Chapter I

Hirado Island, Kyūshū

The purpose of the study on the Hirado Island is,

(1) to describe the features of shore platforms composed of pyroclastic rocks and volcanic rocks,

(2) to find the standard type of shore platforms, and

(3) to discuss some problems concerning the formation of shore platforms.

1 Outline of Study Coast

Shore platforms surround most coasts around Hirado Island located across narrow Hirado Strait to the west of Kitamatsuura Peninsula, kyūshū, except some east coasts. It is presumed that this island tilts to the east from the unsymmetrical landform and its geology. The east coast is a faultline coast with steep sea cliffs, and the west coast is a ria coast with several bays.

This island is composed of Tertiary formations (sandstone, conglomerate, tuff and tuff breccia—Tabira Formation and Hirado Formation, Miocene to Pliocene, and pyroxene andesite, volcanic breccia and tuff—Pliocene) and Quaternary formations (Nanryūzaki conglomerate, basaltic lava and pyroclastics). Narrow alluvial plains are on bayheads.

Platform distributions are outlined as follows:

(1) Southeastern coast

Below the precipitous cliff, relatively large-scale shore platforms composed of tuff breccia (Neogene) are near the high tide level or the inter-tidal zone. Many platforms have profile length over several tens of meters.

(2) Western coast

Shore platforms composed of tuff breccia are seen near the high tide level or within inter-tidal zone. They are several tens of meters in profile length on open coasts, but are smaller on sheltered coasts.

(3) Coast along Hirado Strait

There are only fragmentally small-scale inter-tidal platforms which consist of soft sandstone and mudstone (Tabira Formation, Neogene), and conglomerate (Nanryūzaki Formation, Quaternary).

(4) Northern coast

This coast is hemmed in places by inclined coastal platforms and small-scale shore platforms composed of basalts and pyroclastic rocks (Quaternary).

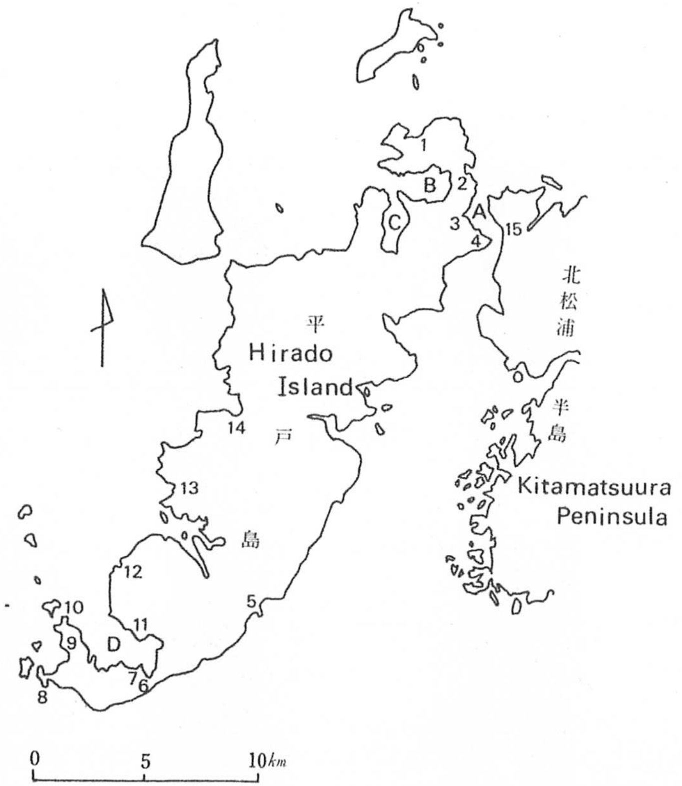


Fig. 1 Index map of Hirado Island

A: Hirado Strait	B: Hakka Bay	C: Furue Bay	D: Shijiki Bay
1: Tanoura	2: Kōnoura	3: Hirado town	4: Nanryūzaki
5: Maetsuyoshi	6: Funakoshi	7: Kōgetsu	8: Toyakushima Island
9: Miyanoura	10: Oihozaki	11: Ōshijiki	12: Haifuku
13: Tsutsumi	14: Nejishi	15: Hiradoguchi	

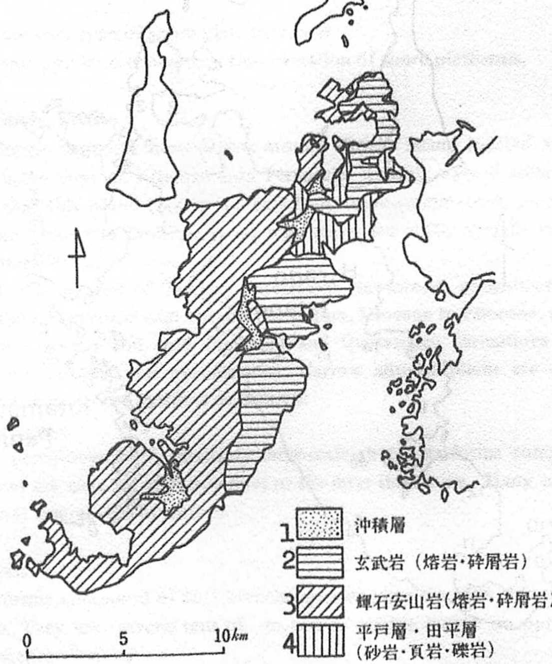


Fig. 2 Geological map of Hirado Island

1: Alluvium
2: Basalt (lava and pyroclastics)
3: Pyroxene andesite (lava and pyroclastics)
4: Hirado Formation and Tabira Formation (sandstone, mudstone or conglomerate)

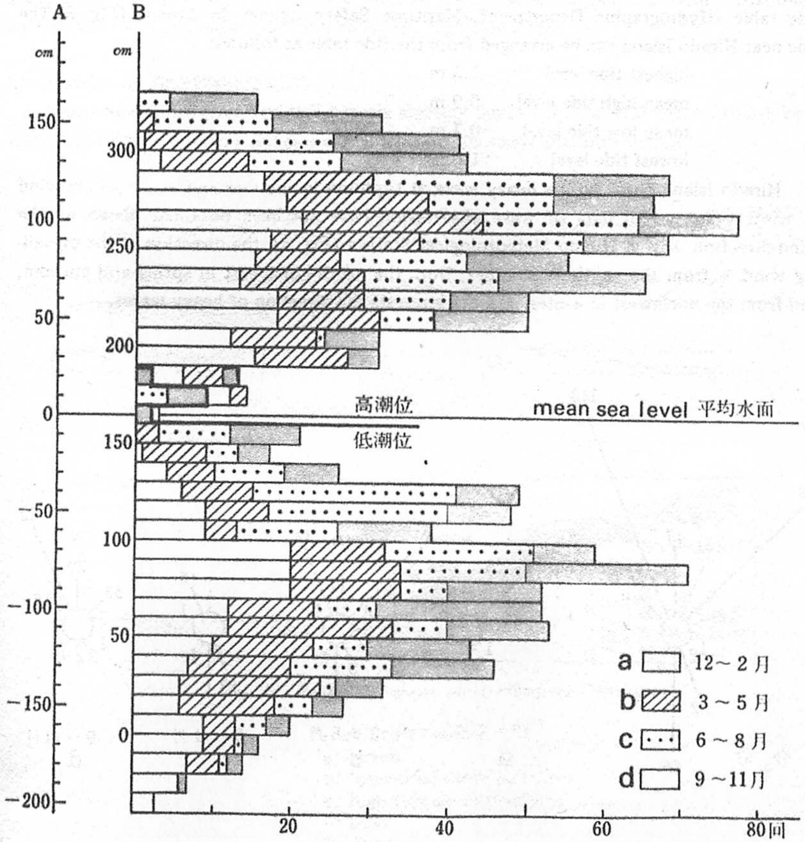


Fig. 3 Frequency of high tide and low tide in each height at Sasebo (1964)

a: winter (Dec. — Feb.)
b: spring (Mar. — May)
c: summer (Jun. — Aug.)
d: autumn (Sep. — Nov.)

In order to identify the features of shore platforms and coastal platforms, the shore profiles are levelled at the intervals of 5 m in about right angles to the shoreline, or at shorter intervals on rugged relief. The mean sea level in the profiles is calculated from the tide table (Hydrographic Department, Maritime Safety Agency in Japan) (Fig. 3).The tide near Hirado Island can be arranged from the tide table as follows:

highest tide level	1.5 m
mean high tide level	0.9 m
mean low tide level	−0.7 m
lowest tide level	−1.8 m

Hirado Island coast suffers heavy wave at typhoon in summer and at prevailing wind in winter. But useful data of wave observation have not been obtained. Based on the wind-direction map at Hirado Meteorological Station (Fig. 4), the direction of the prevailing wind is from the south in summer, from the north-north-east in spring and autumn, and from the northwest in winter, and this suggests the direction of heavy waves.

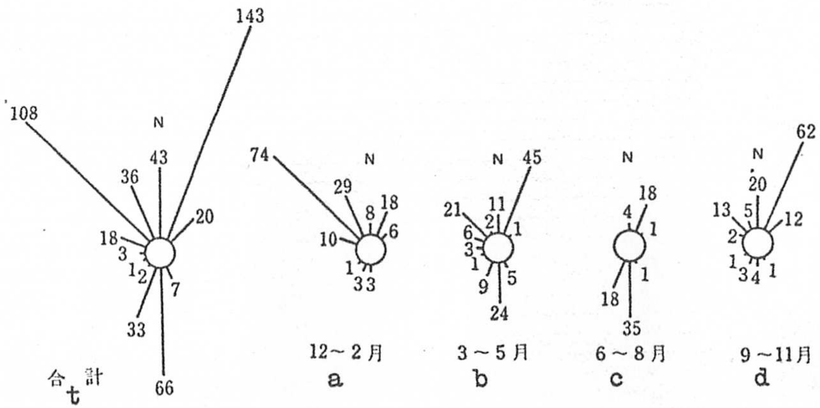


Fig. 4 Wind-direction map of wind over 5.5 m/sec in velocity at Hirado Meteorological Station (1958—60)

a: winter (Dec. — Feb.)
b: spring (Mar. — May)
c: summer (Jun. — Aug.)
d: autumn (Sep. — Nov.)
t: all year

2 Description of Platforms on Some Coasts

For the describing of these platforms, they are classified into three types: inter-tidal shore platform with slightly inclined surface, high tide shore platform with horizontal surface and inclined coastal platform above the high tide level.

1) Coast near Funakoshi (Fig. 5)

This coast is composed of tuff breccia slanting landward in several degree, and dykes intruding. Some projecting dykes are 2—3 m in height above platform surface.

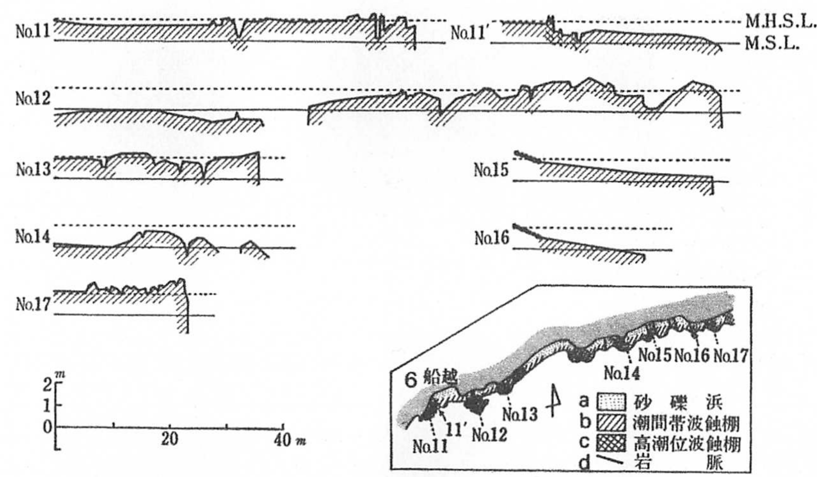


Fig. 5 Profiles of shore platforms near Funakoshi

rock: tuff breccia
a: beach
b: inter-tidal shore platform
c: high tide shore platform
d: dyke
6: Funakoshi

Under the precipitous cliffs protruding into the sea, there are horizontal high tide shore platforms which are dipped at high tide (Profile No. 11, 12, 13 or 17). Some platforms with seaward rampart are inclined landward. Roughness of platform surface seems to be regulated by lithology. Many rough platforms are of a kind of tuff breccia composed of unsorted materials. On the other hand, if the rocks are composed of fine grains, platforms have smooth surfaces, especially when they are surrounded by dykes. Some platforms have the shape of staircase (No. 11'). Regulated by joints or the contact zone of a dyke, wave furrows have deeply carved the front of platform. No gravel is seen on the surface of high tide shore platforms. At the foot of some cliffs behind, there are notches which wave reaches at high tide.

On recessed coast, inter-tidal shore platforms are situated in front of the gravel beaches, and polished gravels are seen in places on the platform surface. These surfaces are slightly inclined and some pass into submarine platform without remarkable nips. Accordingly, these must be influenced by abrasion.

2) Toyaku-shima Island (Fig. 6)

Toyaku-shima Island, southwestern tip of Hirado Island, is composed of tuff breccia and andesite dykes. There are few platforms on the north coast but a series of platforms composed of tuff breccia on east and southwest coasts.

Platform along the east coast is about 20 m in width. It is situated near the mean sea level at the northern part sheltered by Hirado Island across a narrow strait (No. 44, 45 and 46), but gradually increases its height southward. Near southern tip, platform is located at the high tide level and has deeply been carved by wave furrows (No. 31, 42 and 43). On the southwest coast facing the open sea, a series of platforms several meters in width are higher at the bulges of coastline and lower at the recesses. They are horizontal high tide platforms at the projecting coasts, and on the other hand, at sheltered or recessed coasts slightly inclined shore platforms are seen below the high tide level. The north coast with few platforms faces the calm sea surrounded by islands.

3) Coast near Miyanoura (Fig. 7)

To the west of Miyanoura there is a shore platform which consists of tuff breccia and tuff. It has a rampart with height of 1.5—2 m above the high tide level at the headland, but becomes gradually lower toward a recessed part, on which the platform is situated near the mean sea level. The platform at the recessed part inclines slightly seaward with smooth surface composed of tuff. On this surface, polished gravels are seen in places, and behind this platform there is a small beach composed of well rounded gravels. The platform has a seaward rampart of tuff breccis at the recessed part, but at the rim without such rampart the platform is only bordered by a small nip about 20 cm in height, and passes beneath the sea.

4) Coast near Kōnoura (Fig. 8)

The coast at the south of Kōnoura is fringed by inclined coastal platforms of basalt and fragmental inter-tidal shore platforms of pyroclastic rocks. Regulated by the structure of basalt, the coastal platforms have such steep inclined surfaces that some have, for

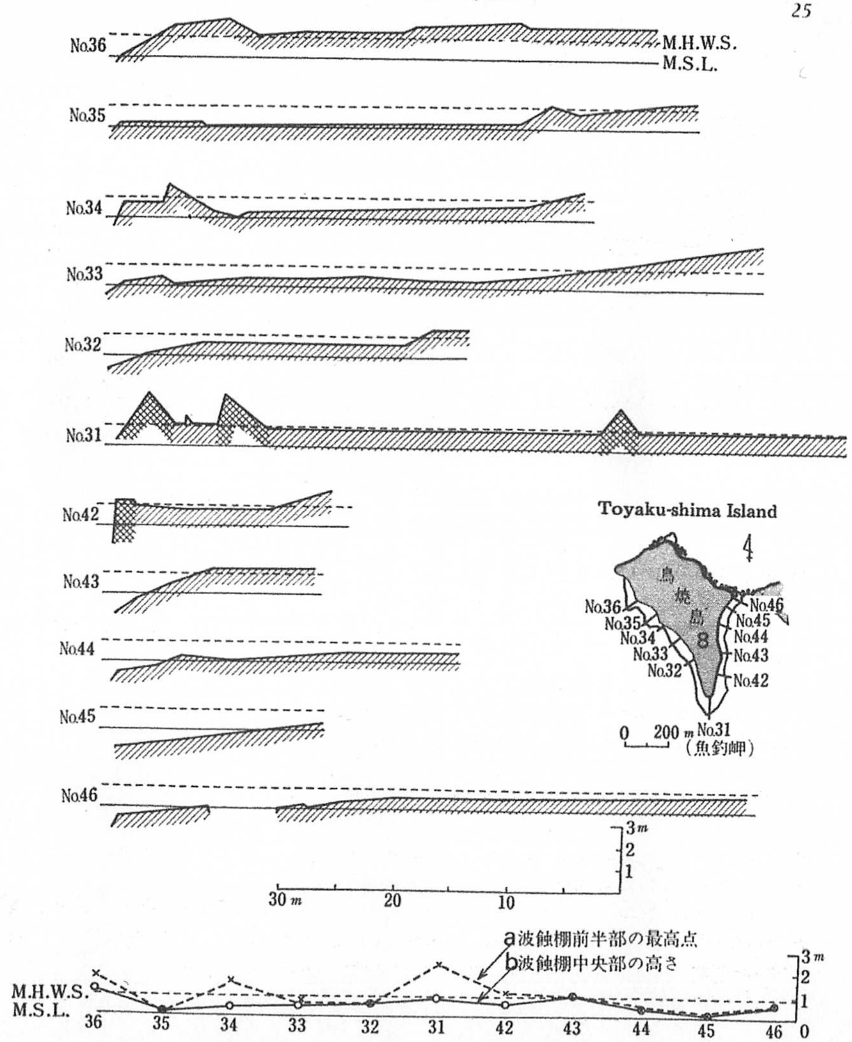


Fig. 6 Profiles of shore platforms around Toyaku-shima Island
oblique lines : tuff breccia crossed lines : dyke of andesite
a: height of the highest point in frontal part of platform
b: height of the center of shore platform

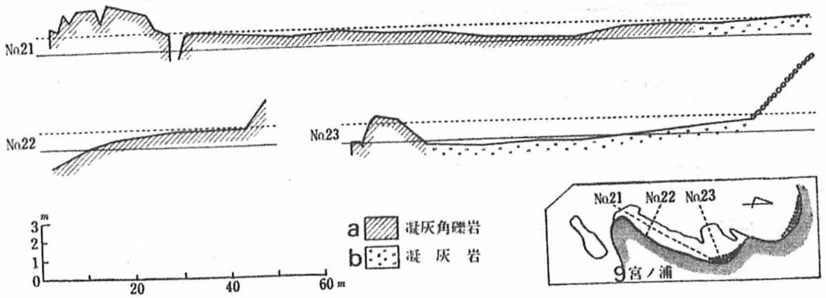


Fig. 7 Profiles of shore platform near Miyanoura
a: tuff breccia b: tuff 9: Miyanoura

instance, inclination of about 30° and extends to several meters in height. These surfaces are judged to be structural plane exposed by heavy wave as it is often observed that storm wave rushes up on these surfaces to several meters in height. Some surfaces of coastal platform are ledge-like, resulted from the selective erosion of storm wave to relatively weak scoriaceous parts of rock (profile No. 51, 52 and 56).

On a little recessed coastline, inter-tidal shore platforms which consist of tuff breccia (Neogene) and loamish vermilion tuff breccia (Quaternary) slightly incline and some gradually pass beneath the sea. Polished gravels are seen in places on these surface.

5) Coast near Cape Nanryūzaki (Fig. 9)

Along the coast facing Hirado Strait, are seen many gravel beaches but few scrappy shore platforms. It is difficult as yet to explain the reason why the coast facing this strait does not have shore platform.

But on the south side of Cape Nanryūzaki there is a shore platform composed of weak consolidated conglomerate (Nanryūzaki formation, Quaternary), which is slightly inclined from the high tide level to the mean sea level, and has a small nip at the rim.

6) Shijiki Bay (Fig. 10, 11 and 12)

A coastal platform composed of andesite lava is on Cape Oihozaki under the influence of strong wave caused by prevailing NNW wind in winter. It has such an inclined surface as the andesite structure, just like the coastal platform of basalt near Kōnoura.

In and out of Shijiki Bay, there are high tide shore platforms on projecting capes

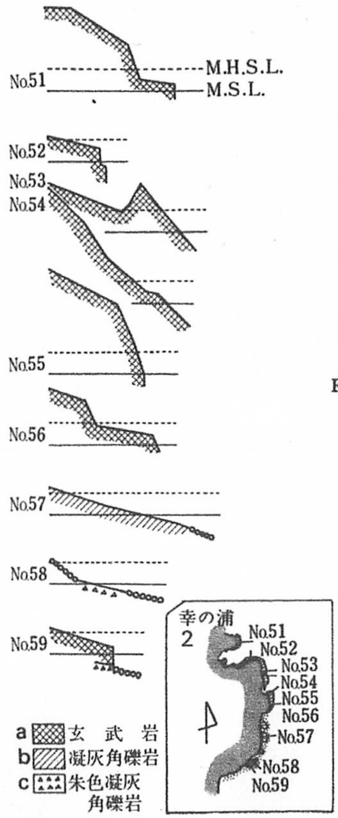
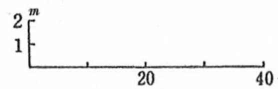


Fig. 8 Profiles of shore platforms near Kōnoura
a: basalt b: tuff breccia
c: loamish vermilion tuff breccia



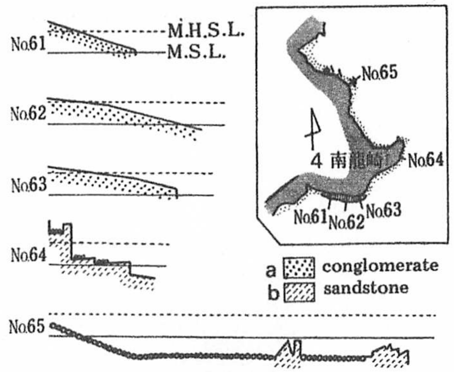
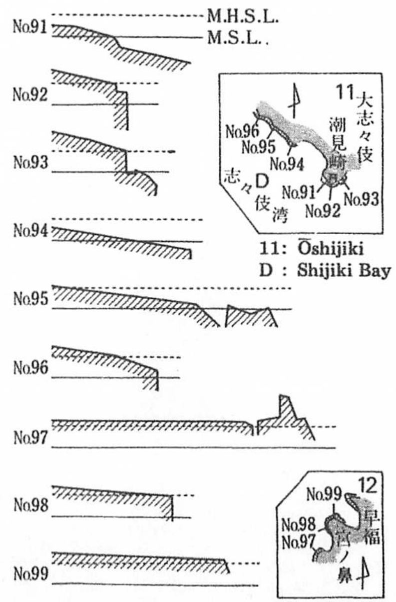


Fig. 9 Profiles of platform near Cape Nanryūzaki



11: Ōshijiki
D : Shijiki Bay

rock: tuff breccia 12: Haifuku

Fig. 11 Profiles of shore platforms near Ōshijiki and near Haifuku and inter-tidal shore platforms on recessed coasts (Fig. 11 and 12). Most of them consist of tuff breccia.

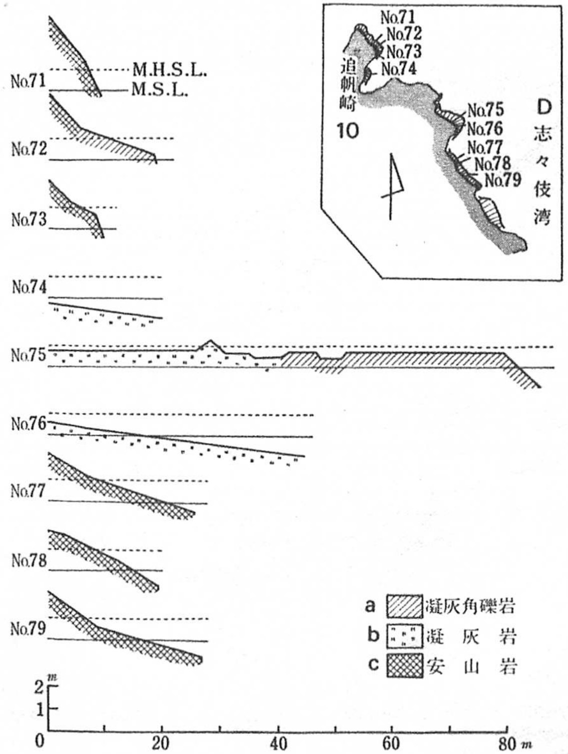


Fig. 10 Profiles of platforms near Oihozaki
a: tuff breccia
b: tuff
c: andesite
10: Oihozaki
D : Shijiki Bay

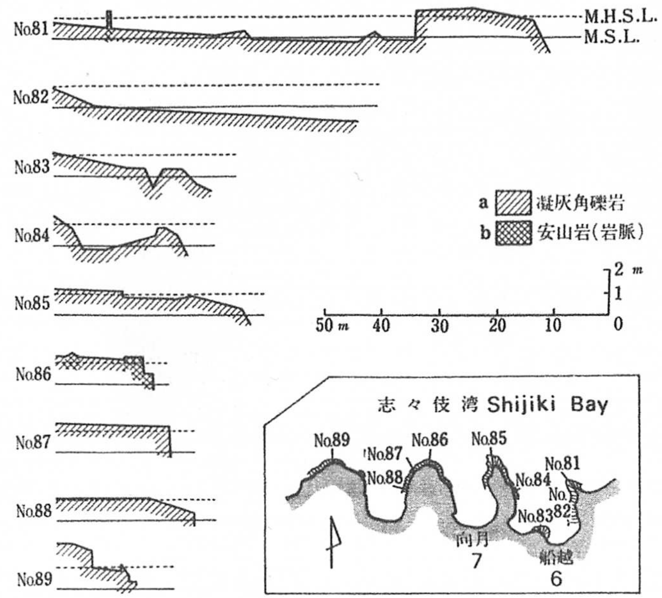


Fig. 12 Profiles of shore platforms on bayhead of Shijiki Bay
a: tuff breccia
b: andesite (dyke)
6: Funakoshi
7: Kōgetsu

7) Other Cases (Fig. 13)

At the west of Tanoura, a narrow shore platform extends within upper inter-tidal zone along the foot of the precipitous cliff which is constructed with tuff breccia or volcanic breccia (Fig. 13 — No. 101, 102 and 103). It has a low seaward rampart and a clear nip. Some parts of the cliff are overhung seaward, and notches have been carved at the foot of the cliff. In front of the beach along a small bay near Maetsuyoshi, shore platforms are fragmentally recognized near the mean sea level (Fig. 13 — No. 111, 112 and 113). They have gravels polished on their slightly inclined surfaces and pass beneath the sea without clear nips.

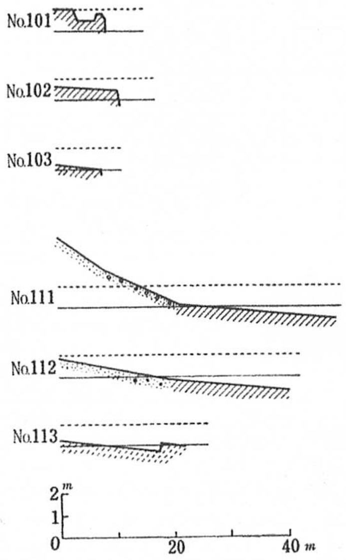


Fig. 13 Profiles of shore platforms near Tanoura (101—103) and near Maetsuyoshi (111—113)

3 Three Types of Platforms

From the above observation, platforms around Hirado Island are satisfactorily classified into three: inter-tidal shore platform, high tide shore platform, and inclined coastal platform, and characterized as follows:

A: inter-tidal shore platforms

(1) They are situated within inter-tidal zone.

(2) Their surfaces incline slightly seaward and pass gradually below the sea.

(3) Some of them join to submarine abrasion platforms without remarkable nip or knick point on recessed coast.

(4) They have no seaward rampart, except the ramparts constructed with resistant rocks.

(5) Their surfaces are comparatively smooth, and are carved by shallow wave furrows only.

(6) There are polished gravels in places on their surfaces, which are often transferred by wave.

(7) Behind the platforms, there are beaches frequently.

(8) The platforms are located at recessed coasts, and they gradually change outward to high tide shore platform in appearance.

(9) Around Hirado Island, they are recognized on the coasts which consist of tuff breccia, volcanic breccia, tuff, conglomerate, or soft sandstone.

B: high tide shore platforms

(1) That are situated near the high tide level, and almost dipped at high tide.

(2) Their surfaces are horizontal, and occasionally some slightly incline landward.

(3) Many remarkably precipitous nips are at the seaward rim of platforms, and some are several meters in height.

(4) Some ramparts are caused by rock control of resistant dykes of igneous rock.

(5) The platforms are deeply carved by wave furrows, whose bottom joins to the surface of submarine abrasion platform.

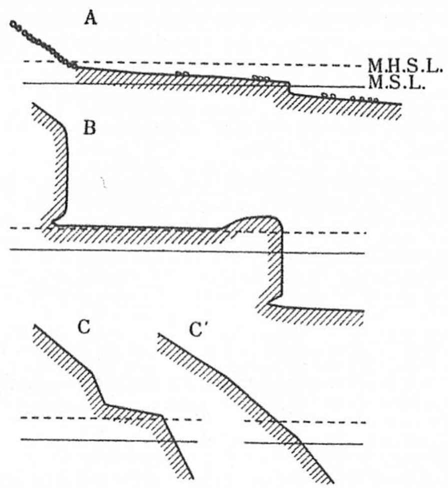


Fig. 14 Types of platforms around Hirado Island

A: inter-tidal shore platform
B: high tide shore platform
C and C′: inclined coastal platform

(6) No polished gravel is observed on their surface, but weathered debris.

(7) The cliff behind is precipitous, and notches are at the foot.

(8) The platforms are located at projecting coasts.

(9) On Hirado Island, they are on the coasts composed of tuff breccia and volcanic breccia.

C: inclined coastal platforms

(1) They have small-scale ledge-like surfaces or comparatively steep inclined surfaces, which have been exposed by storm wave.

(2) Their surfaces are regulated by geological structure and some have inclination of 20°—30°, which are just the lava surfaces washed out by wave. Ledge-like surfaces are resulted from selective denudation of weak scoriaceous parts in volcanic rock.

(3) The nips at the edges of the platform are sometimes several meters in height.

(4) No seaward rampart.

(5) They are carved by wave furrows regulated by joints.

(6) No gravel on the surfaces.
(7) Steep inclined surface often extends to coastal bevel cliff behind without clear knick point.
(8) The platforms are located at projecting headlands.
(9) The platforms are limited on the coasts constructed with basalt and andesite lava.

4 Formation of Platforms

As to the formation of high tide shore platform, many investigators (Bartrum, 1926; Wentworth, 1938; Mii, 1963) discussed that shore platform was caused by the weathering within inter-tidal zone and the wave simply carried away the weathered debris from its surface.

Such views are endorsed by the following platform features on the study coast: High tide shore platforms are horizontal and their seaward ramparts are not caused by rock control. These horizontal surfaces correspond to the horizontal basal level for the sea level weathering, and the seaward ramparts are caused by the fact that the basal level for the weathering is higher at platform rim which always suffers splash by breaker. There is no polished gravel on the surfaces but weathered debris. Moreover, high tide shore platforms do not extend to submarine abrasion platform. These facts must suggest that high tide shore platforms are caused by weathering rather than abrasion.

There coexist or often continue both high tide shore platform and inter-tidal shore platform along a sequence of coast. However, their features and levels are different with each other, notwithstanding that they consist of same rock. The differences of levels and features are possibly attributed to the differences of wave height due to convergent wave at headland and divergent wave inside bay.

Besides the differences in height, it is necessary to examine the differences in mechanism of formation. Inter-tidal shore platforms incline slightly seaward and have not remarkable seaward rampart, except resistant rock ramparts. Moreover, polished gravels and their shifting are recognized on the surface, and there is a beach behind the platform. On recessed coasts, many inter-tidal shore platforms frequently seem to continue to the submarine abrasion platform without remarkable nip. The above features suggest the role of wave abrasion over the surface in formation of inter-tidal shore platforms.

From the above observations, a model of platform transition from baymouth cape to bayhead is assumed (Fig. 15). High tide platform at baymouth cape changes gradually to inter-tidal platform at bayhead. Corresponding to the transition, the role of abrasion in platform formation increases gradually, and inter-tidal platform continues finally to submarine abrasion platform at the bayhead. However, the relation of inter-tidal shore platform to submarine abrasion platform has not been clarified enough as yet.

Coastal platforms composed of basalt or andesite above high tide level are not covered by ordinary wave but sometimes are exposed to storm wave. They are just the storm wave

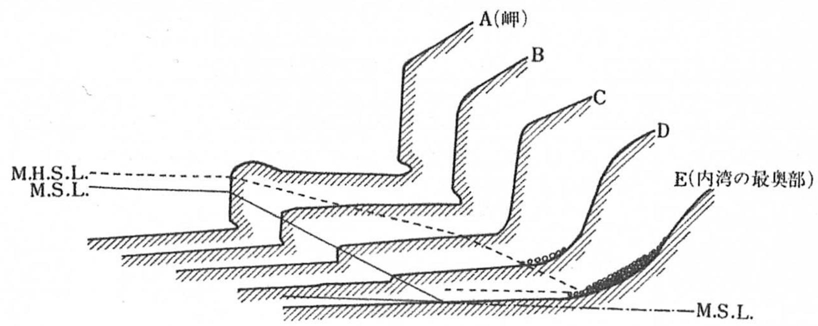


Fig. 15 A model of platform transition inward a bay

A: baymouth cape
E: bayhead

platforms and are formed differently from shore platforms. They are limited at the strong wave coasts. As storm wave acts selectively, features and levels of coastal platforms are various according to the geological condition.