Geomorphological Study of Shore Platforms
— Analytical and Genetical —

Tatsuo TAKAHASHI*

The purpose of this study is to discuss some problems of platform formation by means of morphological analysis of shore platforms. Shore platforms have erosive features continuously denuded, and have no deposits, as materials produced on the platform surface and debris from the cliff behind are carried off in a short time. Though the analysis of deposits is very valid for most geomorphological studies, its possibility is less for the study of shore platforms. So, the shore platforms are investigated principally by the morphological method, and investigators have made profiles of shore and coast for their studies of platform. The features of shore platforms look similar in all study coasts, and are fairly individual in each coast. So far there is scarcely any comparative study about the features on various coasts, and the platform profiles gained are too sporadical and too few for the quantitative analysis. It is necessary to analyze quantitatively for the comparison of the platform features. Therefore, 400 platform profiles of various coasts are statistically collected in this study. The author intends to clarify not only each feature of shore platforms but also their community and individuality by statistical comparison of the profiles, and such a method will approach to the problems about the formation of shore platform.

Some cliffed coasts are bordered by rock platforms horizontal or sloping gently extending in shore zone or beneath the sea. Such platforms have been named various and more or less synonymous terms — wave cut bench, wave cut platform, abrasion bench, abrasion platform, marine bench, shore platform or wave beveled platform. The terms signifying agency have frequently been used.

However, views do not always agree on what is the most important agency in platform formation. Moreover, the term 'abrasion platform' and other synonymous terms have often been confused with 'submarine abrasion platform' which is under low tide level.

Mii (1962) who emphasized the role of sea level weathering in platform formation, consciously avoiding the term signifying agency, gave purely locational terms such as 'shore platform', 'coast platform' and 'offshore platform'. Bird (1968) stated that the platform had often been termed as wave-cut or abrasion platform, but these generic terms could be misleading, and shore platform, a purely descrip-

* Department of Geography, School of Education, Okayama University, 3–1–1 Tsushima-Naka, Okayama City, Japan

tive term, was preferred.

In this paper 'shore platform' is used as a purely descriptive term.

There are some exposed platforms at higher level than shore zone, which should be named 'coast platform' after Mii or 'coastal platform'. They contain both the platforms cut by storm waves from present sea level and those emerged by sea level change or crustal movement after their formation in shore zone.

Some platforms neighbouring each other are difficult to be distinguished from their levels whether shore platforms or coastal platforms. The boundary between both is not always clearly drawn. Therefore, in this paper the term shore platform in a broad sense, containing coastal platform, is used sometimes as a convenient mean.

Analysis of Platform Profiles

1 Method of Analysis

Platform profiles collected for the analysis are listed in Table 1 (Fig. 1):

The collected platform profiles are uneven in number in each coast and the

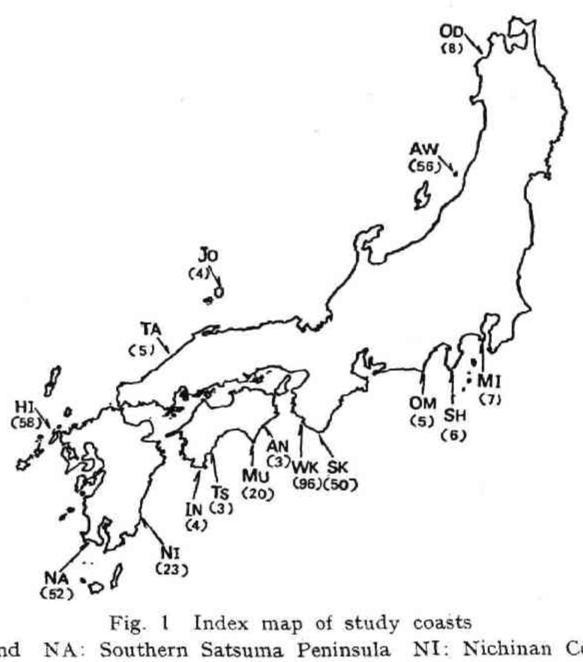


Fig. 1 Index map of study coasts
HI: Hirado Island NA: Southern Satsuma Peninsula NI: Nichinan Coast IN: Inan Coast TS: Tosa-Saga Coast MU: Muroto Cape Peninsula AN: Anan Coast WK: Southwestern Kii Peninsula SK: Southern Kii Peninsula OM: Omaezaki Coast SH: Shimoda Coast MI: Southern Miura Peninsula TA: Tatamigaura JO: Jōdogaura AW: Awashima Island OD: Ōdose

Table 1 List of study coasts

Coast	ab.	Profiles Number	Profiles Surveyor	Tide (Source: Tide table, 1972) mean high water springs	mean low water springs	tide gauge station
Hirado Island	HI	58	Takahashi (1972a)	118.0 cm	−148.9 cm	Nagasaki
Southern Satsuma Peninsula	NA	52	Takahashi (1972b)	108.2	−146.0	Makurazaki
Nichinan Coast	NI	23	Takahashi (1973b)	85.3	−115.4	Aburatsu
Inan Coast	IN	4	Takahashi*	83.2	−113.1	Tosa-Shimizu
Tosa-Saga	TS	3	Takahashi*	83.2	−113.1	Tosa-Shimizu
Muroto Cape Peninsula	MU	20	Takahashi (1974b)	81.0	−109.7	Kōchi
Anan Coast	AN	3	Takahashi*	76.6	−92.4	Komatsushima
Southwestern Kii Peninsula	WK	26	Kumon* (1961)	80.7	−108.1	Shirahama
		27	Mii (1962)			
		43	Takahashi (1973a)			
Southern Kii Peninsula	SK	50	Takahashi (1973a)	77.4	−103.5	Kushimoto
Omaezaki	OM	5	Takahashi*	72.5	−99.0	Omaezaki
Shimoda	SH	6	Sunamura* (1963)	71.1	−96.3	Uchiura
Southern Miura Peninsula	MI	7	Toyoshima (1956)	81.2	−113.0	Yokohama
Tatamigaura	TA	5	Takahashi (1967)	33.3	−26.8	Sotonoura
Jōdagaura, Oki	JO	4	Takahashi*	21.9	−21.9	Saigō
Awashima Island	AW	56	Takahashi (1965b)	21.5	−22.4	Iwasaki
Ōdose	OD	8	Takahashi (1967)	21.5	−22.4	Iwasaki

ab.: abbreviation * unpublished

study coast has not been selected with a certain standard. Moreover, the base lines of profiles chosen in each research are not fixed. Accordingly, the statistic weight of each profile is not equivalent with one another. Therefore, the statistic data about the profiles will be very carefully read and interpreted. Exact interpretation, paying attention to the coastal environment, will bring the real significances.

Platform profiles have so various length, height and rugged relief that it is difficult to compare with one another. For the convenience of comparison 'simplified profiles' were drawn as in Annexed Sheets, which connect the heights of 20 points at equal intervals along the length of profile, where the length is translated into an unit length. Simplified profiles are useful to compare profile patterns and levels of platform surface with one another. But it is impossible to compare inclinations on the apparent figures, because the length of all profiles is translated into an unit length. If a platform is longer, its simplified profile looks steeper. The inclinations measured on the actual profile are listed in Annexed Table. Besides, fine relief on the platform is eliminated in simplified profile. Height frequencies are shown as the histograms about the heights of 20 points

(Annexed Sheets). They are convenient for comparison or classification of platforms in height.

Length, height and inclination of 400 profiles are measured as follows:

(1) Length

Length of platform is measured from the base of the cliff behind to its seaward edge with a nip at nearly right angles to the coastline. Some platforms are

Table 2 Classification of platforms in height and notation

(Cu)	coastal platform
— 5 m above mean sea level —	coastal platform
(Cm)	coastal platform
— 2.5 m above mean sea level —	coastal platform
(Cl)	coastal platform
— 0.5 m above mean high water springs —	
(Hu)	high tide platform
— mean high water springs —	high tide platform
(Hl)	high tide platform; inter-tidal platform
— (medial level) —	inter-tidal platform
(Mu)	inter-tidal platform
— mean sea level —	inter-tidal platform
(Ml)	inter-tidal platform
— (medial level) —	inter-tidal platform
(Lu)	inter-tidal platform; low tide platform
— mean low water springs —	low tide platform
(Ll)	low tide platform
— 0.5 m below mean low water springs —	
(S)	submarine platform (abrasion platform)

Table 3 Classification of rocks of which platforms consist and notation

Primary classification	
M	Mesozoic and Palaeogene
N	Neogene
D	Diluvium
I	Igneous rocks
Secondary classification	
m	mudstone
s	sandstone
a	alternation of sandstone and mudstone
c	conglomerate
t	tuff
b	tuff breccia
w	welded tuff
v	volcanic rocks (andesite and basalt)
d	dolerite

covered with beach at and near the base of the cliff, when the length is measured except the beach. Some platforms pass gradually below sea and do not have remarkable nip, when it is difficult to define the length clearly, and the length differs by tide at levelling.

(2) Height

The platforms are classified with height ranges of tide levels denoted as Cu, Cm, Hu, Hl, Mu, Ml, Lu, Ll, and S (Table 2). Height ranges of tide levels are various in absolute height as tidal range is different place to place, which can be read in tide table (Table 1).

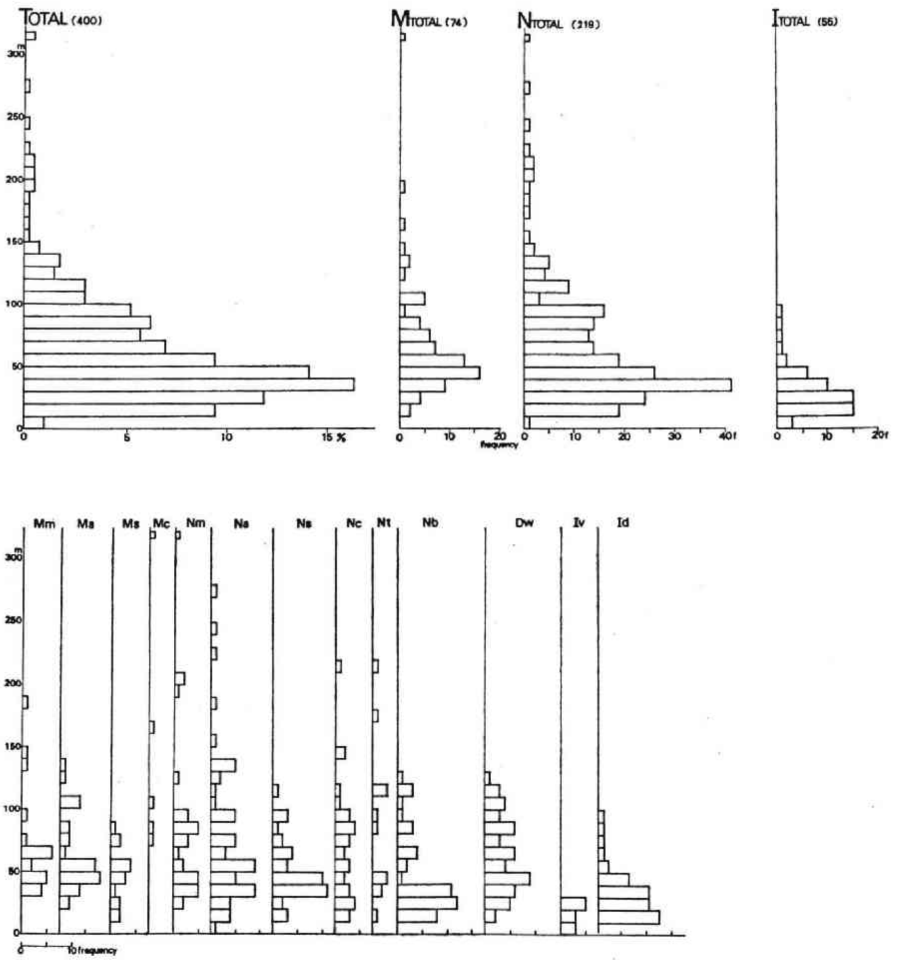


Fig. 2 Histograms of the length of platform profiles in each lithology

Table 4 Average length, and the most frequent class of

lithology		M						
		m	a	s	c	total	m	a
number		22	32	15	5	74	31	51
average length (m)		68.6	62.5	47.0	165.0	68.1	84.4	75.8
the most frequent class	length (m)	61-70	41-50	51-60		41-50	31-40 41-50	31-40 51-60
	inclination (°)	0-0.5	0-0.5	1-2	0-0.5	0-0.5	0-0.5	0-0.5
	height	Hl	Ml	Cm	Hl	Hl	Hu, Hl Ll	Hl
coast		TS MU SK	IN MU AN WK	IN MU WK SK	SK		WK SK AW	NI WK SK OM MI TA JO

Platforms around Awashima Island upheaved at Niigata Earthquake in 1964, and profiles levelled after the Earthquake are restored in height as before the Earthquake for this analysis (Takahashi, 1965a).

(3) Inclination

The inclination of the main platform surface is measured except ramparts and ramp near the cliff behind. Examined the original profile, the surface to measure is chosen, and at the choice some personal error is possible.

(4) Classification in lithology

Rocks of which platforms consist are grouped and marked in each lithology as shown in Table 3.

2 Consideration on the Results of Measurements

From the above measurements and height frequencies, the platforms are characterized as follows:

1) Length (Table 4 and Fig. 2)

The length of profiles averages 68 m on Mesozoic and Palaeogene rocks, 65 m on Neogene rocks, 30 m on igneous rocks and 57 m on all profiles. Of mudstone, mudstone-sandstone alternation, conglomerate and tuff in secondary classification, profiles are fairly long in both average and maximum lengthes. The maximum length is about 400 m on mud-rich Palaeogene conglomerate, at Tako, southern length, inclination and height in each lithology

N					D	I			total
s	c	t	b	total	w	v	d	total	
37	32	13	47	219	52	11	44	55	400
49.8	66.9	87.3	45.6	65.3	63.3	16.8	33.6	30.3	56.7
31-40	21-30 81-90	41-50	21-30	31-40	51-60	21-30	11-20	21-30	31-40(16%)
2-5	0-0.5	0-0.5	0-0.5	0-0.5	3-5	7-10	0.5-3	2-3	0-0.5(30%)
Hl	Hl	Cl	Hl	Hl	Cm	Hl	Hu	Hu	Hl (25%)
NI WK	WK	SH OD	HI JO SH		NA	HI	AW		

Kii Peninsula (Loc. 59), and the next is about 330 m on Neogene mudstone, at Tsuga, southern Kii Peninsula (Loc. 82). On the other hand, the length is comparatively small on sandstone and tuff breccia, and the minimum is on igneous rocks. It is appropriate to consider that rock control in platform formation has revealed such differences. Generally speaking, development of shore platform is conspicuous on the coasts constituted with argillaceous rocks.

Platforms of welded tuff around southern Satsuma Peninsula are relatively long, despite of the resistance of the rock against weathering and wave erosion, because they are a kind of structural platform, i.e. bedding plane of welded tuff with some inclination has been exposed as platform surface after the expulsion of loose non-welded deposits by wave (Takahashi, 1972b).

According to the measurement of 'reefs exposed at low tide' from 1 : 25,000 topographic maps, the average width of 'reefs exposed at low tide' is 56 m on coasts of Mesozoic and Palaeogene, 64 m on Neogene, 35 m on igneous rocks and 58 m on all coasts around Southwestern Japan (Takahashi, 1974a). They have little difference with average lengths of platforms profiles, notwithstanding that the method of measurement is different with each other. Consequently, it may well be considered that platforms in Japan ordinarily have several tens meters in length, though with some differences according to lithology.

Table 5 Statistical table on the height of platform profiles in each coast

coast		Hirado Island	Southern Satsuma Peninsula	Nichinan Coast	Inan Coast	Tosa-Saga Coast	Muroto Peninsula	Anan Coast	Southwestern Kii Peninsula	Southern Kii Peninsula	Omaezaki Coast	Shimoda Coast	Southern Miura Peninsula	Tatamigaura Coast	Jōdogaura Coast	Awashima Island	Ōdose Coast	total
height	Cu		11	7			4											22
	Cm	2	16	5			7		1									31
	Cl	1	7	2	3		5		4	8		4	4	1	3	6	5	53
	Hu	4	3	1			1		8	16		2		1		9	1	46
	Hl	27	5	6	1	1	2		27	22			1			4	1	97
	Mu	20	6	1		2	1	3	23	4				1	1	8	1	71
	Ml	4	4	1					27		3		2	2		8		51
	Lu								6		2					3		11
	Ll															14		14
	S																	4
total		58	52	23	4	3	20	3	96	50	5	6	7	5	4	56	8	400
lithology		Nc Nb Nt Iv	Dw	Na Ns	Ma Ms	Ma	Ma Mm Ms	Ma	Ma Ms Na Ns Nc	Mm Ms Mc Na Nm Ns	Na	Nb Nt	Na	Na	Na Nb	Nm Id	Nt	

2) Height (Table 4 and 5, and Fig. 3)

Profiles located in 'Hl' are the largest in number (25%) and in 'Mu' are the second (17%). Those located between the mean sea level and the highest tide level (total of 'Mu', 'Hu' and 'Hu') are the majority in number. This fact endorses the view that shore platform is originated near high tide level or within upper intertidal zone. However, it is not sufficient to estimate the planation level of shore platform only from the fact mentioned above.

Then, coastal platform above high tide must necessarily be examined. Many coastal platforms are considered as emerged ones by uplifting or eustatic sea level dropping. Muroto Cape Peninsula was elevated 1.2 m at Nankai Earthquake and the area is judged as a remarkable elevating region with the average upheaval rate of 2 mm/year (Yoshikawa, Kaizuka and Ōta, 1964). On southern Kii Peninsula it was inferred that not only coastal terraces but also shore platforms had tilted up (Yonekura, 1968, and Takahashi, 1973a). Miura Peninsula, Tatamigaura Coast and Ōdose Coast upheaved at great Kantō Earthquake in 1923,

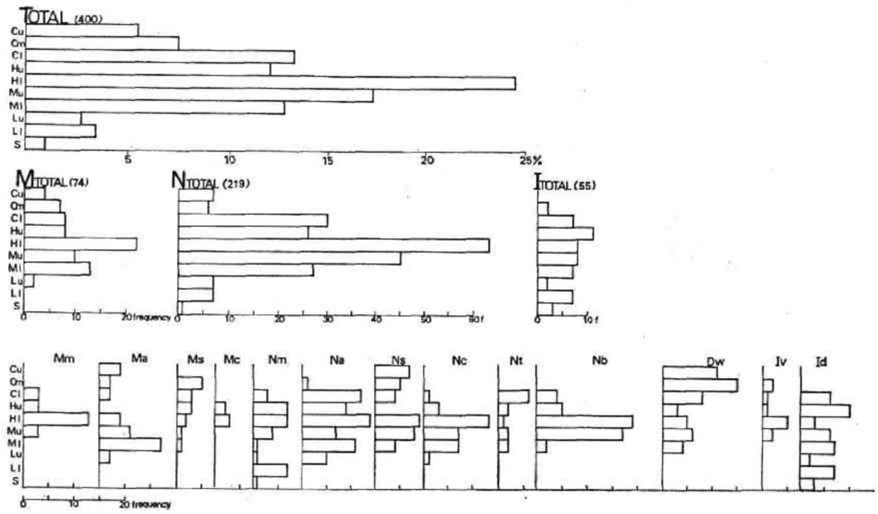


Fig. 3 Histograms of the height of platforms in each lithology

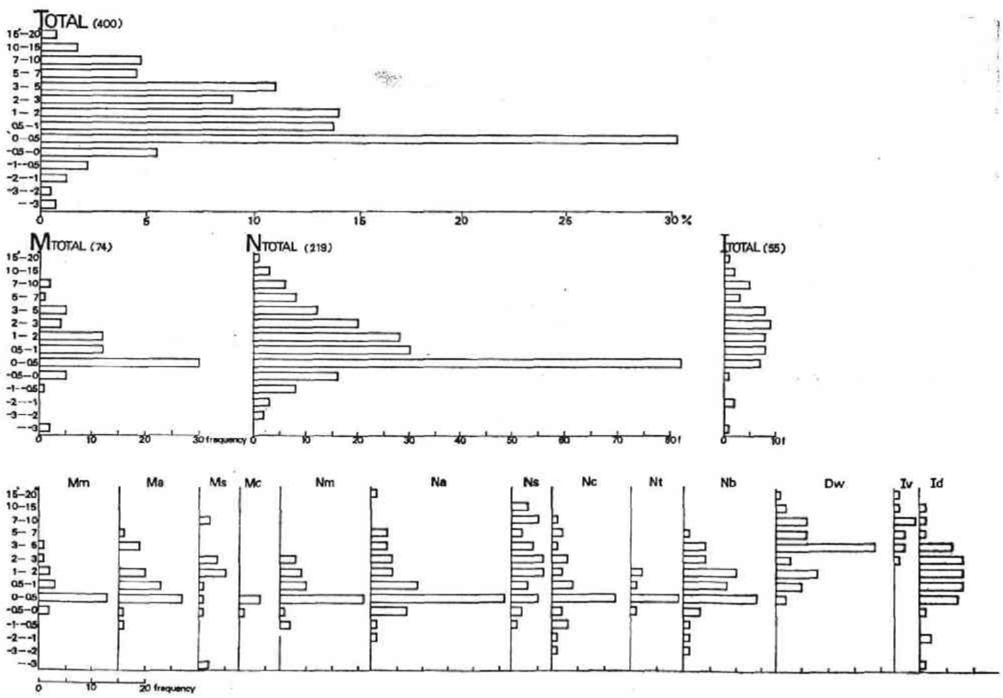


Fig. 4 Histograms of the inclination of platform profiles in each lithology

Hamada Earthquake in 1872 and Kansei Earthquake in 1793. And also, it was estimated by Sunamura (1963) that platforms on Shimoda Coast had upheaved in very recent times. On the coast along southern Satsuma Peninsula, a higher former sea level than the present was pointed out from the relation of coastal platforms and other coastal features to volcanic ash (Takahashi, 1972b). And at Nichinan Coast, it is possible to regard that coastal platforms are the product of former sea levels (Takahashi, 1973b).

Judging from these examples, the coastal platforms above high tide level has in general experienced upheaval, and the original formation level of the platforms is near the high tide level or within the upper inter-tidal zone.

Classified in each lithology, examples in some class are so little in number that exceptional cases are often exaggerated. Therefore, it is difficult to read the relation of platform height to various rocks correctly. However, roughly speaking, except some special cases such as structural or elevated ones, the platforms on igneous rocks are higher than on sedimentary rocks.

3) Inclination (Table 4 and Fig. 4–6)

Platform surface is extremely gentle in inclination and so horizontal that the most frequent class (30% of all) in the histogram of the inclination is 0°–0.5°. Such a tendency is conspicuous on sedimentary rocks, but the platforms especially the higher coastal platorms on sandstone are comparatively steep.

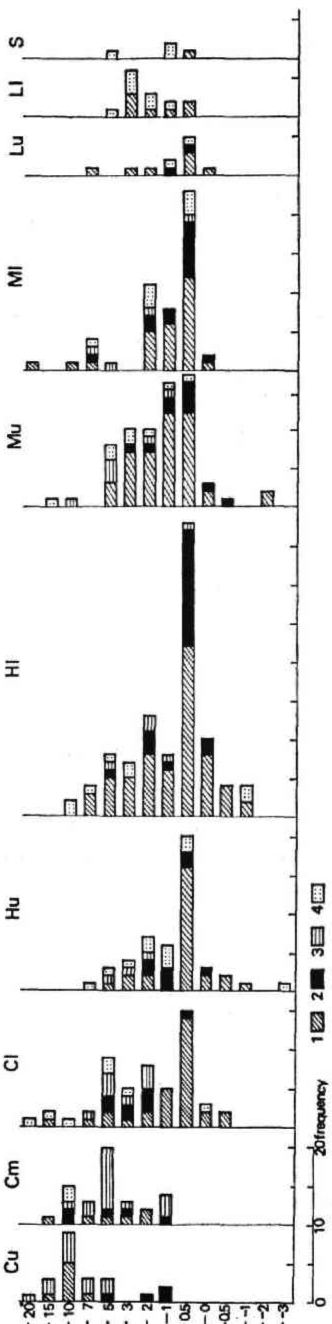


Fig. 5 Histograms of the inclination of platform profiles in each height
1: Neogene 2: Mesozoic and Palaeogene 3: welded tuff 4: igneous rock

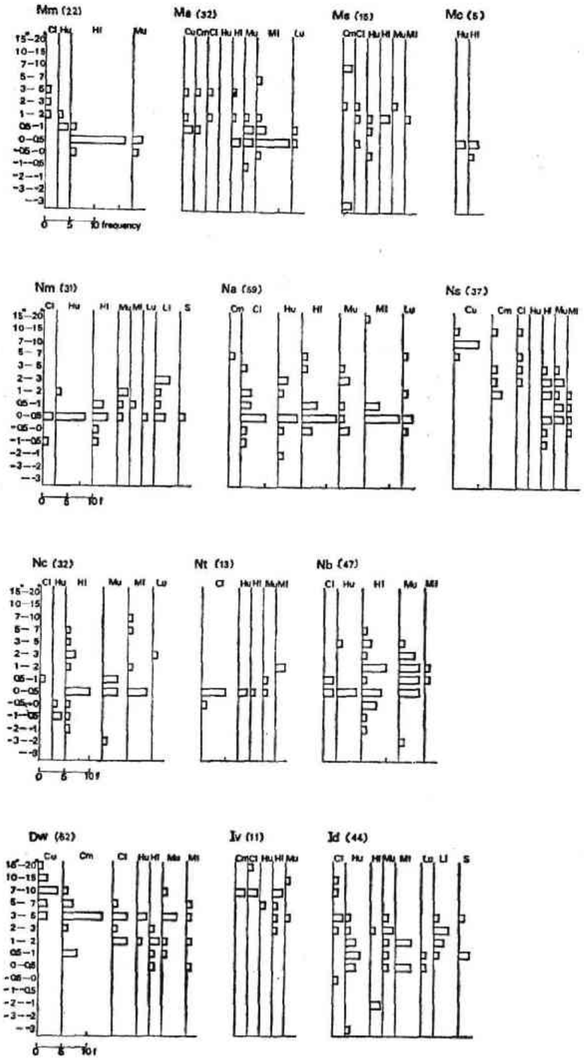


Fig. 6 Histograms of the inclination of platform profiles of each lithology in each height

Otherwise the platform surfaces on igneous rocks or welded tuff are relatively steep, and the most frequent class on andesite and basalt, or on welded tuff is 7°–10°, or 3°–5°. As stated before, the platform of welded tuff is the structural one regulated with inclined bedding plane, and most of the platforms on andesite or basalt are controlled by its structure (Takahashi, 1972a, b).

The relation of inclination to platform height is as follows (Fig. 5 and 6): Most of the platforms located near the high water level ('Hu' and 'Hu') are horizontal, as occupying the class of 0°–0.5°. And the higher the platform is, the steeper the inclination is. Such a relation is clear on the platforms of sedimentary rocks and welded tuff, but the latter is a structural one. The platforms near and below the mean sea level are slightly steeper than the high tide platforms. Such a relation is similar with the result obtained on Tanabe Bay by Mii (1962).

The fact that platform near the high water level is the most horizontal, supports the view that planation level of platform is close to the basal level of sea level weathering and in consequence horizontal platform is cut. The above fact indicates the importance of sea level weathering in platform building.

3 Classification of Simplified Profiles

By comparing the simplified profiles with one another, platform profiles are classified into 4 groups, which are subdivided with regard to their height as follows (Fig. 7):

(1) type I: horizontal platform

type I-Cl: horizontal coastal platform situated at 0.5 m above mean high water springs (near highest tide level) to 2.5 m above mean sea level (within 'Cl' in Table 2)

type I-H: horizontal high tide shore platform situated near mean high water springs (within 'Hu' and 'Hl')

type I-M horizontal inter-tidal platform situated near mean sea level (within 'Mu' and 'Ml')

(2) type II: slightly inclined inter-tidal platform

type II-H: inter-tidal platform inclining seaward above high tide level to slightly below high tide level

type II-H·M: inter-tidal platform inclining seaward from high tide level to mean sea level

type II-H·L: inter-tidal platform inclining seaward from high tide level to low tide level

type II-M·L: inter-tidal platform inclining seaward from mean sea level to low tide level

(3) type III: inclined coastal platform

type III-Cl·H: coastal platform inclining from several meters above mean sea level to high tide level (almost within 'Cl')

type III-Cl·L: coastal platform inclining from several meters above mean sea level to low tide level (almost within 'Cl')

type III-Cu·H: coastal platform inclining from about 10 m above mean sea level to high tide level

type III-Cu·Cm: coastal platform inclining from about 10 m to several meters,

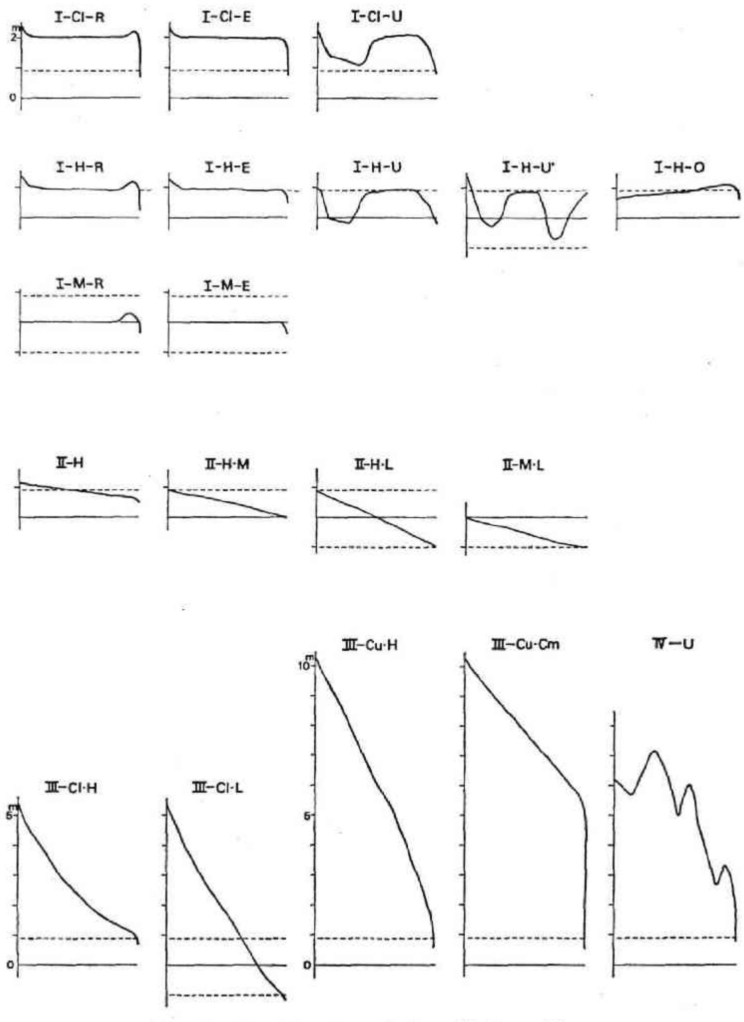


Fig. 7 Classification of simplified profiles

with seaward precipice

(4) type IV-U: rough coastal platform with extremely uneven surface between about 10 m and several meters above mean sea level

Moreover, by the state of platform surface, horizontal platforms (type I) are subdivided into:

E: horizontal platform with even surface

R: horizontal platform with even surface and seaward rampart

U and U': horizontal platform with uneven surface

Table 6 Statistical table on the types of simplified profiles in each coast

type \ coast	Hirado Island	Southern Satsuma Peninsula	Nichinan Coast	Inan Coast	Tosa-Saga Coast	Muroto Peninsula	Anan Coast	Southwestern Kii Peninsula	Southern Kii Peninsula	Omaezaki Coast	Shimoda Coast	Southern Miura Peninsula	Tatamigaura Coast	Jōdogaura Coast	Ōdose Coast	total
I-Cl-R				1							4	3			3	11
E								1	1		1				2	5
U	1							3	11			1	1	2		19
I-H-R	7		1					1	2						2	13
E	6							2	4		1					13
U	6			1	3	3	3	39	16			1	2	1	1	76
O	1			1				1	2							5
L-M-R								7								7
E								4								4
II-E	3							2	5							10
-H·M	13	2	6					5	7							33
-H·L	9	1						6		1		1	1	1		19
-M·L			1					8		4		1				14
III-Cl·H	3	20	4	1		4		3	1				1			37
-Cl·L	9	19	1					14	1			1				45
-Cm·H			3													3
-Cu·H		2	7													9
-Cu·Cm		8														8
IV-U						13										13
total	58	52	23	4	3	20	3	96	50	5	6	7	5	4	8	346

O: horizontal platform with opposite inclined surface

Types of platform, except ones around Awashima Island upheaved at Niigata Earthquake in 1964, are listed in the Annexed Sheets, and are described as follows:

1) type I-H

The horizontal high tide shore platform situated near mean high water springs suffers the sea level weathering caused by alternation of ebb and flow. The basal level for the weathering must be nearly horizontal in inter-tidal zone, because the weathering exerts little influence on the permanently dipped part, but its effect abruptly increases within the inter-tidal zone. It may better be inferred that the basal level of weathering is within upper inter-tidal zone, because the weathering needs the time enough to dry the wetted surface. It is not yet confirmable that the basal level is near high tide level. However, as platforms of this type are universal on all study coasts and many of them are near high tide level, it is reasonably concluded that the planation level of shore platform is within upper inter-tidal zone near high tide level. Besides, horizontal platforms near mean sea level are very limited (type I-M).

The impartial distribution of type I-H platforms suggests the type to be a standard one. 'High tide shore platform' in Bird's classification (1968) concerning cliffed coasts seems to accord closely with the platform of subtype I-H-E.

Some ramparts are caused by rock control (e.g. on Hirado Islands, Takahashi, 1972a) and others are not recognized rock control (e.g. on Ōdose Coast, Takahashi, 1967). The latter must be ridded of sea level weathering, because continuous splash heightens the basal level at the platform rim.

2) type I-Cl

The coastal platform of type I-Cl is similar in shape with type I-H but located higher. As situated above the highest tide level, it rarely suffers sea level weathering. If the platform is originally formed by the storm wave, its surface will have various heights, corresponding to the wave height, and will never be broad and horizontal as the wave subsides abruptly on the surface. Accordingly, it is not proper to judge that platform of this type is originally formed by the storm wave. Almost all coasts with the type has experienced upheaval as stated before. Consequently, the platform of type I-Cl had been originally formed within upper inter-tidal zone, and afterwards was elevated by crustal movement or sometimes emerged by sea level change. Accurately, it has the character of storm

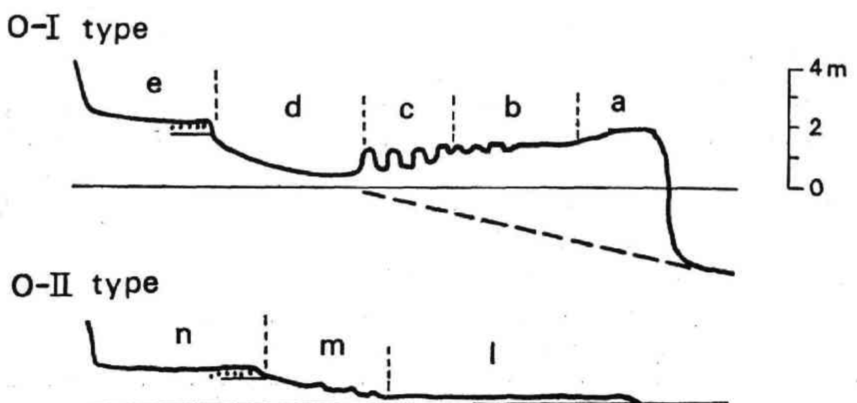


Fig. 8 Types of platforms at Ōdose, Aomori (after Takahashi, 1967)

wave platform too, because of little soil on the surface and suffering erosion at occasional storm wave.

Most of subtype-U is among type I-H and type I-Cl. This subtype has hollows backward which are washed out by wave through side furrows and lowered gradually. Such a destruction seems to connect with the abrasion at sea bottom. It is proper to judge that this subtype is in early stage of platform destruction as stated on southern Kii Peninsula (Takahashi, 1972b) and as observed on Ōdose Coast which had upheaved at the Kansei Earthquake in 1793 (Fig. 8–O-I type, Takahashi, 1967).

3) type I-M

This type is peculiar to the southwestern Kii Peninsula. Correlating the displacement of coastal terraces to the precise relevelling, the coast was judged to have subsided relatively (Yonekura, 1968). The height of raised shoreline on coastal terraces and the level of shore platforms are in the same tendency of crustal movement (Takahashi, 1973a). However, there are not yet other evidences to confirm that the platform lowered from the high tide level into the mean sea level by crustal movement. More studies are necessary about the cause of such platform level.

4) type II

Platform of this type inclines very slightly from a level to another lower level within inter-tidal zone, but some platforms with long profile are nearly horizontal, and accordingly, are similar to the high tide platform in shape. Some platforms have seaward rampart. It is considered that the platform of type II-H·L accords with 'inter-tidal shore platform' by Bird (1968).

As there are some polished gravels in places on the platform surface, it is not unreasonable to judge that not only sea level weathering but also abrasion have influenced the surface. Though sea level weathering must have played a principal role at the formation of the high tide shore platform, it is impossible to explain that every platform was caused by sea level weathering. About the formation of the inter-tidal shore platform, the role of the abrasion by wave crossing over the surface ought to be taken up seriously, because of its seaward-inclined surface and polished gravels thereon (Takahashi, 1972a).

The platforms of type II-M·L are distributed on Omaezaki Coast and southwestern Kii Peninsula on which relative subsidence is inferred (Takahashi, 1973a). On Omaezaki Coast, too, recent subsidence of land was reported from relevelling. However, it is impossible as yet to decide whether platforms of such level were lowered by crustal movement or not.

5) type III

Most of the inclined coastal platforms classified into type III are those on the igneous rock coasts or on the uplifted coasts. All platforms of type III on southern Satsuma Peninsula are the structural ones regulated by the bedding plane of welded tuff, and some of which have the precipices controlled by joint plane at frontal rim (type III-Cu·Cm). It was discussed, through the relation of some coastal features and covering volcanic ash, that they may have formed in maximum phase of transgression in the Recent (Takahashi, 1972b). On the other hand, the inclined coastal platforms on Nichinan Coast (III-Cu·H) are the non-structural ones carved on a thick monoclinal bed of sandstone. About those platforms, too, the possibility of the formation at higher former sea level have been discussed (Takahashi, 1973b).

On Hirado Island platforms of this type are composed of igneous rocks and most of them are controlled with their structure. And also most of those on southwestern Kii have been regulated by the structure of sandstone.

Accordingly, it is arranged that the inclined coastal platforms of type III include one regulated by lithology and geological structure, and another caused by relative subsidence of sea level. And they are still suffering influence by storm wave.

6) type IV-U

Only platforms on Muroto Cape belong to this type. They are characterized with both elevated platform and storm wave coastal platform with remarkably rough relief attacked by violent storm wave.

Problems of Platform Formation

1 Planation Level of Shore Platform and Agency of Platform Formation

As stated before, many shore platforms are within upper inter-tidal zone near the high tide level at almost every study coast. This fact suggests that planation level of shore platform is situated within upper inter-tidal zone or near the high tide level.

Sea level weathering is caused by alternation of wet and dry, changes of temperature or humidity, which happen within inter-tidal zone, and it is an important agent for platform formation. The basal level for sea level weathering may correspond to the low tide level. The most effective sea level weathering, however, must be within upper inter-tidal zone, because the upper limit of soaking in rocks falls in retard with ebb tide and the alternation of wet and dry for the active sea level weathering is expected at the comparatively higher level. And the planation level of shore platform is nearly at the level of the most active sea level weathering.

High tide shore platform is more horizontal than other platforms, as described before. This corresponds with the fact that the planation level caused by sea level weathering is horizontal. At the high tide, wave passes over the surface of high tide shore platform and carries away weathered debris from the surface, and keeps it horizontal.

Hence, it is judged that the planation level of horizontal shore platform is situated within upper inter-tidal zone near the high tide level.

Mii (1962) thought the platform within upper inter-tidal zone at Tanabe Bay as elevated. However, it is not proper to judge that every high tide shore platform is always originated only from elevation. Shore platform within inter-tidal zone is actually suffering the sea level weathering, which has lowered it to the planation level in a short time, even if it was once raised above the planation level.

The level of the active sea level weathering differs in height by lithology. Among Nichinan Coast which consists of sandstone-mudstone alternation, the platform at Yōkōen with thick mudstone and very thin sandstone is lower than other parts (Takahashi, 1973b).

With inter-tidal zone, there are different kinds of platform, besides high tide shore platform. Slightly inclined inter-tidal shore platforms extend across the shore zone, and sometimes beneath the sea without remarkable nip. They have polished gravels in places, and some of them are covered with gravel beach behind them. As to the formation of such platforms, the role of wave abrasion ought to be added (Takahashi, 1972a). Inter-tidal shore platform is accordingly a little lower than high tide shore platform, and it is gradually lowered with the increase of abrasion.

Horizontal high tide shore platform at promontory changes gradually to inclined inter-tidal shore platform at bayhead (Takahashi, 1972a). Although both platforms continue, they are formed at different levels and with different features. At promontory, high tide shore platform and submarine abrasion platform adjoin each other with remarkable nip. On bayhead, inter-tidal shore platform connects to submarine platform without remarkable staircase. Inter-tidal shore platform stands in contact between shore platform and submarine platform.

2 Higher Platforms

Higher platforms above highest tide level are not usually dipped with seawater, but temporarily exposed to storm wave, water splash, rain wash, or wind, and properly called storm wave platform.

Most structural platforms are situated at higher level. Storm wave rushes up to the fairly higher level along the structural boundary, eroding weak layers easily. Structural platforms composed of igneous rock are above highest tide level around Hirado Island (Takahashi, 1972a). Structural platform is a kind of storm wave platform.

However, most coastal platforms are not always originated by the present storm wave. There are higher coastal platforms with fossil notches and caves as the evidences of former higher sea level at Cape Muroto, which are properly judged to be upheaved platforms (Takahashi, 1974b). The platforms around southern Kii Peninsula are concluded also to have been upheaved by crustal movement (Takahashi, 1973a).

Some higher platforms are products of upheaval at earthquakes, such as on Cape Muroto at Nankai Earthquake (1946), on Miura Peninsula at Great Kantō Earthquake (1923), on Tatamigaura, San-in, at Hamada Earthquake (1872), on Ōdose, Aomori Prefecture, at Kansei Earthquake (1793).

Higher coastal platforms on southern Satsuma Peninsula are concluded to have been originated at the former higher sea level from the relation of some coastal features and volcanic ash, notwithstanding that they are structural platforms regulated by geological condition of welded tuff (Takahashi, 1972b). Along Nichinan Coast there are coastal platforms with relatively steep slope in the range of 2–13 m above mean sea level. They are regarded as the product of former sea level from their correspondence to other emerged landforms (Takahashi, 1973b).

It is appropriate to judge that most higher platforms are elevated ones by crustal movement or by sea level dropping, while they are storm wave platforms still exposing to storm wave, rain wash, or wind. Therefore, in order to examine crustal movement or sea level change in Recent, it is important to study higher platform.

3 Planation Age of Platforms

In order to decide the planation age of platforms, various methods will be tried, as the method has not been firmly founded as yet.

It is effective to infer the formation age from the relation of platform and deposits covering it. The history of coastal evolution on southern Satsuma Peninsula was compiled, from the relation of several coastal features and volcanic products with some radiocarbon ages measured, that higher coastal platform several meters above sea level was originated in the maximum phase of transgression in Recent (Takahashi, 1972b). However, ordinarily such useful deposits covering platform are too scarce to find, and it is difficult to infer the age from exposed surface.

With the advance of coastal terrace studies, the displacements of former shoreline are much clarified. The vertical displacement of former shoreline, representing the tendency of the late Quaternary crustal movement, is believed to continue till present. Shore platforms suffering the same crustal movement, must have been upheaved. Platforms on southern Kii Peninsula have the different levels in localities, corresponding to the vertical displacement of coastal terrace. From the correlation of both displacements, it is estimated that the platforms have originated since two thousand several hundred to two thousand years ago (Takahashi, 1973a). This age approximates Fairbridge's Abrolhos stage, and Toyoshima's estimation. Toyoshima (1968) estimated, based on archaeological materials, that the platform at Hashigui-iwa had been formed since 3,000 years ago.

The author tried to infer the planation age of platforms around Cape Muroto, based on the same view point (Takahashi, 1974b). From the result of relevelling after the earthquake and the height of Monastirian shoreline restored by coastal terraces, the upheaval rate of Cape Muroto is calculated 2 mm/year. Platforms are thought to have been upheaved in the same rate. Then, if the upheaval curve with the rate of 2 mm/year is superposed on Fairbridge's curve (1961) of eustatic sea level change, the planation of platforms 4–4.5 m above the present sea level is aged 3,000–2,000 years ago. Fairbridge's chronology is not always agreeable with views of other investigators, but it seems to accord relatively with some facts indicating eustatic sea level change in alluvial plain of Japan (Iseki, 1974). Therefore, for the present it is comparatively appropriate and convenient to use Fairbridge's chronology.

If the platforms are upheaving with the rate less than secondary lowering rate, they are always lowered by denudation acting near the sea level and never emerge above the high tide level. On the other hand, the platforms must be rapidly emerged in order to keep their initial surfaces. Combined the above two inferences, 'submergence' and the succeeding 'emergence' are necessary for formation and keeping of platform. Adopting this view, platform planation are aged from the eustatic sea level change curve as follows: 6,000–3,500 years, 3,000–2,000 years, and 1,500–0 years ago. Possibly corresponding to these ages, two levels of the emerged coastal platforms and one of the present shore platform are seen around Cape Muroto.

Extending the above-mentioned, it is concluded that there are in general two levels of elevated coastal platforms, whose origins are in 6,000–3,500 years and 3,000–2,000 years ago respectively. The height of platforms is various according to the crustal movement particular in each coast. But from some regional studies, the coastal platforms of several meters to about 10 m in height were originated in the former age, and those below several meters were formed in the latter age (Table 7).

The platforms with recorded upheaval at earthquake, such as on Miura

Table 7 Correlation of coastal platforms

region \ age	6,000–3,500 years B.P.	3,000–2,000 years B.P.
Southern Satsuma Peninsula	higher platform (several meters) (emerged caves at Ishigaki (3-5 m))	middle platform (1–2 m)
Nichinan Coast	Udo-type platform (2–10 m) (emerged cave at Udo Shrine coastal terraces at Kinchaku Island (several-10 m))	previous platform covered with sand deposits at Aoshima Island (about 1 m)
Muroto Cape	10 m coastal platform (several-10 m) (emerged caves at Mikurodo (11–16 m))	4 m coastal platform (several meters) (emerged notch at Gyōzuinoike (3–5 m))
Southern Kii Peninsula	(6 m raised beach at Tanabe Bay*)	1 m platform at the southern part (1–2 m) (2 m raised beach and platform at Tanabe Bay*)
San-in	(emerged platform (7–10 m) and caves (5 m)**)	1.5 platform at Jōdogaura (1–2 m) (2.5 m emerged platform**)

* after Mii (1962) ** after Toyoshima (1967)

Peninsula, on Ōdose Coast, or on Tatamigaura Coast, are not to be thought as the product by the very earthquake only, but by the continuous elevation for a long time.

4 Platform Destruction

Suffering secondary erosion by wave, rain wash, or wind, platforms, especially elevated platforms, are gradually lowered or destroyed. Secondary erosion not only lowers all over the surface, but also destroys the frontal part, enlarging furrows, cutting notches or caves, and the rear part is denuded by wave rushing through furrows.

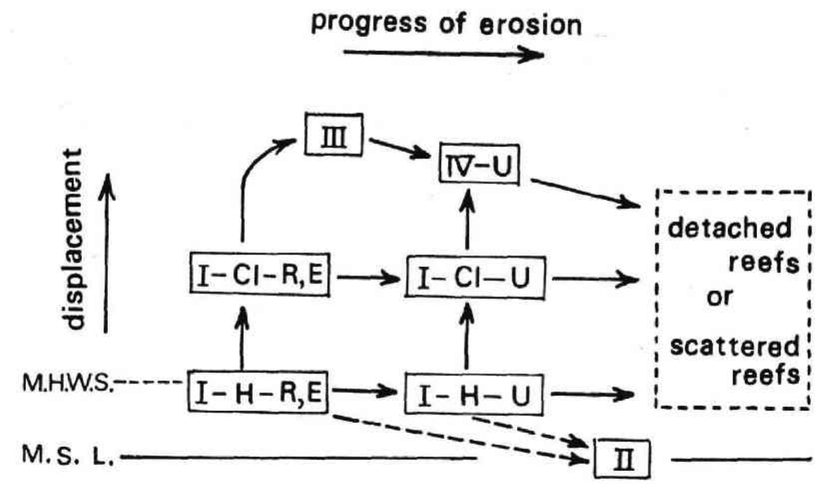


Fig. 9 Evolution of the types of simplified profiles

When the inter-tidal shore platform is lowered all over the surface, the platform gradually approaches to the submarine abrasion platform.

The horizontal platform experiences other process of destruction. Deeply carved from the seaward rim by wave furrows, cut into pieces in the frontal part, the platform at last has more rugged relief or transforms into a group of scattered reefs.

Submarine notches and caves at the foot of seaward nip are gradually enlarged by wave action, overhanging rocks become unstable and are plucked down into the sea in front of platform, such as observed on southern Satsuma Peninsula (Takahashi, 1972b).

If the rim of platform is resistant in lithology, the platform is not easily carved from the front, but it is cut from the back by wave and washout through side furrows, and the inside lowers gradually. Splashed water and rain water attacking the front flushes landward onto the lowered inside, and the surface gets inclined landward and later, when the inside is deeply dug, the frontal part remains as a detached reef. The above destruction is clearly represented in subtype-U of simplified profiles.

From the above mentioned point of view, the sequence of profile change is arranges as in Fig. 9. It is possible to judge the platform in process of destruction through platform profile.

The author is deeply indebted to Professor Kasuke Nishimura of Tōhoku University for his continuing guidance and encouragement. It is a pleasure to acknowledge the hospitality and encouragement of Professor Toshio Noh and the staff of Institute of Geography, Faculty of Science, Tōhoku University. The author also would like to express his appreciation to Professor Ken-ichi Tanabe of Miyagi University of Education, Dr. Akio Mogi of the Hydrographic Department, Maritime Safety Agency in Japan, Professor Masatami Nakayama of Saitama University and the late Dr. Hideo Mii for their many helpful suggestions. Thanks are also presented to Mr. Masashi Shimoyama, Mr. Seiichi Kawada, Mrs. Yoshiko Murakami, Mrs. Kazuko Muro, Miss Eriko Kawakami and Miss Yōko Hayashi for their assistance in field work and drawing of figures.

References (* in Japanese)

Bird, E.C.F. (1968): Coasts. Australian National Univ. Press, Canberra

Fairbridge, R.W. (1961): Eustatic Changes in Sea Level. Physics and Chemistry of Earth **4** 99–185

Kumon, H. (1961): On the Distribution and the Formation of Wave-cut Benches near Tanabe Bay, Wakayama Prefecture.* Graduation Thesis Osaka Gakugei Univ.

Mii, H. (1972): Coastal Geology of Tanabe Bay. Sci. Reps. Tōhoku Univ. 2nd Ser. (Geol.) **34** 1–93

——— (1963): Relation of Shore Erosions to Sea Level.* Jour. Mar. Geol. **2** 8–17

Sunamura, T. (1964): On the Mechanism of the Wave-cut Bench Formation near Shimoda, Shizuoka Prefecture. Graduation Thesis Tokyo Kyōiku Univ.

Takahashi, T. (1965a): Measuring the Heights of Elevated Coast along the Awashima Island Caused by the Niigata Earthquake.* Study Reps. Baika Women's College **14** 55–62

——— (1965b): Shore Profiles along the Awashima Island, Niigata Prefecture.* Study Reps. Baika Women's College **14** 63–72

——— (1967): The Morphological Studies on the Emerged Shore Platforms.* Annals Tōhoku Geogr. Assoc. **19** 53–60

——— (1972a): A Geomorphological Study on Wave-cut Benches along the Coast of Hirado Island, Kyūshū.* Bull. Educ. Okayama Univ. **33** 83–99

——— (1972b): Coastal Geomorphology of the Southern Coast of the Satsuma Peninsula, Kyūshū, Japan.* Geogr. Rev. Japan **45** 267–282

——— (1973a): Formation and Evolution of Shore Platforms around Southern Kii Peninsula. Sci. Reps. Tōhoku Univ. 7th Ser. (Geogr.) **23** 63–89

——— (1973b): Shore Platforms and Coastal Platforms along Nichinan Coast, Southern Kyūshū. Sci. Reps. Tōhoku Univ. 7th Ser. (Geogr.) **23** 119–133

——— (1974a): Distribution of Shore Platforms in Southwestern Japan. Sci. Reps. Tōhoku Univ. 7th Ser. (Geogr.) **24** 33–45

——— (1974b): Level and Age of the Planation of Emerged Platforms near Cape Muroto, Shikoku. Sci. Reps. Tōhoku Univ. 7th Ser. (Geogr.) **24** 47–58

Toyoshima, Y. (1956): On Wave-cut Benches along the South Coast of the Miura Peninsula, Kanagawa Prefecture.* Geogr. Rev. Japan **29** 240–252

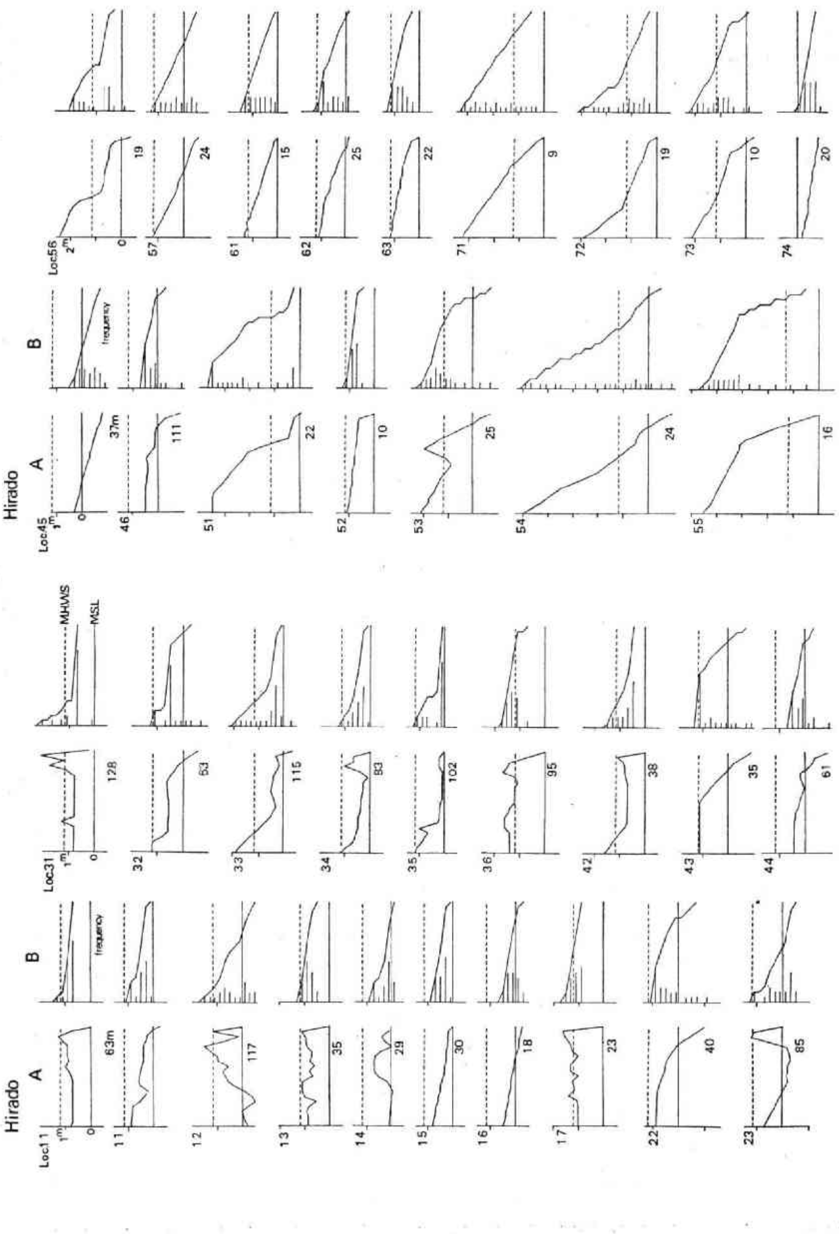
——— (1967): A Study on Marine Erosive Features along San-in Coast.* Jour. Facul. Edu. Tottori Univ. (Natural Sci.) **18** 64–98

——— (1968): Abrasion Platform and Wave-cut Bench at Kushimoto-Machi, Wakayama Prefecture.* Jour. Facul. Edu. Tottori Univ. (Natural Sci.) **19** 41–48

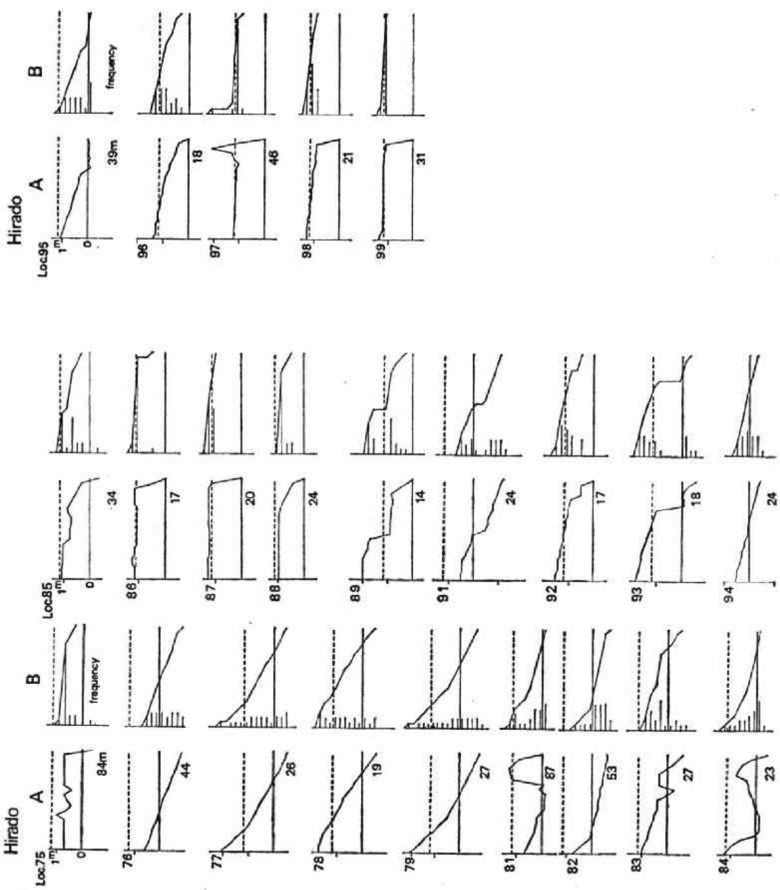
Yonekura, N. (1968): Geomorphic Development and Mode of Crustal Movement on the South Coast of the Kii Peninsula, Southwestern Japan.* Jour. Geogr. Tokyo Geogr. Soc. **77** 1–23

Yoshikawa, T., Kaizuka, S. and Ōta, Y. (1964): Mode of Crustal Movement in the Late Quaternary on the Southeast Coast of Shikoku, Southwest Japan.* Geogr. Rev. Japan **37** 627–647

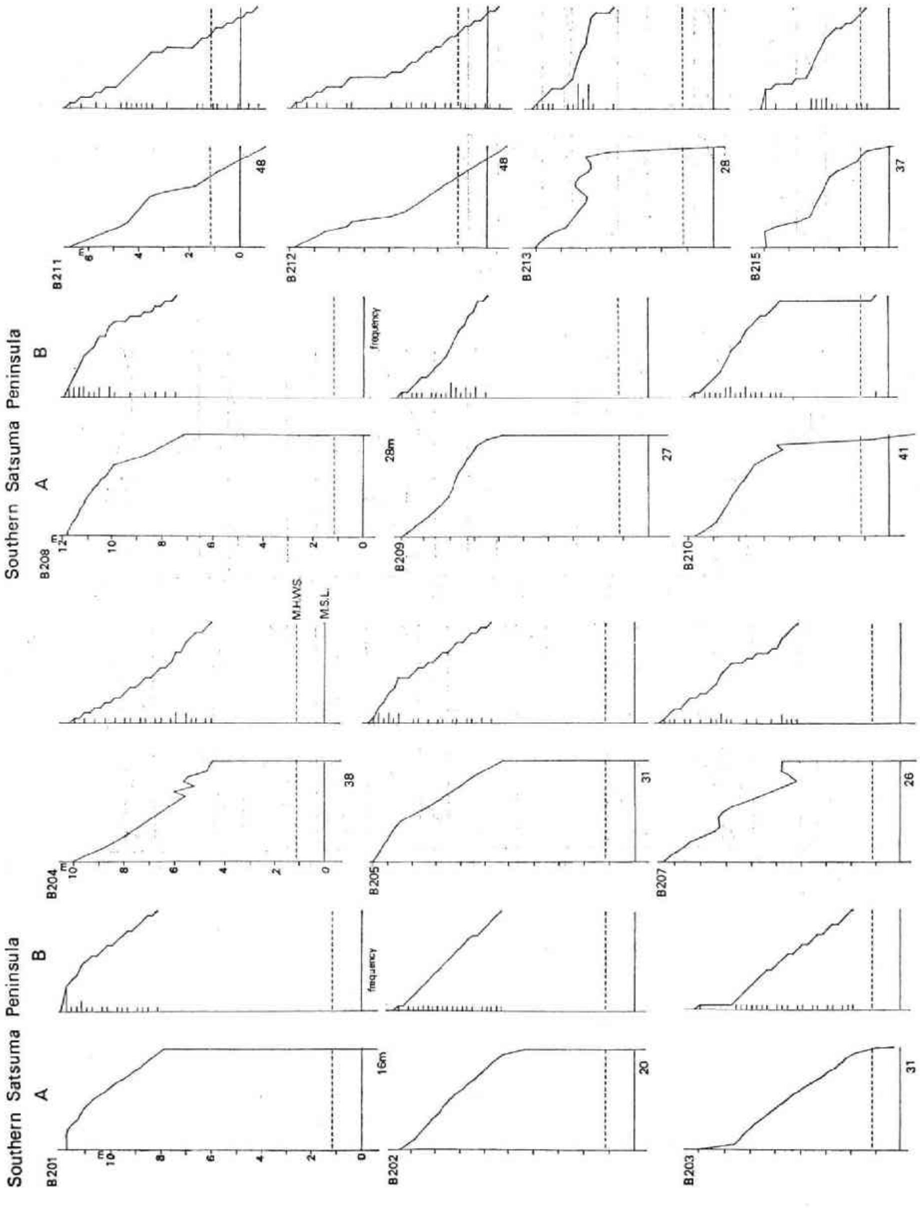
Annexed Figures Simplified profiles and height frequencies of shore platforms and coastal platforms



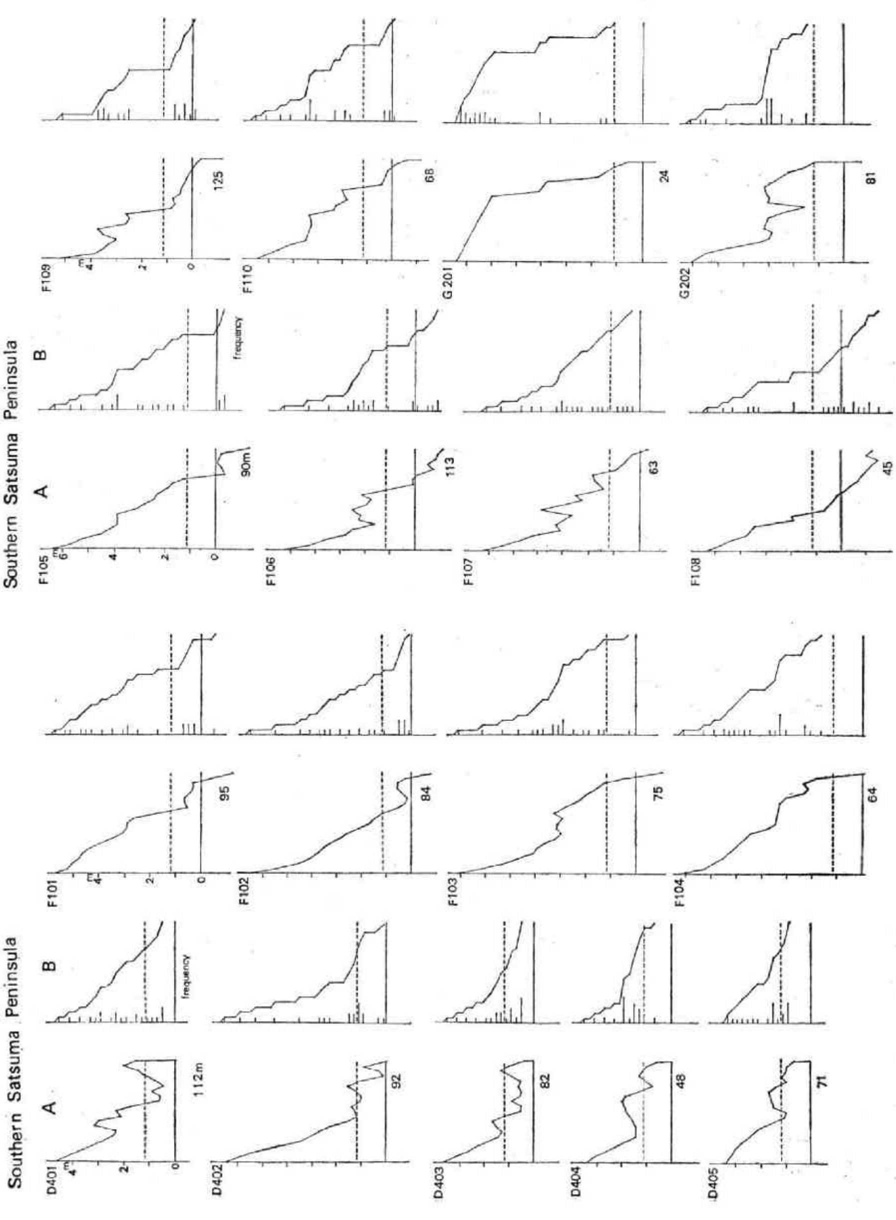
Annexed Figures 1



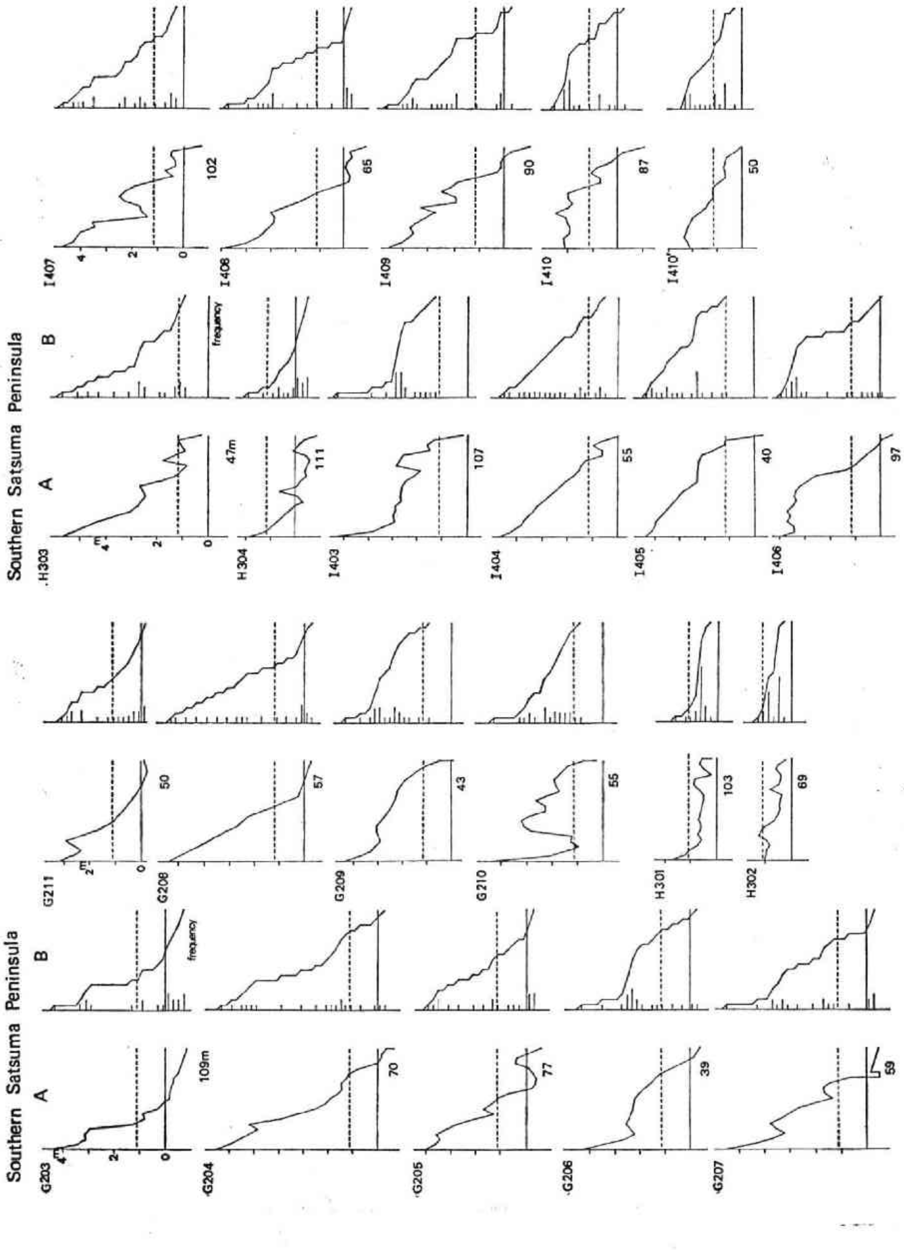
Annexed Figures 2



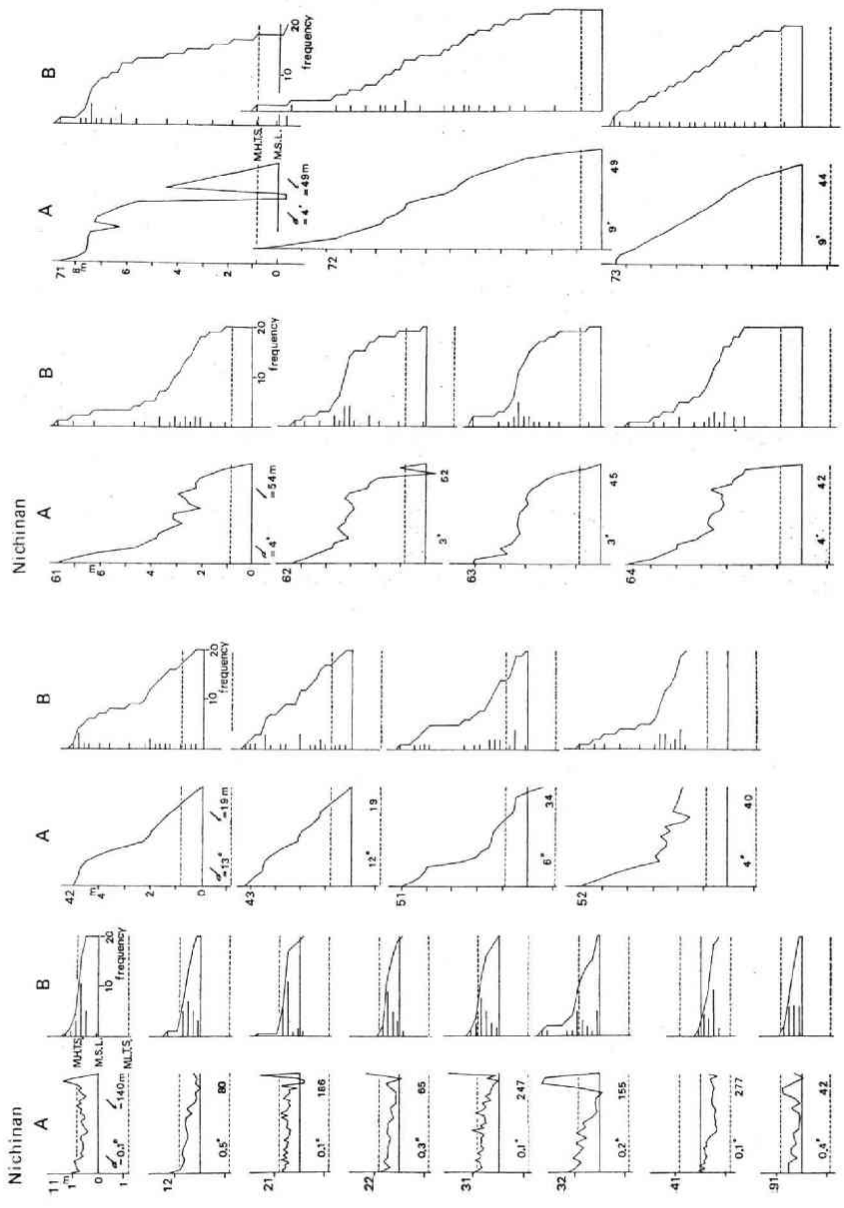
Annexed Figures 3



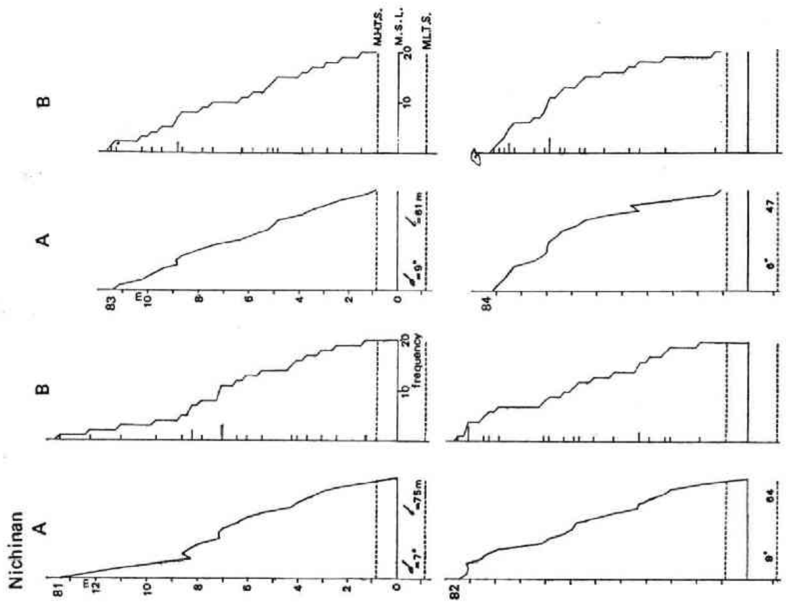
Annexed Figures 4



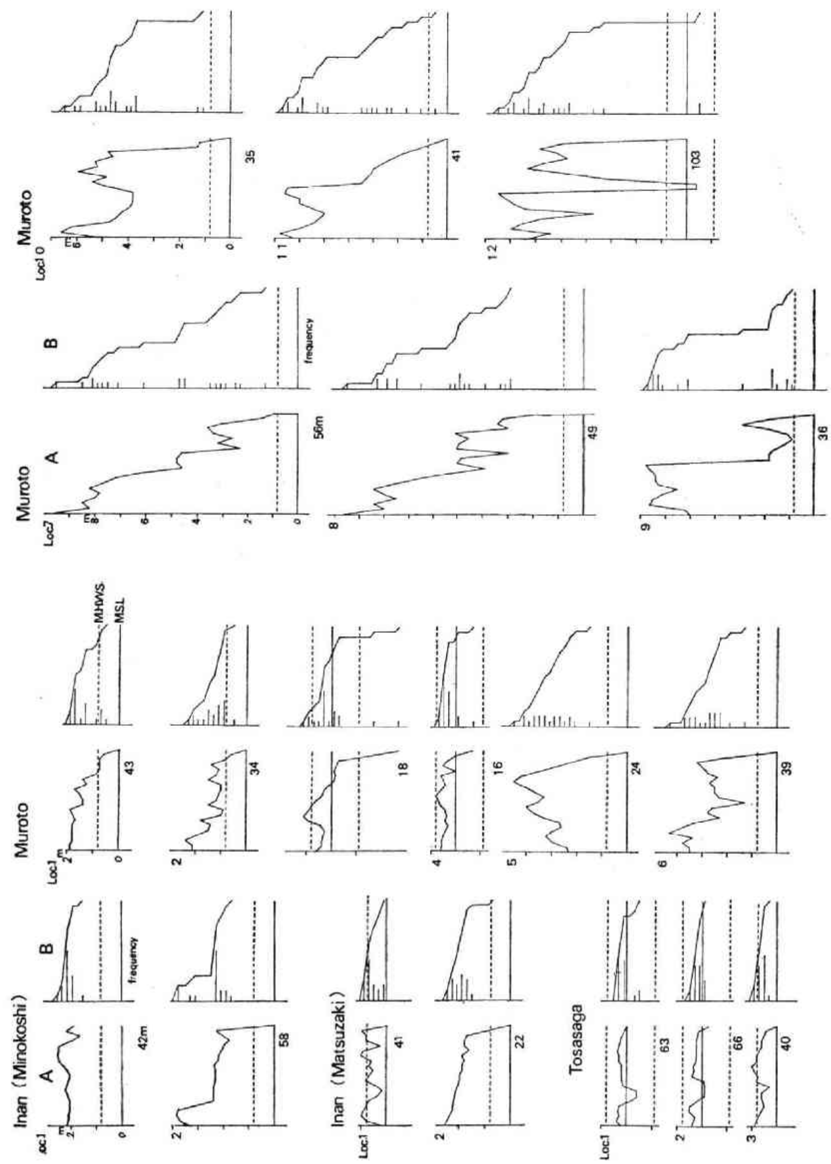
Annexed Figures 5



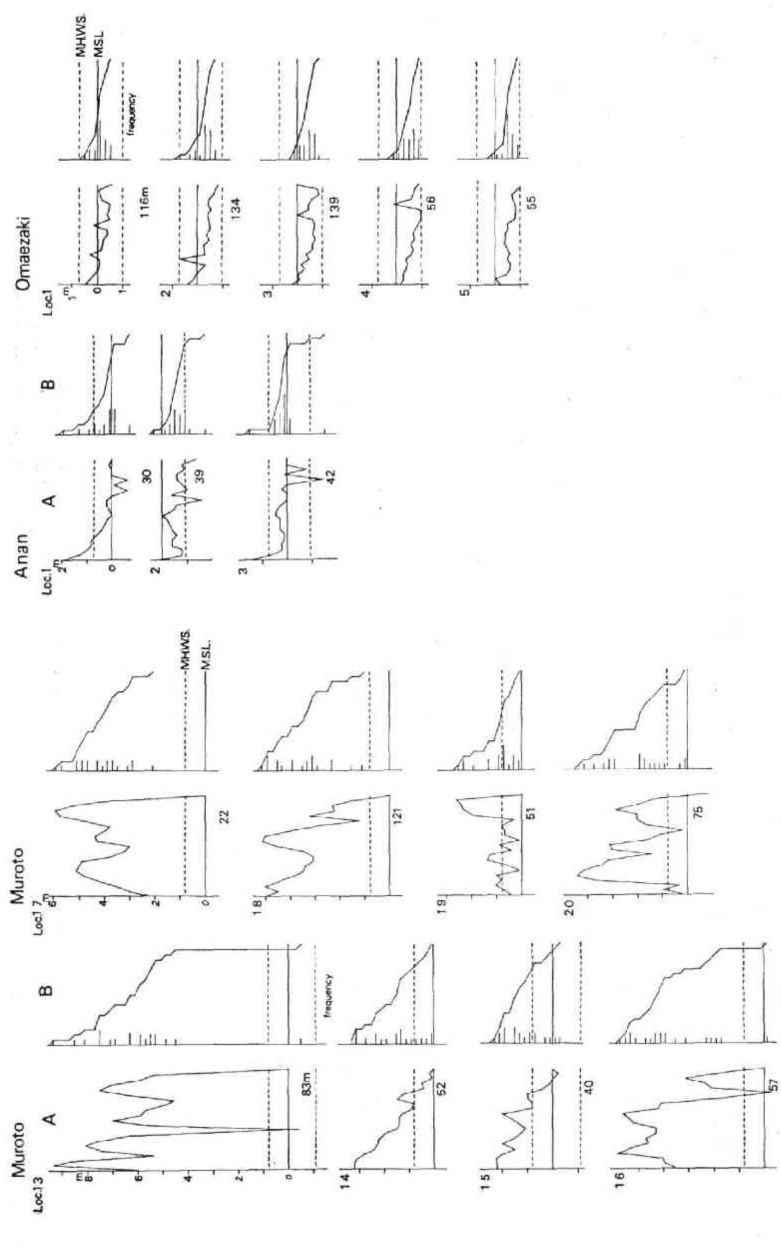
Annexed Figures 6



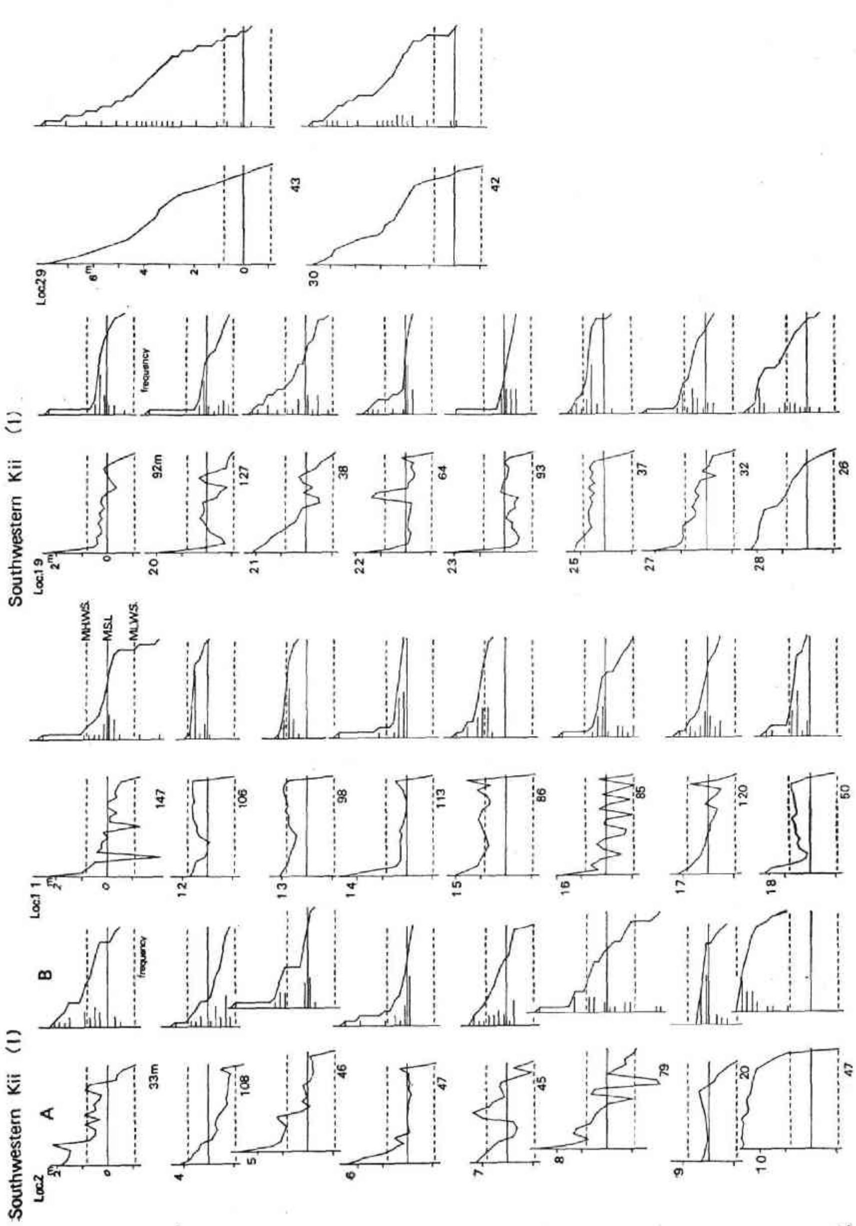
Annexed Figures 7



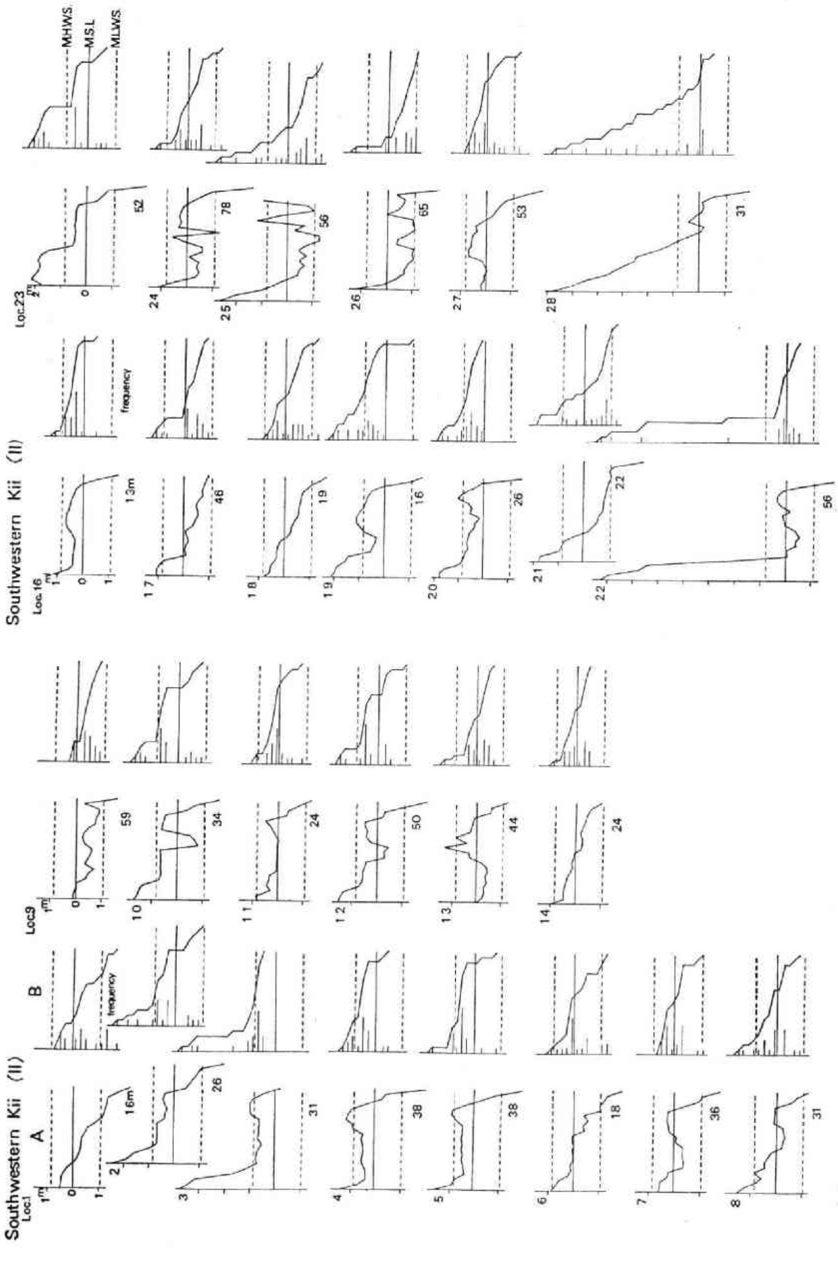
Annexed Figures 8



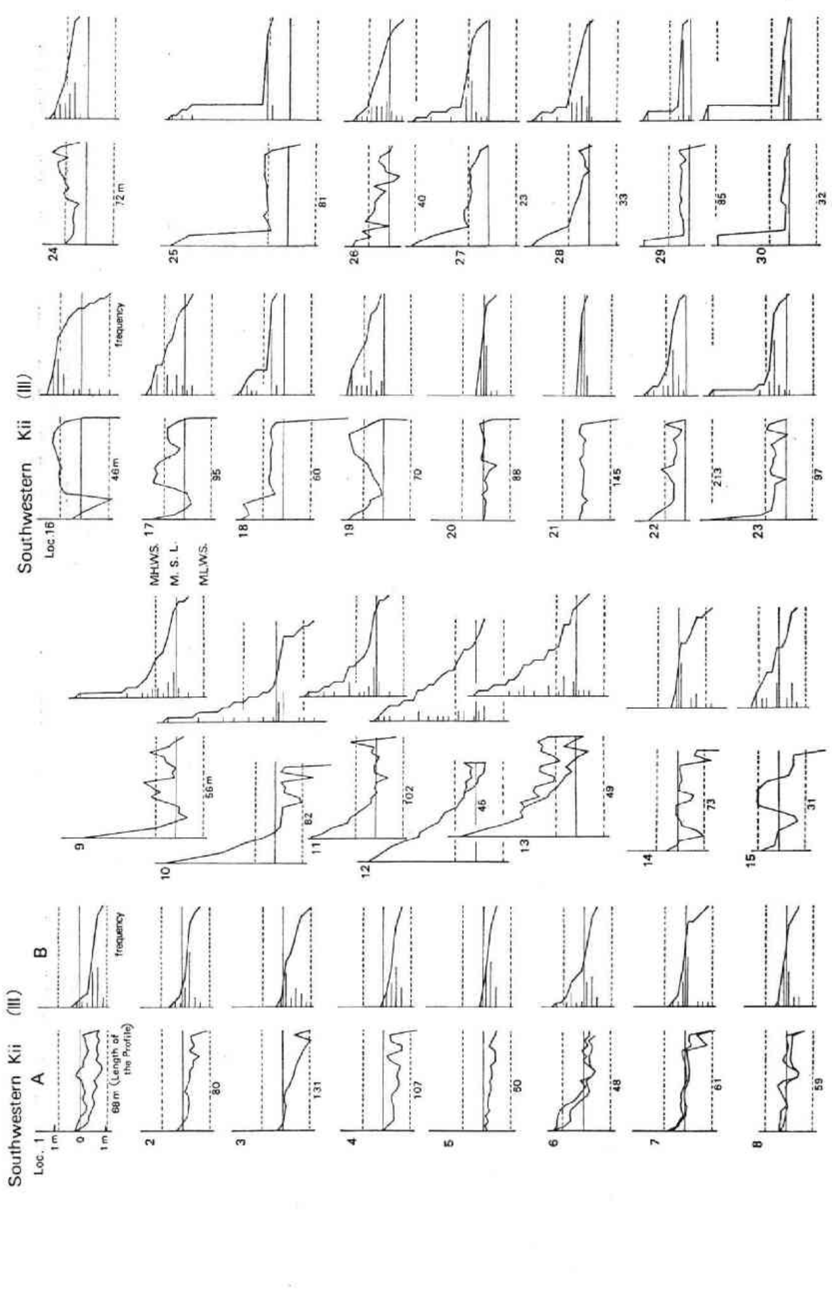
Annexed Figures 9



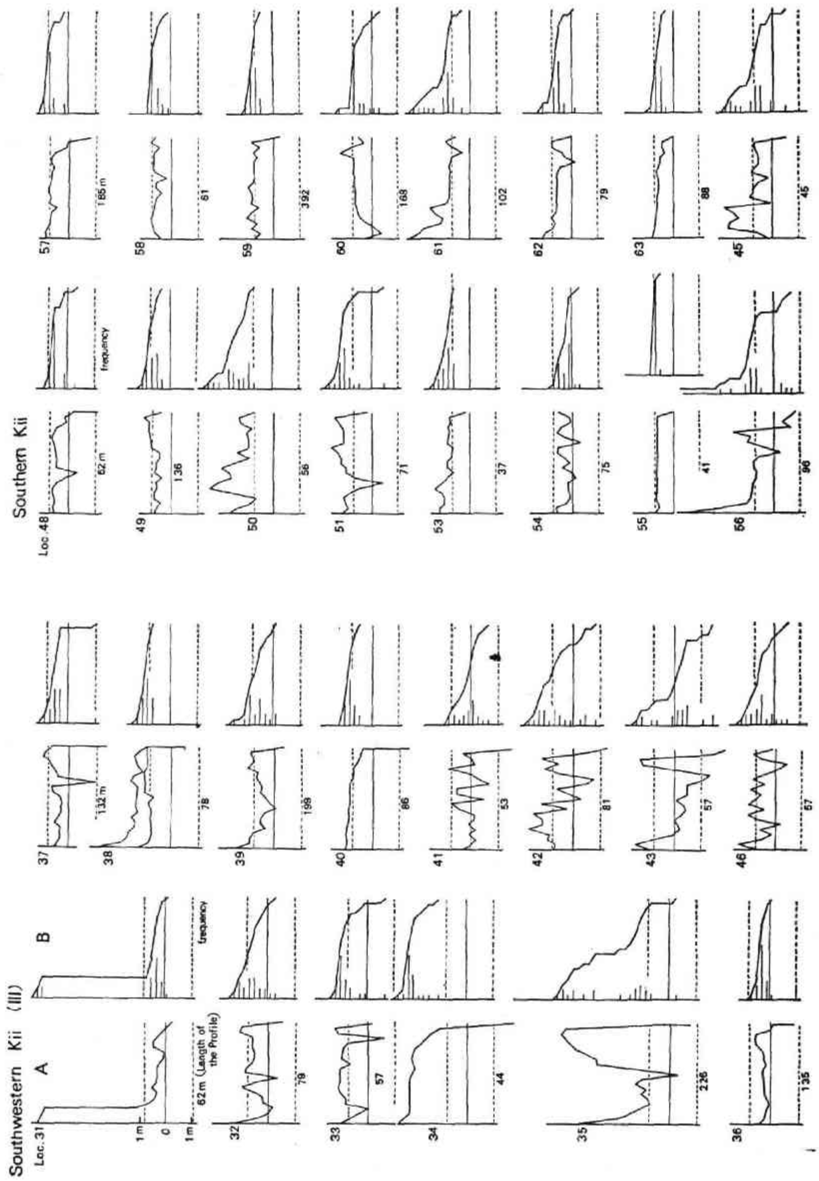
Annexed Figures 10



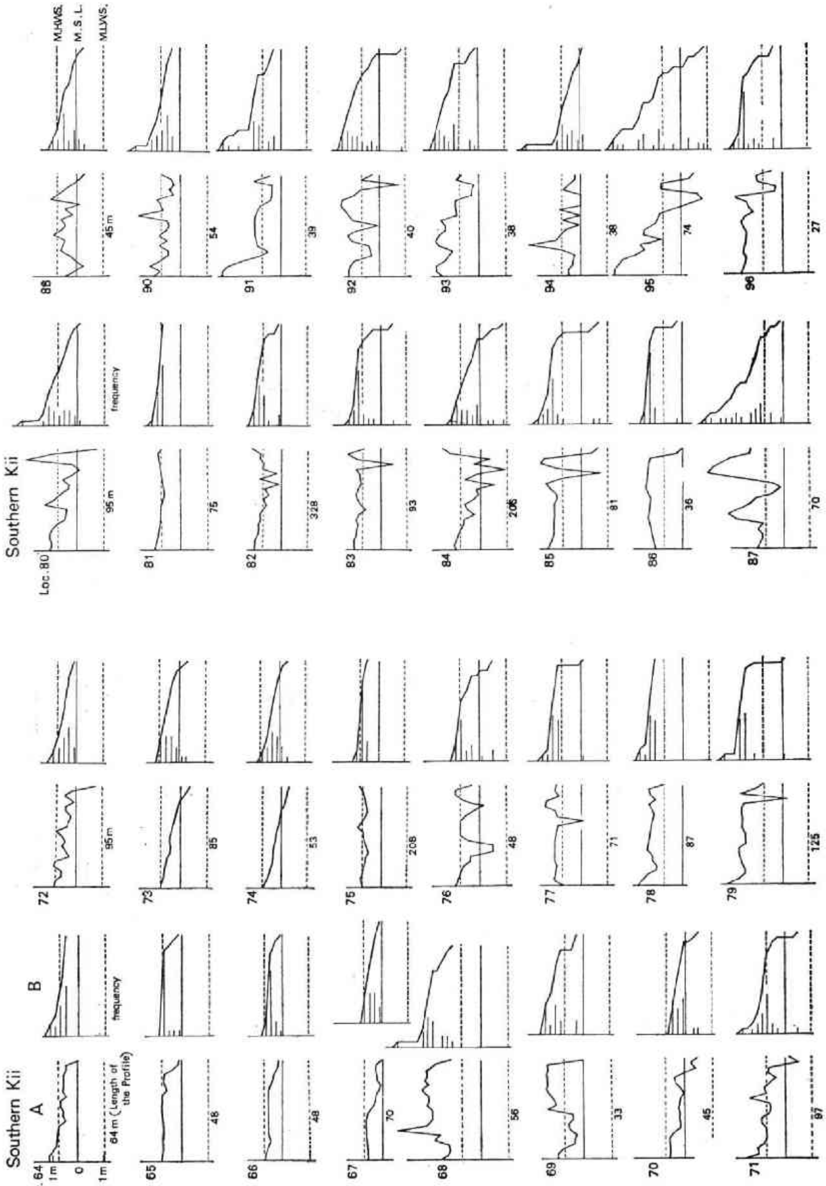
Annexed Figures 11



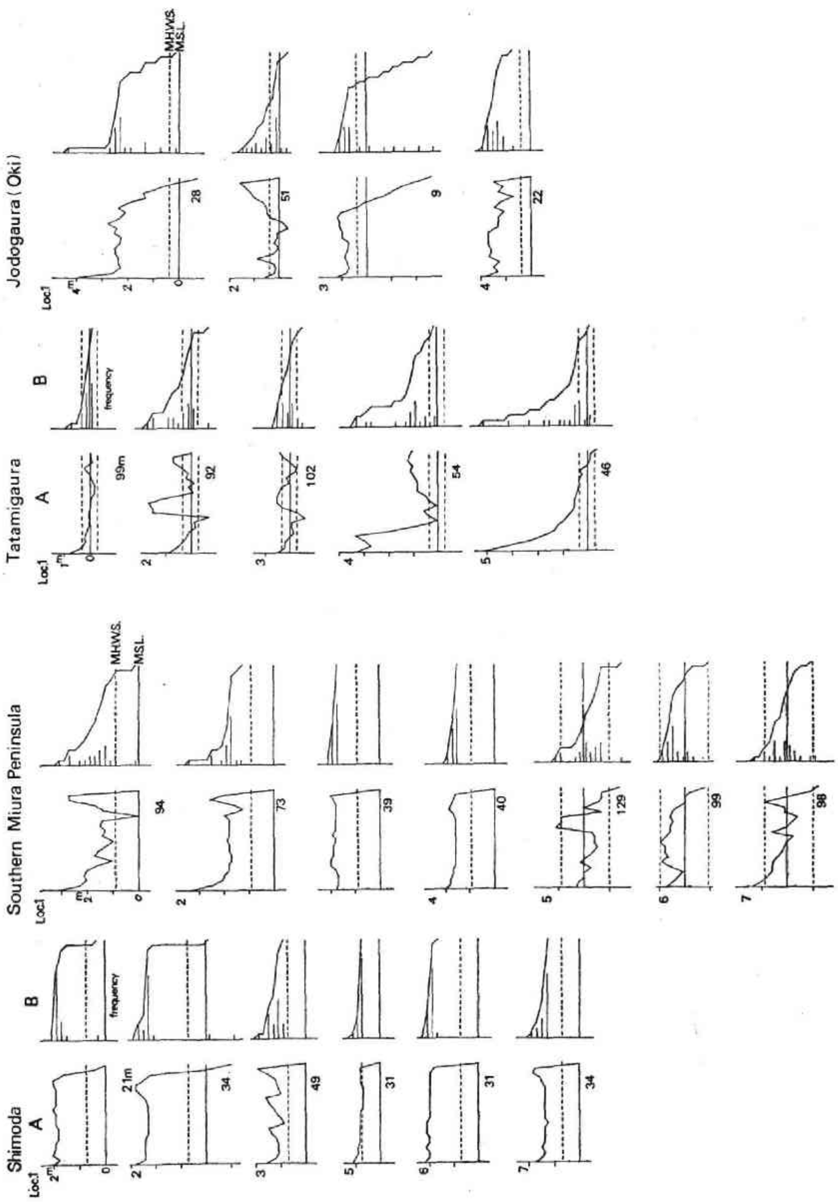
Annexed Figures 12



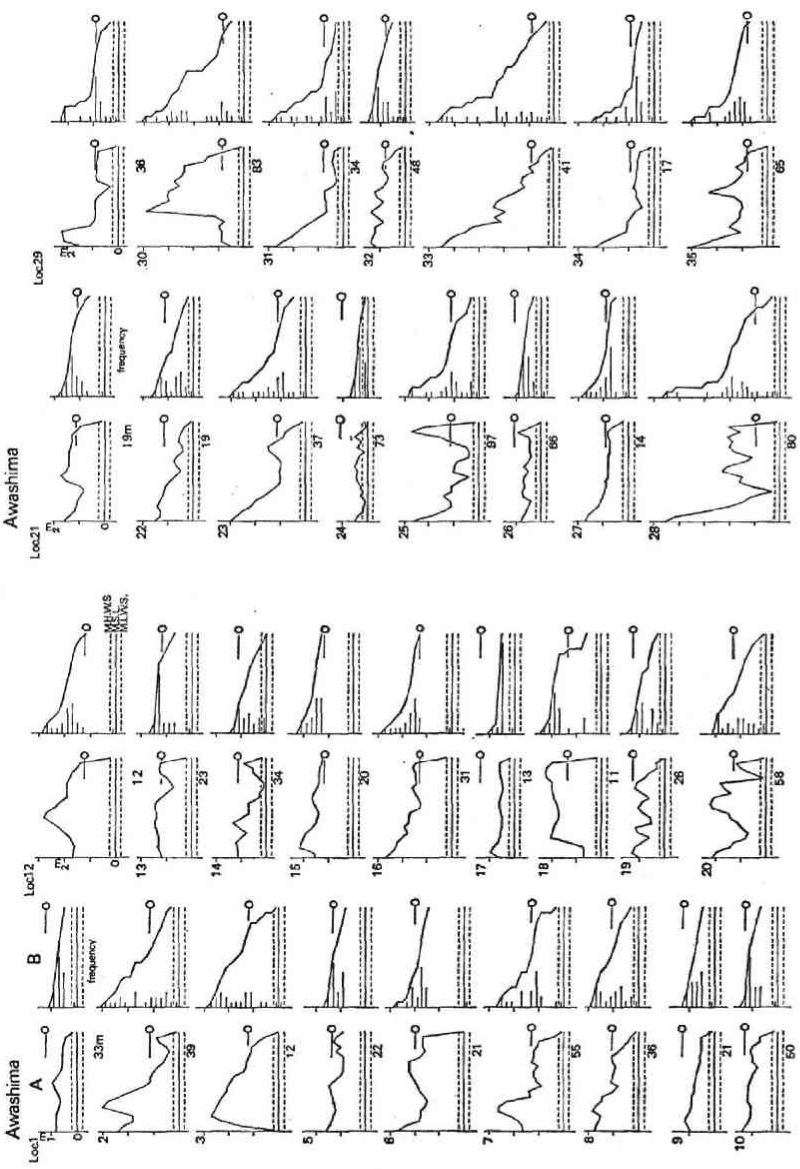
Annexed Figures 13



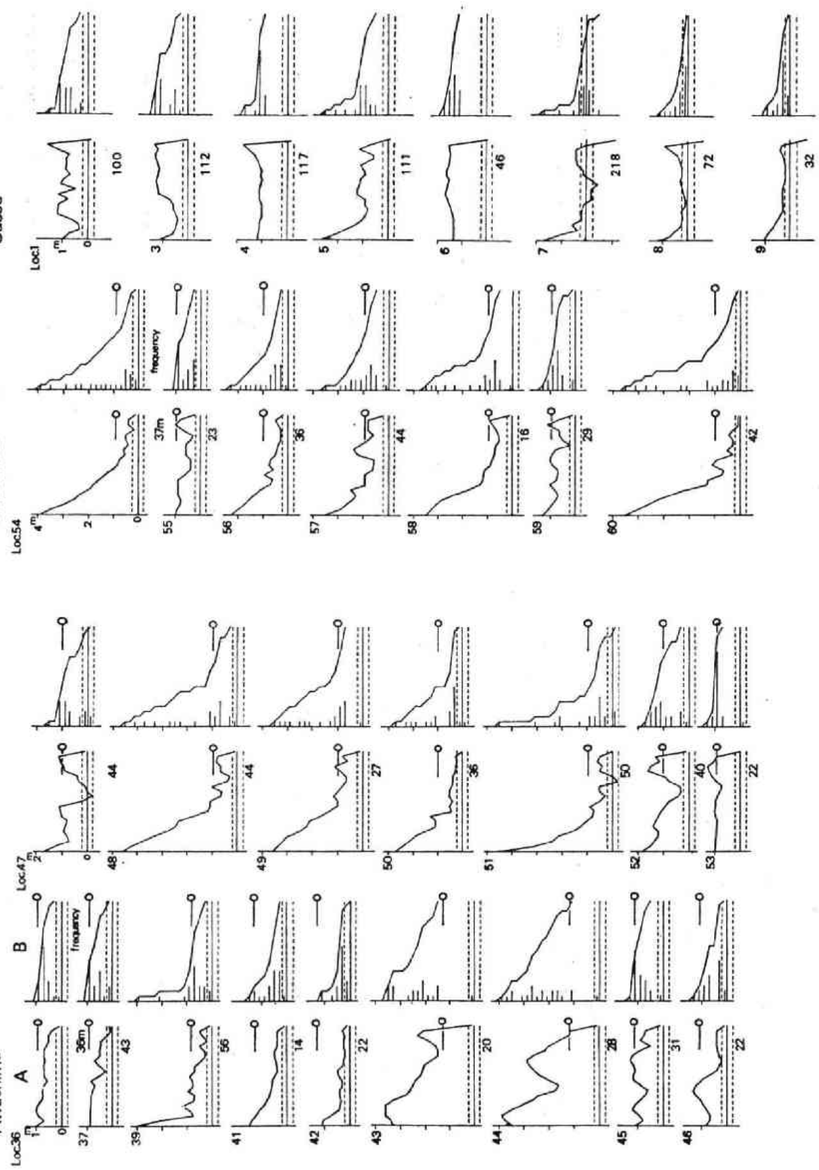
Annexed Figures 14



Annexed Figures 15



Annexed Figures 16



Annexed Figures 17

Annexed Table
Some features of platforms

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Hirado Island	11	Nb	63	−0.3	Hl		I-H-R
	11′	Nb	63	0.7	Mu		II-H·M
	12	Nb	117	−0.8	Hl		I-H-U
	13	Nb	35	−0.3	Hl		I-H-E
	14	Nb	29	0.6	Mu		I-H-U
	15	Nb	30	1.3	Mu		II-H·M
	16	Nb	18	2.2	Mu		II-H·L
	17	Nb	23	−1.0	Hl		I-H-O
	22	Nb	40	1.6	Hl		II-H·M
	23	Nt	85	0.8	Mu		I-H-U
	31	Nb	128	0.0	Hl		I-H-R
	32	Nb	63	0.3	Hl		I-H-E
	33	Nb	115	0.6	Mu		II-H·M
	34	Nb	83	0.4	Mu		I-H-U
	35	Nb	102	0.2	Mu		II-H·M
	36	Nb	95	0.2	Hu		I-H-R
	42	Nb	38	−0.4	Hl		I-H-R
	43	Nb	35	6.0	Hl		I-H-E
	44	Nb	61	1.2	Mu		II-H·L
	45	Nb	37	1.7	Ml		II-H·L
	46	Nb	111	0.5	Mu		II-H·M
	51	Iv	22	8.7	Cm	S	III-Cl·H
	52	Iv	10	2.3	Hl	S	II-H·M
	53	Iv	25	5.7	Hu	S	I-Cl-U
	54	Iv	24	13.5	Mu	S	III-Cl·L
	55	Iv	16	7.1	Cm	S	III-Cl·H
	56	Iv	19	5.1	Hl	S	III-Cl·L
	57	Nb	24	4.4	Mu		II-H·L
	61	Nc	15	4.9	Hl		II-H·M
	62	Nc	25	2.7	Hl		II-H·M
	63	Nc	22	2.6	Hl		II-H·M
	71	Iv	9	20.0	Cl	S	III-Cl·L
	72	Nb	19	4.9	Hl		III-Cl·L
	73	Iv	10	7.7	Hl	S	III-Cl·L
	74	Nt	20	1.7	Ml		II-M·L
	75	Nt	84	0.0	Hl		I-H-E
	76	Nt	44	2.0	Ml		II-H·L
	77	Iv	26	4.3	Hl	S	III-Cl·L
	78	Iv	19	7.5	Hl	S	III-Cl·L
	79	Iv	27	4.2	Mu	S	III-Cl·L
	81	Nb	87	0.8	Mu		I-H-U
	82	Nb	53	0.9	Ml		II-H·L
	83	Nb	27	1.7	Mu		II-H·M
	84	Nb	23	−2.5	Mu		I-H-U
	85	Nb	34	1.2	Hl		II-H·M
	86	Nb	17	0.7	Hl		I-H-R
	87	Nb	20	0.0	Hu		I-H-E
	88	Nb	24	1.4	Hl		I-H-E
	89	Nb	14	1.6	Hl		III-Cl·H
	91	Nb	24	2.9	Mu		II-H·L
	92	Nb	17	2.4	Hl		II-H

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Hirado Island	93	Nb	18	3.8	Hu		III-Cl·L
	94	Nb	24	2.4	Mu		II-H·L
	95	Nb	39	1.8	Mu		II-H·M
	96	Nb	18	3.3	Hl		II-H
	97	Nb	46	0.2	Hl		I-H-R
	98	Nb	21	1.1	Hl		II-H
	99	Nb	31	0.4	Hu		I-H-R
Southern Satsuma Peninsula	B201	Dw	16	16.0	Cu	S	III-Cu·Cm
	202	Dw	20	12.1	Cu	S	III-Cu·Cm
	203	Dw	31	9.5	Cu	S	III-Cu·H
	204	Dw	38	7.6	Cu	S	III-Cu·Cm
	205	Dw	31	9.2	Cu	S	III-Cu·Cm
	207	Dw	26	14.4	Cu	S	III-Cu·Cm
	208	Dw	28	9.5	Cu	S	III-Cu·Cm
	209	Dw	27	5.7	Cu	S	III-Cu·Cm
	210	Dw	41	3.8	Cu	S	III-Cu·Cm
	211	Dw	48	0.9	Cm	S	III-Cl·L
	212	Dw	48	7.8	Cm	S	III-Cl·L
	213	Dw	28	6.3	Cu	S	III-Cu·H
	215	Dw	37	3.1	Cm	S	III-Cl·H
	D401	Dw	112	2.0	Hl	S	III-Cl·H
	402	Dw	92	2.5	Hl	S	III-Cl·H
	403	Dw	82	1.0	Hl	S	III-Cl·H
	404	Dw	48	1.5	Cl	S	III-Cl·H
	405	Dw	71	1.1	Hu	S	III-Cl·H
	F101	Dw	95	3.3	Mu	S	III-Cl·L
	102	Dw	83.5	4.6	Mu	S	III-Cl·L
	103	Dw	74.5	4.9	Cm	S	III-Cl·H
	104	Dw	64	4.0	Cm	S	III-Cl·H
	105	Dw	90	3.6	Cm	S	III-Cl·L
	106	Dw	113	1.3	Cl	S	III-Cl·L
	107	Dw	63	3.5	Cm	S	III-Cl·H
	108	Dw	45	5.4	Ml	S	III-Cl·L
	109	Dw	125	1.1	Mu	S	III-Cl·L
	110	Dw	68	4.0	Cm	S	III-Cl·L
	G201	Dw	24	5.0	Cu	S	III-Cl·H
	202	Dw	81	2.8	Cm	S	III-Cl·H
	203	Dw	109	1.3	Ml	S	III-Cl·L
	204	Dw	70	4.2	Hu	S	III-Cl·L
	205	Dw	77	4.1	Ml	S	III-Cl·L
	206	Dw	39	4.5	Cm	S	III-Cl·H
	207	Dw	59	6.0	Cm	S	III-Cl·L
	208	Dw	57	7.7	Mu	S	III-Cl·L
	209	Dw	43	3.1	Mu	S	III-Cl·L
	210	Dw	55	3.1	Cm	S	III-Cl·H
	211	Dw	50	3.7	Cl	S	III-Cl·H
	H301	Dw	103	0.2	Hl	S	II-H·M
	302	Dw	69	0.8	Mu	S	II-H·M
	303	Dw	47	4.1	Cm	S	III-Cl·H
	304	Dw	111	0.4	Ml	S	II-H·L
	I403	Dw	107	0.7	Cm	S	III-Cl·H

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
	404	Dw	55	4.8	Hu	S	III-Cl·H
	405	Dw	40	5.4	Cl	S	III-Cl·H
	406	Dw	97	0.6	Cm	S	III-Cl·L
	407	Dw	102	2.6	Cl	S	III-Cl·H
	408	Dw	65	5.7	Cm	S	III-Cl·L
	409	Dw	90	3.5	Cl	S	III-Cl·L
	410	Dw	87	1.5	Cl	S	III-Cl·L
	410′	Dw	50	1.8	Hl	S	III-Cl·H
Nichinan Coast	11	Na	140	0.1	Hl		I-H-R
	12	Na	80	0.4	Hl		II-H·M
	21	Na	186	0.1	Hl		II-H·M
	22	Na	65	0.5	Hl		II-H·M
	31	Na	247	0.1	Hl		II-H·M
	32	Na	155	0.2	Hu		II-H·M
	41	Na	277	0.1	Ml		II-M·L
	42	Ns	19	14.9	Cm		III-Cl·H
	43	Ns	19	12.7	Cl		III-Cl·H
	51	Ns	34	4.4	Hl		III-Cl·L
	52	Ns	40	2.3	Cl		III-Cl·H
	61	Ns	54	3.0	Cm		III-Cl·H
	62	Ns	52	1.2	Cm		III-Cm·L
	63	Ns	45	1.6	Cm		III-Cm·H
	64	Ns	42	3.1	Cm		III-Cm·H
	71	Ns	49	6.6	Cu		III-Cu·H
	72	Ns	49	10.7	Cu		III-Cu·H
	73	Ns	44	8.9	Cu		III-Cu·H
	81	Ns	75	8.3	Cu		III-Cu·H
	82	Ns	64	8.9	Cu		III-Cu·H
	83	Ns	61	9.9	Cu		III-Cu·H
	84	Ns	47	9.4	Cu		III-Cu·H
	91	Na	42	0.9	Mu		II-H·M
Inan Coast	1	Ms	41.5	−0.4	Cl		I-H-O
	2	Ms	58	1.9	Cl		I-Cl-R
	3	Ma	41	0.5	Hl		I-H-U
	4	Ma	21.5	2	Cl		III-Cl·H
Tosa-Saga Coast	1	Mm	62.8	0.3	Mu		I-H-U
	2	Mm	62.8	0.3	Mu		I-H-U
	3	Mm	40.0	0.5	Hl		I-H-U
Muroto Cape Peninsula	1	Mm	42.5	1.7	Cl		III-Cl·H
	2	Mm	33.5	1.1	Hu		III-Cl·H
	3	Ms	18	2.5	Mu		I-H-U
	4	Ms	16	1.8	Hl		I-H-U
	5	Ms	23.8	−6.9	Cm		IV-U
	6	Ms	38.5	2.1	Cl		IV-U
	7	Ms	56	7.3	Cm		IV-U
	8	Ms	49.5	7.2	Cm		IV-U
	9	Ma	35.5	1.8	Cu		IV-U
	10	Ma	35	3.4	Cm		IV-U

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Muroto Cape Peninsula	11	Ma	40.6	0.8	Cu		IV-U
	12	Ma	102.5	0.7	Cu		IV-U
	13	Ma	83	3.4	Cu		IV-U
	14	Mm	51.5	3.9	Cl		III-Cl·H
	15	Mm	40	2.6	Cl		III-Cl·H
	16	Ms	57	2.4	Cm		IV-U
	17	Ms	22	−4.2	Cm		IV-U
	18	Ma	121	0.9	Cm		IV-U
	19	Ma	50.8	0.4	Hl		I-H-U
	20	Ma	75	4.5	Cl		IV-U
Anan Coast	1	Ma	30	0.9	Mu		I-H-U
	2	Ma	38.5	0.4	Mu		I-H-U
	3	Ma	42	0.7	Mu		I-H-U
Southwestern Kii Peninsula (I) (after Kumon, 1961)	2	Ma	32.5	1.4	Hl		III-Cl·L
	4	Ma	108.3	0.6	Lu		II-H·L
	5	Ma	45.8	1.3	Mu		III-Cl·L
	6	Ma	47	0.2	Ml		I-M-R
	7	Ms	45	1.4	Ml		I-H-U
	8	Ms	79	1.5	Hl		I-H-U
	9	Nc	19.5	−2.0	Mu		I-M-R
	10	Nc	46.5	1.0	Cl		III-Cl·H
	11	Nc	147	0.5	Ml		I-H-U
	12	Nc	106	0.1	Hl		I-H-U
	13	Nc	98	−0.3	Hl		I-H-U
	14	Nc	113	0.1	Mu		I-M-R
	15	Nc	85.9	−0.5	Hu		I-H-R
	16	Ns	84.5	0.5	Mu		I-H-U
	17	Ns	120	0.6	Ml		II-H·L
	18	Ns	49.5	−0.5	Hl		I-H-U
	19	Ns	92	0.3	Mu		II-H·M
	20	Na	126.9	0.4	Mu		I-H-U
	21	Ns	38	2.6	Mu		III-Cl·L
	22	Ns	64	0.3	Ml		I-M-R
	23	Ns	92.5	−0.3	Ml		I-H-U
	25	Ns	37.2	0.3	Hl		I-H-E
	27	Ns	31.8	2.5	Hl		II-H·M
	28	Ns	26	5.3	Cl		III-Cl·L
	29	Na	43	5.4	Cm		III-Cl·L
	30	Ns	41.5	4.1	Cl		III-Cl·L
Southwestern Kii Peninsula (II) (after Mii, 1962)	1	Nc	15.8	8.3	Ml		II-H·L
	2	Nc	25.5	5.1	Hl		III-Cl·L
	3	Nc	30.6	0.5	Hl		I-H-U
	4	Ns	37.9	0.4	Hl		I-H-U
	5	Ns	38.2	−0.3	Hl		I-H-U
	6	Na	17.6	3.9	Mu		II-H·L
	7	Ns	35.8	0.8	Mu		I-H-U
	8	Ns	30.9	1.5	Mu		I-H-U
	9	Na	58.9	0.6	Ml		II-M·L
	10	Na	34.2	0.5	Hl		I-H-U

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Southwestern Kii Peninsula (II) (after Mii, 1962)	11	Na	23.9	2.6	Mu		I-H-U
	12	Ns	50.3	1.5	Hl		I-H-U
	13	Na	44.2	0.5	Ml		I-H-U
	14	Na	23.6	2.9	Mu		II-H·L
	16	Ns	13.3	3.9	Mu		I-H-U
	17	Ns	46.1	1.1	Ml		II-N·L
	18	Na	18.5	5.5	Lu		II-H·L
	19	Na	15.8	6.5	Hl		III-Cl·H
	20	Na	25.7	3.1	Hl		I-H-U
	21	Nc	22.2	2.8	Lu		III-Cl·L
	22	Nc	55.9	5.7	Ml		I-H-U
	23	Nc	51.7	1.4	Hl		III-Cl·L
	24	Nc	77.5	0.5	Ml		I-H-U
	25	Na	56.0	0.5	Lu		I-H-U
	26	Na	64.8	−0.1	Lu		I-H-U
	27	Na	53.2	0.8	Mu		I-H-U
	28	Na	30.9	16.4	Ml		III-Cl·L
Southwestern Kii Peninsula (III)	1	Ma	68	0.5	Lu		II-M·L
	2	Ma	80	0.4	Ml		II-M·L
	3	Ma	131	0.4	Ml		II-M·L
	4	Ma	107	0.3	Ml		II-M·L
	5	Ma	60	0.3	Ml		II-M·L
	6	Ma	48	0.5	Ml		II-M·L
	7	Ma	61	0.6	Ml		I-M-E
	8	Ma	59	0.6	Ml		I-M-E
	9	Ma	56	−0.7	Mu		I-H-U
	10	Ma	82	0.2	Ml		III-Cl·L
	11	Ma	102	0.2	Mu		I-M-R
	12	Ma	45	6.5	Ml		III-Cl·L
	13	Ma	59	3.5	Hl		III-Cl·L
	14	Nc	73	0.4	Ml		I-H-U
	15	Nc	31	1.7	Ml		I-H-U
	16	Nc	46	−0.9	Hu		I-H-U
	17	Nc	95	0.6	Mu		I-H-U
	18	Nc	60	0.2	Hl		I-H-E
	19	Nc	70	−1.2	Hl		I-Cl-U
	20	Nc	88	0.1	Ml		I-M-R
	21	Nc	145	0.0	Mu		I-M-R
	22	Nc	213	0.1	Hl		II-H·M
	23	Nc	97	0.2	Hl		I-H-U
	24	Nc	72	−0.7	Hl		I-Cl-U
	25	Nc	81	−0.1	Hu		I-H-O
	26	Ns	40	2.7	Mu		III-Cl·L
	27	Ns	23	1.7	Hl		II-H
	28	Ns	33	2.2	Hl		II-H·M
	29	Nc	85	0.2	Mu		I-M-R
	30	Nc	32	0.9	Mu		I-M-E
	31	Nc	62	0.7	Mu		II-H·M
	32	Na	79	−0.3	Hl		I-H-U
	33	Na	57	0.5	Hu		I-H-U
	34	Na	44	0.3	Cl		I-Cl-E

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Southwestern Kii Peninsula (III)	35	Na	226	−1.3	Hu		I-Cl-U
	36	Na	135	−0.2	Mu		I-H-U
	37	Na	132	−0.2	Hl		I-H-U
	38	Na	78	0.4	Hu		III-Cl·H
	39	Nm	199	−0.2	Hl		I-H-U
	40	Nm	86	0.3	Hu		II-H
	41	Na	53	−0.2	Ml		I-H-U
	42	Ms	81	0.6	Hu		I-H-U
	43	Ma	57	1.1	Ml		I-H-U
Southern Kii Peninsula	45	Mm	45	0.5	Hl		I-H-U
	46	Mm	57	0.7	Hl		I-H-U
	47	Mm	141	0.5	Hl		I-H-U
	48	Mm	62	0.2	Hl		I-H-U
	49	Mm	136	−0.1	Hl		I-H-O
	50	Ms	56	1.8	Hu		I-Cl-U
	51	Ms	71	−0.2	Hu		I-Cl-U
	53	Mm	37	0.7	Hu		II-H
	54	Mm	75	−0.2	Mu		I-H-U
	55	Mm	41	0.0	Hl		I-H-E
	56	Mm	95	0.6	Hu		I-H-U
	57	Mm	185	0.1	Hl		II-H
	58	Mm	61	0.2	Hl		I-H-U
	59	Mc	392	0.0	Hu		I-H-E
	60	Mc	168	−0.1	Hl		I-H-U
	61	Mc	102	0.4	Hu		II-H
	62	Mc	79	0.2	Hl		I-H-U
	63	Mc	88	0.2	Hl		II-H·M
	64	Mm	64	0.5	Hl		II-H
	65	Mm	48	0.1	Hl		I-H-E
	66	Mm	48	0.2	Hl		II-H·M
	67	Mm	70	0.5	Hl		II-H·M
	68	Na	56	−0.4	Cl		I-Cl-U
	69	Na	33	−0.9	Cl		I-Cl-U
	70	Nm	45	1.1	Mu		I-H-U
	71	Nm	97	0.3	Hu		II-H
	72	Nm	95	0.5	Mu		II-H·M
	73	Nm	85	0.6	Hl		II-H·M
	74	Nm	53	1.1	Mu		II-H·M
	75	Nm	208	0.1	Hl		I-H-R
	76	Nm	48	−0.5	Hl		I-H-U
	77	Nm	71	0.2	Hu		I-Cl-U
	78	Nm	87	0.2	Cl		I-Cl-U
	79	Nm	125	0.1	Cl		I-Cl-E
	80	Nm	95	1.3	Hu		I-H-U
	81	Nm	75	0.0	Hl		I-H-E
	82	Nm	328	0.1	Hu		I-H-U
	83	Nm	93	0.2	Hu		I-H-R
	84	Nm	206	0.4	Hl		I-H-U
	85	Nm	81	0.2	Hu		I-Cl-U
	86	Nm	36	−0.5	Cl		I-H-O
	87	Na	70	−0.4	Hu		I-Cl-U

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Southern Kii Peninsula	88	Na	45	0.6	Hl		I-H-U
	90	Na	54	0.7	Hl		II-H·M
	91	Na	39	0.4	Hu		I-Cl-U
	92	Na	40	1.4	Cl		I-Cl-U
	93	Na	38	2.3	Hu		III-Cl·H
	94	Na	38	0.9	Hl		I-H-U
	95	Na	74	2.5	Hu		III-Cl·L
	99	Na	27	0.4	Cl		I-Cl-U
Omaezaki Coast	1	Na	116	0.3	Ml		II-H·L
	2	Na	134	0.2	Ml		II-M·L
	3	Na	139	0.5	Ml		II-M·L
	4	Na	56	1.2	Lu		II-M·L
	5	Na	55	0.4	Lu		II-M·L
Shimoda Coast (after Sunamura, 1963)	1	Nb	20.5	0.6	Cl		I-Cl-R
	2	Nt	33.5	0.3	Cl		I-Cl-R
	3	Nt	49.0	0.2	Hu		I-Cl-R
	5	Nb	30.5	0.4	Hu		I-H-E
	6	Nb	30.5	0.4	Cl		I-Cl-E
	7	Nb	34	0.3	Cl		I-Cl-R
Southern Miura Peninsula (after Toyoshima, 1956)	1	Na	94	0.6	Cl		I-Cl-U
	2	Na	73	0.0	Cl		I-Cl-R
	3	Na	39	0.0	Cl		I-Cl-R
	4	Na	40	0.0	Cl		I-Cl-R
	5	Na	128.5	0.2	Ml		II-M·L
	6	Na	99	0.5	Hl		I-H-U
	7	Na	98	0.9	Ml		II-H·L
Tatamigaura Coast	1	Na	99	0.4	Ml		II-H.L
	2	Na	92	−0.4	Mu		I-H-U
	3	Na	102	1.0	Ml		I-H-U
	4	Na	54	1.4	Cl		I-Cl-U
	5	Na	46	1.4	Hu		III-Cl·L
Jōdogaura Coast	1	Nb	27.5	1.0	Cl		III-Cl·H
	2	Nb	51	0.3	Mu		I-H-U
	3	Na	9.4	3.3	Cl		I-Cl-U
	4	Na	22	1.0	Cl		I-Cl-U
Awashima Island	1	Nm	32.5	0.6	Ll		
	2	Id	38.5	3.0	Hu·Ll		
	3	Id	12	10.2	Cl·Mu		
	5	Id	22	2.1	Ml		
	6	Id	21	0.3	Ll		
	7	Id	55	0.3	Ml		
	8	Id	36	2.5	Hu·Lu		
	9	Nm	21	2.2	Ll		
	10	Nm	50	0.5	Lu		
	12	Id	12	3.3	Hu		
	13	Id	23	−1.0	Hl		

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Awashima Island	14	Id	33.5	2.9	Ml		
	15	Id	20	0.8	Hu		
	16	Id	30.5	1.2	Hu		
	17	Id	12.5	1.0	S		
	18	Id	10.5	−6.0	Hu		
	19	Id	26	1.3	Ll		
	20	Id	58	1.0	Hu		
	21	Id	19	1.2	Hl		
	22	Id	19	3.7	Ll		
	23	Id	37	0.6	Lu		
	24	Nm	72.5	0.3	S		
	25	Id	96.5	0.4	Ml		
	26	Nm	66	0.4	Ll		
	27	Id	14	1.6	Ml		
	28	Id	80	−0.2	Cl		
	29	Id	36	0.3	Mu		
	30	Id	83	1.5	Cl·Mu		
	31	Nm	34	0.4	Ml·Ll		
	32	Id	48	0.6	Hu		
	33	Id	41	4.1	Cl		
	34	Id	17	2.2	Ll		
	35	Id	65	0.3	Hu		
	36	Id	36	0.4	Lu		
	37	Nm	43	0.9	Mu		
	39	Nm	56	0.8	Ml		
	41	Id	14	3.5	S		
	42	Id	22	0.8	S		
	43	Id	20	7.1	Cl		
	44	Id	28	4.7	Cl		
	45	Id	30.5	0.7	Mu		
	46	Id	22	1.3	Ll		
	47	Id	44	−1.2	Mu		
	48	Id	44	3.4	Lu		
	49	Id	27	2.1	Lu		
	50	Id	36	1.0	Ll		
	51	Id	50	3.0	Ll		
	52	Id	40	2.2	Hl		
	53	Nm	22	0.7	Mu		
	54	Nm	36.5	2.6	Ll		
	55	Id	23	1.9	Ml		
	56	Nm	36	1.3	Ll		
	57	Id	43.5	1.8	Ml		
	58	Id	15.5	6.2	Ml		
	59	Id	29	0.5	Ml		
	60	Nm	42	2.4	Ll		

Annexed Table (continued)

coast	Loc.	lithology	length (m)	grade (degree)	height	*	type
Ōdose Coast	1	Nt	100	0.3	Cl		I-Cl-U
	3	Nt	112	−0.1	Cl		I-Cl-U
	4	Nt	117	0.1	Cl		I-Cl-R
	5	Nt	111	0.2	Cl		I-Cl-R
	6	Nt	45.5	0.4	Cl		I-Cl-E
	7	Nt	218	0.3	Mu		I-H-U
	8	Nt	72	0.2	Hl		I-H-R
	9	Nt	32	0.4	Hu		I-H-R

S in *: structural platform
notation: See Table 3 (lithology), Table 2 (height) and Fig. 7 (type).