley Loess (Russei, R. J.)
 Broken lines—Sanborn Loess (Sweineford, A. and Frye, J. C.)
 Full line—Wind-blown dust (Ditto)

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References Cited

- ANDERSON, T. & FLETT, J. S. (1903)-"Report of the Eruptions of the Soufriere in St. Vincent in 1902 and on a Visit to Montagne Pelée in Martinique", Pt. I, Phil. Trans. Roy. Soc. London, Ser. A. Vol. CC, 353-355
- BARKSDALE, J. D. (1951)-Cretaceous Glassy Welded Tuff-Lewis and Clark Count Montana, Am. Jour. Sci., **249**, 439-443
- GILBERT, C. M. (1938)-Welded tuff in Eastern California, Bull. Geol. Soc. Am., **49**, Pt. 2, 1830-1861
- IHARA, K. (1930)-Explanatory Text of the Geological Map-Kagoshima (scale 1:75,000) Geol. Surv., Japan
- (1931)-Ditto-Ijūin
- (1934)-Ditto-Kaseda
- INOUE, K. (1909)-Explanatory Text of the Geological Map-Kaseda (scale 1:200,000) (in Japanese), Geol. Surv., Japan
- KOTO, B. (1916)-The Great Eruption of Sakura-Jima in 1914, Jour. Coll. Sci. Imp. Univ. Tokyo, **38**
- LACROIX, A. (1904)-"La Montagne Pelée et ses Eruptions", Paris
- MATSUMOTO, Tad. (1933)-On the Aira Volcano (in Japanese), Geog. Review., Japan, **9**, 614
- (1943)-The four Gigantic Caldera Volcanoes of Kyusyu, Jap. Jour. Geol. Geog., **19**, sp. No.
- MOOR, B. N. (1934)-Deposits of Possible Nuée Ardente Origin in the Crater Lake Region, Oregon, Jour. Geol., **42**, 355-375
- NAKASHIMA, K. (1895)-Explanatory Text of the Geological Map-Kagoshima (Scale 1:200,000) (in Japanese) Geol. Surv. Japan
- NISHIHARA, M. (1953)-Pleistocene Volcanic Activity in the Sendai River "Basin", Kagoshima Prefecture, Graduation thesis, Kyūsyū Univ., Japan
- ODA, R. (1917)-Geology of Yoshinodai, the City of Kagoshima, Jour. Geol. Soc. Japan, **24**, 233-244
- PERRET, F. A. (1937)-The Eruption of Mt. Pelée 1929-1932, Carnegie Inst. Washington
- RUSSEL, H. J. (1944)-Lower Mississippi Valley Loess, Bull. Geol. Soc. Am., **55**, 1-40
- SATO, D. (1925, 1940)-Ganseki Chishitsu Gaku (Rocks and geology),
- SWINEFORD, A. & Frye, J. C. (1945)-A Mechanical Analysis of Wind-Blown Dust Compared with Analyses of Loess, Am. Jour. Sci., **234**, 249-255
- TANEDA, S. (1950)-Cordierite-bearing "Ash stone" around the Bay of Kagoshima (in Japanese), Sci. Rep. Fac. Sci. Kyushu Univ., Geol., **2**, 47-53
- (1953)-Explanatory Text of the Geological Map (Scale 1:200,000) of Kagoshima Prefecture (in Japanese), Published by the prefectural office
- TANEDA, S. & ARITA, T. (1953)-Geological Map (Scale 1:200,000) of Kagoshima Prefecture, Ditto
- VERHOOGIN, J. (1951)-Mechanic of Ash formation, Am. Jour. Sci., **249**, 729-739
- WENTWORTH, C. K. (1926)-"Pyroclastic Geology of Oahu", Bernice P. Bishop Mus. Bull., **30**
- YAMAGUCHI, K. (1933)-Petrological Study of "Ash Stone" around Bay of Kagoshima (in Japanese), Jour. Geol. Soc. Japan, **40**, 377-379

- (1937)-Petrological Study of "Ash Stone" around the Bay of Kagoshima (part 1) (in Japanese), Jour. Geol. Soc. Japan 44, 745
- (1938)-Petrological Study of the Pumice around the Bay of Kagoshima (part 3) (in Japanese), Jour. Geol. Soc. Japan, 45, 782-790
- (1952)-Geology of the "Shirasu" bed in Miyazaki Prefecture (in Japanese), Jour. Geol. Soc. Japan, 58, 303-304

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