

*Stratigraphy of the Yoshida-mura Shell
beds of Kagoshima Prefecture, Kyushu.*
— *On the so-called "Shirasu" and "Hai-ishi" (II)* —

By Yasuma GOHARA

Department of Geology, Faculty of Liberal Arts and Science, Shinshu University, Japan

(Received on Dec. 26, 1964)

Introduction

The shell beds are well distributed in the environ of Kagoshima city and the Yoshida-mura shell bed is a famous one of them, which were studied on the geological age by H. YABE (1941, 1946).

The view of H. YABE was based on the shell fossils and the stratigraphical information of the shell bed depended upon the volcanologist, K. YAMAGUCHI (1937), who studied the pyroclastics around the northern district of Kagoshima Bay.

That is to say, the sedimentaries including shell fossils above mentioned are closely connected with the pyroclastics, therefore the determination of the shell bed's horizon are related to the stratigraphical study of pyroclastics developed around the Kagoshima Bay.

I have stratigraphically studied the effusive matters of Ata and Aira volcanoes in Osumi Peninsular for several years (1961, 1962), and tephrochronologically the Quaternary deposits of Kyushu (1963).

The results of their studies can be adapted effectively to the determination of shell bed's horizon.

Prior to the issue, a glance should be thrown on the Quaternary volcanic history of Kyushu, in order to define the characters of volcanic matters interbedded the shell beds.

The origin of the recent volcanic activities may be traced back to the middle Pleistocene, which are divided in the San'in and Ryukyu volcanic types and their effusives closely connected with the terrace-forming movements.

The former are situated in the northern district of Kyushu and their effusives are mainly hornblende-andesite. The tectonics are characterized by the Graben which preceded the activities of central cones.

The later are situated in the southern district of Kyushu and characterized

by the Caldera which depressed after the violent explosive eruptions of the pyroclastic flow.

In the early Pleistocene, there was no areal division of activity type through in Kyushu and the effusives include the various chemical composition, from basic basalt to acidic dacite, but typical one is the two-pyroxene andesite. They are the so-called Tsukushi type in the lump.

In the region where widely distributes the dacitic tsukushi type overlain by the younger dacitic pyroclastics, it is difficult to recognize the difference between both effusives petrographically, but able to differ from each other stratigraphically. For example, in the neighbourhood of Kagoshima city, we may face the exposures like that case. Around the Kagoshima Bay, both effusives named "Shirasu" usually belong to the different formation and the Yoshida-mura shell bed is interbedded between them.

In this paper, their stratigraphical relations will be reported on the field observations and correlations with the Quaternary volcanic history of Kyushu.

I Geology of Yoshida-mura

In the latest years, the correlations of Yoshida-mura shell beds to the Quaternary chronology have been examined in the several papers, without the stratigraphical descriptions. So, I studied the geological formations of Yoshida-mura, where exposed the famous shell beds and the "Shirasu" beds.

Their orders of succession are as follows (Fig. 1).

Aira pyroclastic flow (pumice flow)
 ~~~~~  
 Yoshida-mura formation  
 ~~~~~  
 Ata pyroclastic flow (welded tuff)
 ~~~~~  
 Gravel bed  
 ~~~~~  
 Sataura formation

1 Aira and Ata pyroclastic flows

Aira pumice flow, which led to a large calderon depression, forms the table-land like as Yoshino-dai on the west coast of the northern division of Kagoshima Bay.

This flow extended in all direction from the position of the blind head of recent Kagoshima Bay and filled up the low-land and valley of the older formations in the districts far off the effusive center.

In Yoshida-mura, this flow covers uncomformably the older formations, not only the Sataura formation, but also the Ata welded tuff in the same manner of the Osumi Peninsular (GOHARA and KOMORI 1961; 1962).

Ata pyroclastics consist of three beds in this district (Fig. 2), and cover the gravel bed comformably.

Its lower part is interbedded with gravel and covered by the middle

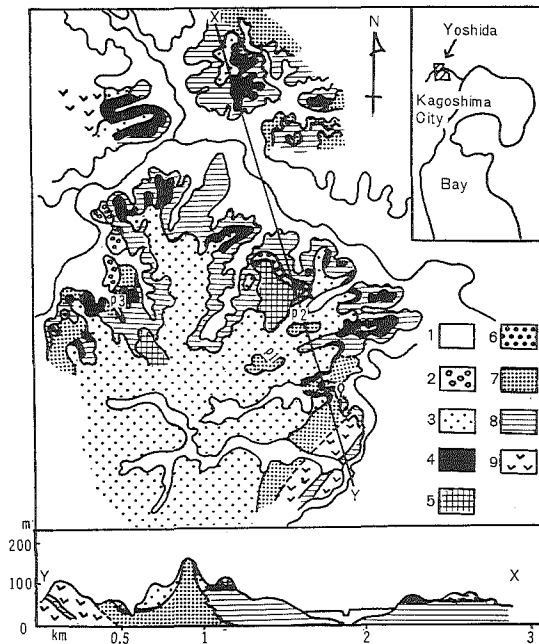


Fig. 1 Geological map and cross section of Yoshida-mura, Kagoshima-gun, in the northward district of Kagoshima city.

1 : Alluvium, 2 : Terrace gravel beds, 3 : Aira pumice flow, 4 : Yoshida-mura formation, 5 : Ata welded tuff, 6 : gravel bed, at the base of Ata welded tuff, 7-9 : Sataura formation; 7 : Andesite (partly welded tuff), 8 : tuff breccia, 9 : diatomaceous and tuffaceous silt. Symbols in the map; X : Localities of Yoshida-mura shell beds, † : Plant fossil bed collected samples by S. Endo (1939), p1, p2, p3 : localities of Plate Fig. 1, 2, 3.

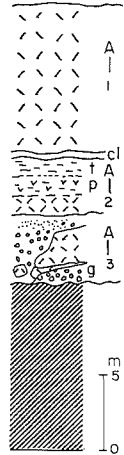


Fig. 2 Columnar section at Shirouchi of Yoshida-mura.

A 1-3 : three beds of Ata welded tuff, cl : tuffaceous clay, t and p : members of A-2, t : tuff, p : pumice.

showing partly the welded pumiceous tuff facies. The upper is the thick and typical welded tuff developing around Kagoshima city.

2 Yoshida-mura and Sataura formations

Yoshida-mura formation overlain by the Aira pumice flow is the horizontal layer at an altitude of 40-60 meters.

Its basal conglomerate contains occasionally the cobbles of the Ata welded tuff, base of which is 80-100 meters high above sea level.

Therefore, in spite of no exposure of contact very point between Ata and Yoshida-mura formation, the unconformity between them may be assumed.

In the surrounding regions of Kagoshima city, we can ascertain the relation between both layers as mentioned later (Fig. 3).

Sataura formation consists of gravel, sand, tuffaceous mud, diatom earth and pyroclastics including andesite, welded tuff, tuff breccia and pumice.

Among them, dacitic tuff breccia or white pumice bed shows the same litho-facies as the Aira pumice flow except lamination. therefore, it is named popularly on the Laminated (or Sedimentary) "Shirasu". But, it can not be regarded in the same name "Shirasu" as the Aira Shirasu (pumice flow), because they are differ from each other stratigraphically and are related with the unconformity.

Sataura formation is covered by the Ata welded tuff in order of succession, but in the almost case, the Ata welded tuff is eroded out and overlain directly by the Aira pumice flow. So, in the area along river where the Aira pumice flow was denuded, the Yoshida-mura shell beds underlain by the Sataura formation are exposed at the surface (Fig. 1).

II Yoshida-mura shell beds

The Yoshida-mura formation, about 1 meter in thickness, consists of gravel, sand, pumice and marine molluscus.

Through the whole formation, quartz grains rich and coarse sand, iron sand, tuffaceous silt, glassy andesite breccia and white pumice are dominant and the pumice bed have the lamination.

It is assumed the white pumice eruption of Aira volcano in the sea, which might be the fore-activity of the voluminous pumice flow.

At the locality of shell bed, the basal conglomerate overlies the diatom earth of Sataura formation uncomformably and there is the shell fossil bed being 5 meters in thickness on this gravel. The molluscus are cemented with the coarse sand and the little shell fragments.

Molluscan and brachiopod from the shell bed were studied by H. YABE and M. HATAI (1941) and after the investigation of shell fossils, H. YABE concluded that this formation might be the youngest Pliocene and the bed deposited in the shallow water of an enclosed bay.

But, after my stratigraphical study, this formation is interbedded between the Aira and Ata pyroclastics.

The age of Aira pyroclastics measured by carbon 14 dates of black humic clay at its base is $22,000 \pm 850$ years B. P. (KIGOSHI and ENDO, 1963), and the age of Ata pyroclastics deduced from the tephrochronology is the middle Pleistocene (GOHARA, 1963).

The formations lying at the same stratigraphic horizon distribute here and there around Kagoshima city, for instance, Riukyujinmatsu and Kogashira.

At Ryukyujinmatsu, there is the ostrea bed, 15 meters in height above sea level (MINATO and KATSUI, 1957) and at Kogashira, there is the same horizon

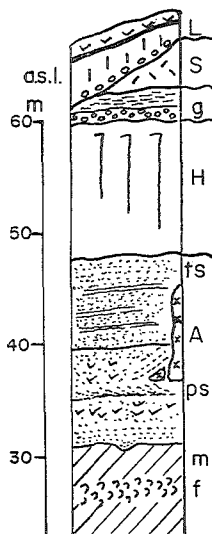


Fig. 3 Columnar section at Kogashira, in the western division of Kagoshima city (Refer to the geological map by Y. OTSUKA, (1931)).

L : Loam, S : Aira pumice flow (white colour), g : gravel bed correlated to Yoshida-mura formation, H : Ata welded tuff (black colour), ts~f : Kogashira formation, correlated to Sataura formation; ts : black tuffaceous sand, A : andesite lava, ps : white pumiceous sand (so-called "Sedimentary Shirasu"), m : blue tuffaceous mud, f : shell fossils.

sedimentaries without fossil (Fig. 3). Considering from each height, it is assumed that the area near Sakurajima subsided down and the area far from Sakurajima, upheaval relatively.

On the other hand, the Sataura formation includes the fauna and floral remains, and there are many fossil beds of the same horizon around Kagoshima city, they are Kogashira (Fig. 3), Shiroyama, Sebaru, and other shell beds (OTSUKA, 1931).

They are differ from the Yoshida-mura formation on their stratigraphic position and it may not allow to confuse them, as mentioned above.

The flora fossils from Yoshida-mura studied by S. ENDO (1939) are included in the diatomaceous tuff of Sataura formation. S. ENDO reported that the composition ratio of *Fagus crenata* is over 90% of the total specimens, among tree leaves. This fact shows a plant growth under a climate decidedly cooler than that now and its geological age the Pleistocene.

Through his consideration of these shell and floral fossils, H. YABE informed that the lower formation entombs a fossil flora with a younger aspect and the upper a fossil fauna with an older aspect (H. YABE, 1946).

But, in the stratigraphic fact, the lower formation entombs with an older one and the upper with a younger.

Pyroclastics and Shell fossils : Around the Kagoshima Bay, many pyroclastics from Ata and Aira volcanoes belonging to the Ryukyu volcanic system erupted in the Quaternary ice age.

And the eustatic transgression of Shimosueyoshi stage immersed the area around the Kagoshima Bay in the height 50 meters above the recent sea level.

This sedimentaries began to deposit the basal conglomerate with the cobble

from Ata welded tuff and next the coarse sand including many shell remains interbedded with the white pumiceous sand.

That is to say, the shell beds develop (Plate, Fig. 3) at the localities, where the basal conglomerate, a few meters in thickness, cover directly the diatomaceous silt of Sataura formation, and many shell extinct under the influence by the submarine activity of Aira volcano.

This relation between the fossil bed and the diatomaceous silt may show the circumstances of inhabitation of shell fossils.

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Explanation of Plate

Pl; Fig. 1 The so-called “Laminated (or Sedimentary) Shirasu” constituted by the white pumice of Sataura formation. This litho-facies is similar to the Aira pumice flow, but laminated.

Therefore, the mistake occasionally happen, which consider this bed to be the sedimentary facies of the Aira “Shirasu” (pumice flow). But, these two beds are differ stratigraphically and the Aira pumice flow is the *nuées ardentes* deposit flowed on the land surface.

Fig. 2 The uncomformity between Ata, Aira pyroclastics and Sataura formation. S :

Aira pumice flow, H : Ata welded tuff, g : gravel bed, D : diatom earth of Sataura formation.

Fig. 3 Yoshida-mura shell bed covers the diatom earth uncomformably at Kaizaka (Shell Slope) of Kukiuto. P : Aira pumice flow, Sh : shell bed, Cg : basal conglomerate, D : diatom earth.



Fig. 1

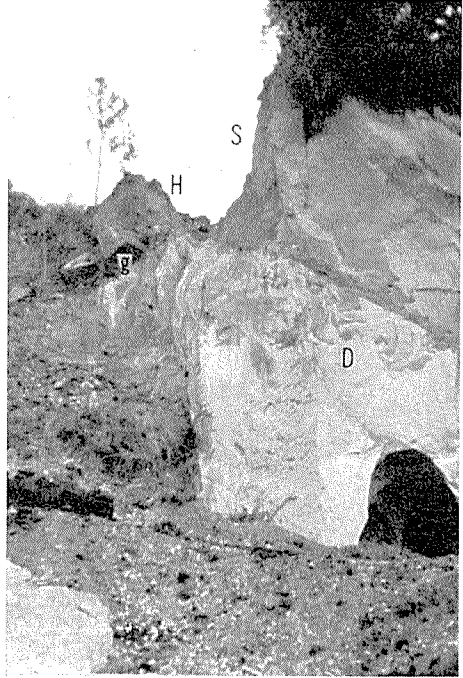


Fig. 2



Fig. 3