A Facies Model for the Sedimentation in the Marukirizawa Syncline, Central Omine Belt, Nagano Prefecture

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I. Introduction

The Omine Belt (KOSAKA, T., 1979) is a narrow strip of land, three to five kilometers wide and about fifty kilometers long, at the western margin of the so-called northern Fossa Magna. It is limited by the Itoigawa-Shizuoka Tectonic Line on the west, and by the Otari-Nakayama Fault on the east. The Belt is underlain mainly by the Pliocene-Pleistocene Omine Formation and Miasa Formation in the middle and southern parts, but some older sediments ranging down to the Upper Miocene are also exposed in the northern part. The sediments of this belt especially of the Omine Formation are characterized by a large amount of coarse clastics intercalating many layers of conglomerates with colossal boulders. It reminds us of molasse-type formations that are widely known along piedmont areas of many mountain ranges. Really the thick sediments of coarse clastics are supplied mainly from the "Western Mountains" of the natives, i. e. the Japanese Alps, and they reflect the rapid upwarp of the latter. Both the age and nature of the movement reveal that the sediments are the products of the Island-Arc Movement of Y. FUJITA (1970). The sediments are characterized further by frequent intercalations of volcanic rocks of pyroclastics and lava flows ranging in composition from dacitic to rhyolitic chemistry (KOSAKA et al., 1979 ; KOSAKA, 1980 b).

In this paper the writer attempts to depict a facies model for the sedimentaion of thick, coarse clastic sediments at the foot of the Japanese Alps. The area of the Marukirizawa Syncline to the east of Lake Aoki at about the middle way in the Omine Belt was chosen as a field of detailed examination on the characters of the sediments. Here they form the lower part of the second cycle of sedimentation-volcanism in the whole sequence of the Omine Belt. It will present a more concrete and vivid movement picture of the up-rising Alps and the subsiding Omine basin.

II. An Outline of the Geology of the Omine Belt

The Omine Belt, as noted above, is limited by large faults on both the east and west sides. It runs from north to south in general, but is broadly arcuate projecting westward towards the Japanese Alps. The rocks of the western area, i. e. of the Japanese Alps, are the thick and deformed, Paleozoic to Mesozoic sediments such as sandstones and mudstones with chert, green stones and some limestones, and also granites and volcanics, of which the last are represented mainly by pyroclastics and lavas of andesites, dacites and rhyolites. The igneous rocks both of plutonic and effusive origins are of late Mesozoic to early Cainozoic ages.

The rocks of the area to the east of the Omine Belt are the Neogene deposits of the so-called Fossa Magna, though the uppermost part of the sequence attains to early Pleistocene in age. They are composed generally of mudstones and sandstones, but conglomerates are not uncommon, and are rather well developed in some higher horizons. Also there are basic to acidic volcanic rocks which are frequent in the lower formations. In some cases masses of quartz-diorite and dykes and sheets of porphyrites are found in this area. They are more frequent in the lower formations.

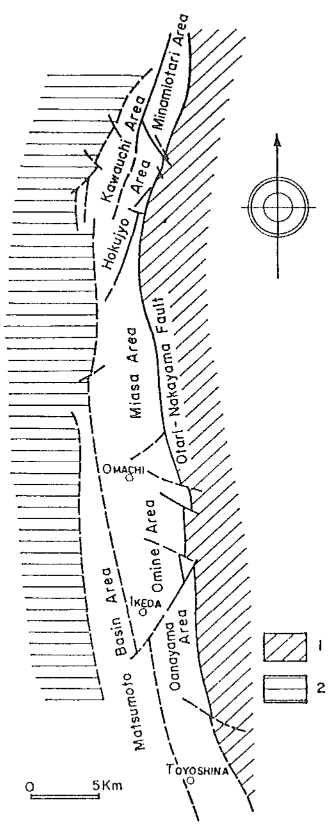


Fig. 1 Subdivisions or blocks (areas) of the Omine Belt (after KOSAKA, 1980).
1. Folded Tertiary rocks
2. Older Sedimentary or Igneous rocks

Neogene formations are folded severely exhibiting synclines running from NNE to SSW. This direction is not parallel with the north-south trending Omine Belt, namely the synclines are cut obliquely by the Belt. The clastic sediments of Neogene formations are fairly well indurated, but the grade of induration is markedly lower than that of Palaeozoic, Mesozoic and Palaeogene rocks of the Japanese Alps.

The Omine Belt itself is divided into several areas or blocks by several oblique faults as shown in Fig. 1. The formations are folded generally to form a longitudinal syncline. But the syncline is cut into many parts by the oblique faults mentioned above so that it is represented by a short syncline or a half-basin in each block. The forma-

Table 1 Correlation chart of the upper Tertiary~lower Quaternary formations of the Omine Belt (after KOSAKA, 1980).

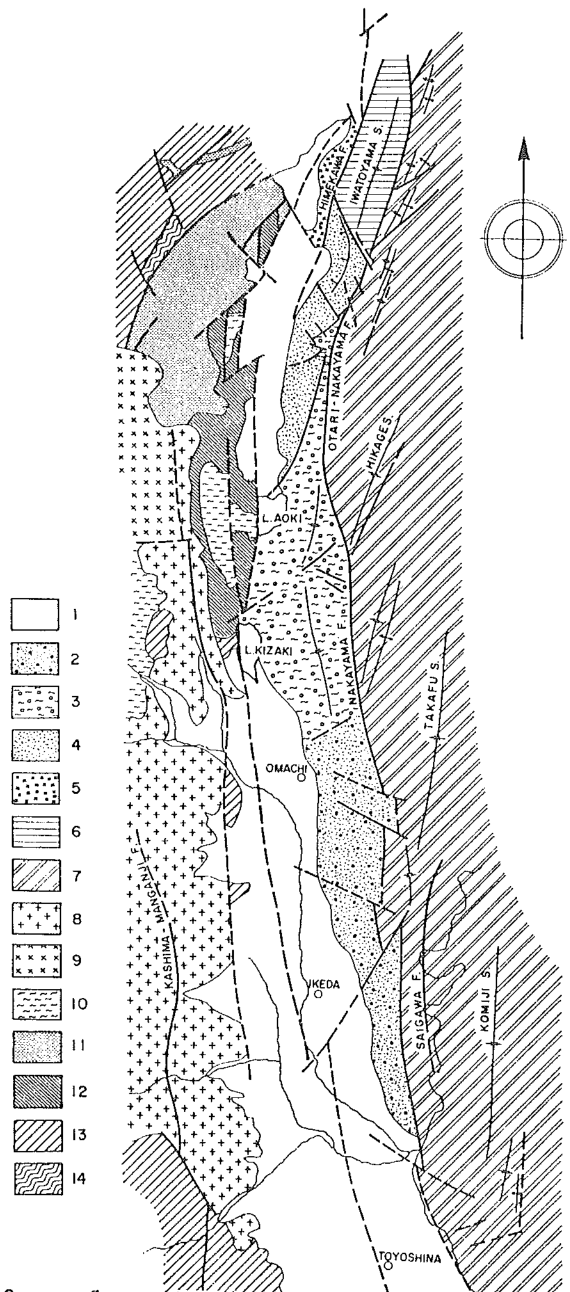
AGE	(Stage)	MINAMIOTARI	KAWAUCHI	HOKUJYO	MIASA	OMINE
PLEISTOCENE	SARUMARU st.					Omine f.: f.
						Oanayama m.
						Omine m.
						Shinhikizawa m.
					Miasa fm.: Shingyo m.	
PLIOCENE					Toge m.	
				?	Kota m.	
		f.	?	Hokujyo fm.: Goshyakubo m.	?	
	SHIGARAMI st.	Minamiotari fm.: Iwatoyama m.	Kawauchi fm.: Sengenyama m.	Kayo m.		
				Tatenoma m.		
			Chikuni m.	Takatoyama m.		
			f.	Suga m.		
				?		
		Hosogai m.				
		Uchu m.				
MIOCENE	OGAWA st.	?				

tions are composed of coarse-grained clastics as well as of volcanic rocks. The clastic rocks are indurated rather weakly, and those of the higher horizons are often scratched easily by a shovel.

Marine shells are not rare in the lower horizons, but are absent from the middle and upper horizons. On the contrary leaves and stems of land plants are not uncommon in the middle and upper horizons, which, together with welded textures observed generally in the pyroclastics, suggest subaerial deposition of these sediments.

As the sediments show remarkable horizontal variations in rock facies from block to block, different formation names are given to those of the different blocks, though they are partly or wholely equivalent in age (Table 1). The Minamiotari Formation includes the oldest sediments in the Omine Belt, and it ranges down probably to the uppermost Miocene. It is composed mainly of mudstone and sandstone with some intercalations of conglomerate. Andesitic pyroclastics are also found in the higher horizons. It is about 1300m thick.

The Kawauchi Formation is 1, 300m thick, and is composed mostly of andesitic to dacitic pyroclastic rocks. Several beds of conglomerate are also found intercalated. The Hokujo Formation is nearly equal to the preceding Kawauchi Formation in rock facies. Namely, it is characterized by rich pyroclastic rocks of andesitic to dacitic chemistry. Conglomerates are also intercalated. It is about 2, 500m in



1. Alluvium
2. Omine F.
3. Miasa F.
4. Hokujyo F.
5. Kawauchi F.
6. Minamiotari F.
7. Folded Tertiary of the Takafu Belt
8. Cretaceous Granites
9. Cretaceous Granodiorites
10. Welded tuff (Mesozoic~Paleogene)
11. Serpentine
12. Kuruma F., Kizaki F.
13. Paleozoic
14. Metamorphic rocks

Fig. 2 Simplified geological map of the Omine Belt (after KOSAKA, 1980).

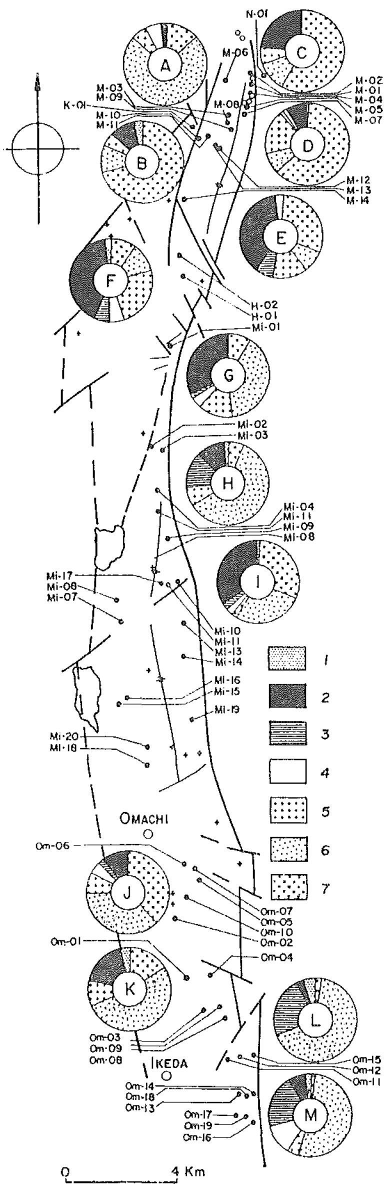


Fig. 3 Localities of pebble analyses (after KOSAKA, 1980).

thickness. The Miasa Formation, about 2,000m thick, is composed of mudstone, sandstone, conglomerate and dacitic-rhyolitic pyroclastics. The Omine Formation is the youngest of the deposits in the Omine Belt, and is developed most extensively in the middle and southern parts. It is about 2,000m thick, and is composed of conglomerates and pyroclastics. The pyroclastics are dacitic to rhyolitic, and are often welded. The conglomerates contain, in some cases, colossal boulders, of which the maximum diameter attains to 3.5m.

In his previous papers (KOSAKA, 1979, 1980 a•b, 1982), the author presented the results of analytical studies on the conglomerates of the Omine Belt. According to the results of these studies source areas of the sediments were present not only to the west of the Omine Belt, but also to the east, i. e. in the Tertiary areas. And even the areas of the Omine Belt itself had become source areas several times since early Pliocene time. It suggests that upheaval and erosion resulting from fault movements occurred several times since the beginning of the Pliocene.

An outline of the geology of the Omine Belt and its surroundinge is illustrated in Fig. 2, while localities of pebble analyses are shown in Fig. 3.

III. Pebble analyses : size, shape, roundness, and composition

In Tables 2–A, –B, –C and –D are shown the pebble compositions in each locality of the Omine Belt and the Takafu Belt*. The details of analyses are described in the previous papers (KOSAKA, 1979, 1980 a, 1982).

This time, three diameters that are perpendicular to each other are measured

Table 2–A Pebble composition in each locality of the northern part of the Omine Belt.

	Basement Rocks (%)									Tertiary Rocks (%)												
	QP	Gr	Dr	Gb	Sp	Gss	Sl	Ch	Oths	dr	phy	cgl	ss	ms	bs	and	dac	rhy	wd	t	gr	oths
Mi 01	8.3	6.3	8.3	—	—	20.8	20.8	—	—	—	—	—	2.1	—	12.5	—	18.8		2.1	—	—	—
Mi 01	8.5	6.4	—	—	—	19.1	17.0	—	—	—	—	—	38.2	—	—	—	—	—	—	10.6	—	—
Mi 03	—	4.0	—	—	—	40.0	14.0	42.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mi 04	12.2	12.0	—	—	—	55.1	—	14.3	2.0	—	—	—	—	—	2.0	—	—	—	2.0	—	—	—
Mi 05	8.2	4.1	—	—	—	32.7	4.1	18.4	—	—	—	—	18.4	—	4.1	6.1	2.0		—	—	2.0	—
Mi 06	22.0	—	—	—	—	—	—	—	—	—	—	—	2.0	—	—	2.0	—	—	74.0	—	—	—
Mi 07	100.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mi 08	10.2	6.1	2.0	—	—	36.7	4.1	18.4	—	—	—	—	2.0	—	4.1	6.1	—	—	10.2	—	—	—
Mi 09	18.0	2.0	—	—	2.0	48.0	4.0	16.0	—	—	—	—	—	—	10.0	—	—	—	—	—	—	—
Mi 10	4.4	2.2	—	—	—	31.1	8.9	22.2	6.7	—	—	—	—	—	13.3	6.7	—	—	—	—	4.4	—
Mi 11	—	4.0	—	—	—	42.0	6.0	24.0	—	—	—	—	10.0	2.0	—	2.0	—	—	4.0	—	4.0	—
Mi 12	4.0	2.0	—	—	—	46.0	8.0	32.0	2.0	—	—	—	2.0	—	—	2.0	—	—	2.0	—	—	—
Mi 13	28.0	6.1	2.0	—	—	28.6	8.2	4.1	—	—	—	—	4.1	—	—	4.1	—	—	2.0	12.2	—	—
Mi 14	—	8.0	—	—	—	30.0	4.0	12.0	—	—	—	—	2.0	—	—	—	2.0		36.0	—	2.0	—
Mi 15	54.0	—	—	—	—	—	2.0	—	2.0	—	2.0	—	—	—	2.0	26.0	2.0		8.0	—	—	—
Mi 16	98.0	—	—	—	—	—	2.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mi 19	50.0	2.0	—	—	—	12.0	4.0	—	—	—	—	—	2.0	4.0	2.0	—	2.0		8.0	4.0	8.0	—
Mi 20	10.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	90.0	—	—	—
Mi 21	4.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.0	4.0		90.0	—	—	—

(Mi 01–21:Miasa FFormation

Table 2-B Pebble composition in each locality of the middle part of ehe Omine Belt.

	Basement Rocks (%)									Tertiary Rocks (%)												
	Qp	Gr	Dr	Gb	Sp	Gss	Sl	Ch	Oths	dr	phy	cgl	ss	ms	bs	and	dac	rhy	wd	t	gr	oths
M 01	10.6	4.3	—	—	—	27.7	2.1	51.1	—	—	—	—	—	—	—	4.3	—	—	—	—	—	—
M 02	4.3	8.7	—	—	—	39.1	4.3	43.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M 03	14.0	6.0	—	—	—	28.0	2.0	40.0	—	—	2.0	—	6.0	—	—	—	—	—	—	2.0	—	—
M 04	8.2	4.1	—	—	—	49.0	4.1	32.7	—	—	—	—	—	—	—	—	2.0	—	—	—	—	—
M 05	2.0	4.0	—	—	—	38.0	6.0	50.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M 06	82.0	2.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.0	4.0	—	—	—	2.0
M 07	61.2	16.3	—	—	—	4.1	—	12.2	—	—	—	—	—	—	4.1	4.1	4.1	—	—	—	—	4.1
M 08	56.3	2.1	2.1	2.1	—	10.4	2.1	—	—	—	—	—	—	—	—	20.8	4.2	—	—	—	—	—
M 09	63.3	8.2	2.0	—	—	4.1	6.1	2.0	—	—	—	—	2.0	—	—	2.0	10.2	—	—	—	—	—
M 10	68.0	14.0	—	2.0	—	—	—	—	—	—	—	—	2.0	—	2.0	8.0	6.1	—	—	—	2.0	—
M 11	61.2	20.4	2.0	—	—	8.2	—	—	—	—	—	—	—	—	—	6.1	—	—	—	—	2.0	—
M 12	54.0	18.0	—	—	—	—	2.0	2.0	—	—	—	—	—	—	—	6.0	8.0	4.0	2.0	—	—	—
M 13	46.8	17.0	—	—	—	8.5	2.1	2.1	—	—	—	2.1	—	—	2.1	14.9	—	—	2.1	—	2.1	—
M 14	16.3	10.2	—	2.0	—	6.1	—	—	2.0	—	—	—	10.2	—	10.2	10.2	20.4		12.2	—	—	—
H 01	17.4	13.0	2.2	2.2	—	—	—	—	—	—	—	—	—	—	—	32.6	28.3		2.2	2.2	—	—
H 02	2.0	20.4	—	2.0	12.2	18.4	4.1	—	8.2	—	—	—	12.2	—	—	22.4	—	—	—	2.0	—	—
K 01	6.3	10.4	6.3	—	—	4.2	6.3	—	—	—	—	—	2.1	—	—	45.8	12.5		—	4.2	—	—

M 01～14:Minamiotari Formation
H 01～02:Hokujo Formation
K 01 :Kawauchi Formation

Table 2-C Pebble composition in each locality of the southern part of the Omine Belt.

	Basement Rocks (%)									Tertiary Rocks (%)												
	Qp	Gr	Dr	Gb	Sp	Gss	Sl	Ch	Oths	dr	phy	cgl	ss	ms	bs	and	dac	rhy	wd	t	gr	oths
Om 01	44.0	14.0	2.0	—	—	12.0	8.0	2.0	—	—	—	—	—	—	—	—	2.0		16.0	—	—	—
Om 02	36.0	8.0	—	—	—	18.0	6.0	8.0	—	—	—	—	4.0	—	—	—	6.0		6.0	8.0	—	—
Om 03	68.0	16.0	—	—	—	2.0	6.0	—	—	—	—	—	—	—	2.0	2.0	—	—	12.0	—	—	—
Om 04	2.0	—	—	—	—	50.0	12.0	20.0	—	—	—	—	—	—	—	12.0	—	—	2.0	—	—	—
Om 05	42.0	8.0	—	—	—	12.0	6.0	2.0	—	—	—	—	—	—	4.0	18.0	8.0		—	—	—	—
Om 06	—	4.0	—	—	—	48.0	8.0	12.0	—	—	—	—	6.0	—	—	10.0	8.0		—	—	—	—
Om 07	32.0	24.0	—	—	—	24.0	10.0	4.0	—	—	—	—	—	—	2.0	—	4.0		—	—	—	—
Om 08	14.0	18.0	—	—	—	32.0	6.0	20.0	2.0	—	—	—	—	—	—	4.0	4.0		—	—	—	—
Om 09	4.0	2.0	—	—	—	28.0	4.0	30.0	—	—	—	—	—	—	8.0	22.0	—	—	—	—	2.0	—
Om 10	—	—	—	—	—	46.0	4.0	26.0	2.0	—	—	—	—	—	—	8.0	6.0		8.0	—	—	—
Om 11	4.0	2.0	—	—	—	38.0	—	48.0	—	—	—	—	6.0	—	—	—	—	—	—	—	2.0	—
Om 12	2.0	—	—	—	—	36.0	—	32.0	—	—	—	—	10.0	4.0	—	—	—	—	2.0	—	4.0	—
Om 13	—	—	—	—	—	49.6	2.1	12.5	—	—	—	—	41.7	—	2.1	—	—	—	2.1	—	—	—
Om 14	2.0	4.1	2.0	—	—	49.1	—	22.4	—	—	—	—	10.2	—	—	—	—	—	4.1	—	4.1	—
Om 15	—	—	—	—	—	6.0	2.0	42.0	2.0	—	—	—	38.0	4.0	—	—	—	—	—	—	6.0	—
Om 16	2.0	2.0	—	—	—	22.0	—	30.0	—	—	—	—	26.0	—	—	4.0	6.0		—	—	6.0	—
Om 17	2.0	8.0	—	—	—	20.0	—	14.0	6.0	—	—	—	2.0	8.0	—	2.0	—	—	2.0	—	2.0	—
Om 18	—	8.2	—	—	2.0	40.8	2.0	20.4	6.1	—	—	—	4.1	—	—	2.0	6.1		8.2	—	—	—
Om 19	—	6.0	—	—	6.0	28.0	2.0	24.0	2.0	—	—	—	26.0	2.0	—	2.0	2.0		—	—	—	—

(Om 01～19 : Omine Formation)

Table 2-D Pebble composition in each locality of the western part of the Takafu Belt.

	Basement Rocks (%)									Tertiary Rocks (%)												
	QP	Gr	Dr	Gb	Sp	Gss	Sl	Ch	Oths	dr	phy	cgl	ss	ms	bs	and	dac	rhy	wd	t	gr	oths
N 01	—	—	—	—	—	10.0	—	—	—	—	2.0	—	10.0	66.0	6.0	—		2.0	—	—	—	—
N 02	2.0	8.0	—	—	—	36.0	—	52.0	—	—	—	—	—	—	—	2.0	—	—	—	—	—	—
Kn 01	2.2	8.7	—	—	—	43.5	4.3	41.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kn 02	—	2.2	—	—	—	54.3	4.3	23.9	4.3	—	—	2.2	—	—	—	—	—	—	—	—	—	8.7
Kn 03	2.0	8.0	—	—	—	58.0	4.0	20.0	—	—	—	—	2.0	—	4.0	—	—	—	—	—	—	2.0
Kn 04	6.1	8.2	—	—	—	49.0	2.0	32.7	—	—	—	—	—	—	—	—	—	—	—	—	—	2.0

N 01～02 : Nakatsuchi Formation, Kn 01～04 : Kinasa Formation

QP : Quartz porphyry　Gr : Granite　Dr : Diorite
Gb : Gabbro　Sp : Serpentine　Gss : Graywacke sandstone
Sl : Slate　Ch : Chert　Oths : Others
dr : diorite　phy : porphyrite　cgl : conglomerate
ss : sandstone　ms : mudstone　bs : basalt
and : andesite　dac : dacite　rhy : rhyolite
wd : welded tuff　t : tuff　gr : green tuff

on each pebble. They are the length or the longest axis (a axis), the breadth or the intermediate axis (b axis), and the thickness or the shortest axis (c axis). Among the three diameters the length or the longest axis is chosen as a representative for grain-size scale in Fig. 4.

Grain shape is grouped into four classes according to the method by ZINGG (1935). Namely, two ratios, b/a and c/b, are taken as two axes of coordinates, and the area is divided into four parts as shown in Fig. 4-a. Accordingly,

Class I : disk-shaped
Class II : spherical
Class III : blade-shaped
Class IV : rod-shaped.

Roundness is represented according to the roundness scale proposed by POWER (1953).

The results of analyses are as follows:

A. Minamiotari Area

The Minamiotari Formation is subdivided into three members, i. e. the Uchu, Hosogai and the Iwatoyama Member in ascending order. The former two members consist mostly of sandstone and conglomerate.

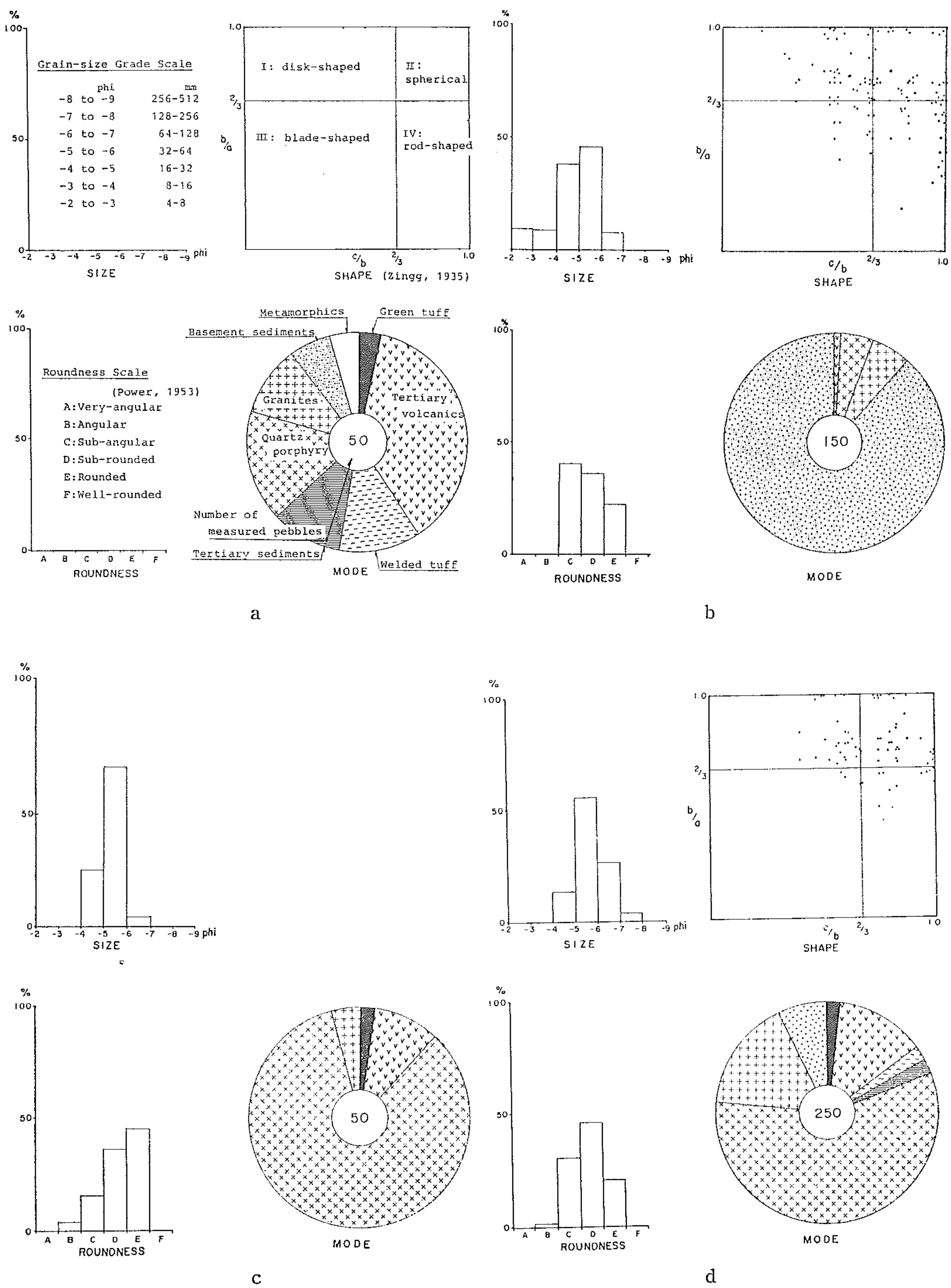
1. Uchu Sandstone-Mudstone Member

The Uchu Member consists mainly of sandstone and sandy mudstone, and it grades upward into conglomerates.

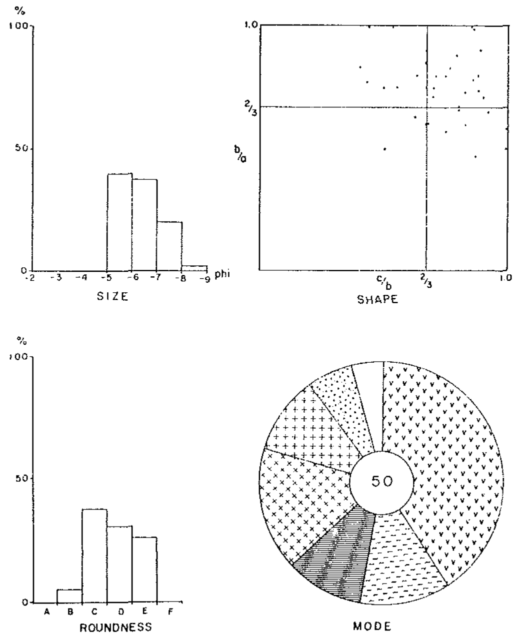
Localities M-02, -04 and -05 are all in the same lower part (horizons) of this member. The data of grain size, grain shape, roundness and pebble composition are summarized in Fig. 4-b. The histogram of size-frequency distribution shows that the chief ingredient (dominant class, maximum) is -5 phi to -6 phi in grade. As to pebble shape classes I and II (disk-shaped and spherical) are dominant, while classes C (subangular) to E (rounded) are dominant in roundness, in these localities. In pebble composition, they are composed mainly of such older sedimentary rocks (85. 8%-94%) as chert, graywacke sandstone and slate. But there are also some pebbles of granite (4. 0%-8. 7%), quartz-porphyry (2. 0%-8. 2%), and Tertiary volcanic rocks (2. 0%).

Localities M-06 and -07 are both in the upper part (horizons) of this member. The dominant classes of grain size range from -5 phi to -6 phi. Pebbles of class E are dominant in roundness. In pebble composition, they are in striking contrast to

* Though the synclines to the east of the Omine Belt are arranged en échelon and not parallel to the Omine Belt, other kind of zones are distinguished that are parallel to the Omine Belt. These zones, accordingly, cross the synclines obliquely. Among them that adjacently to the east of the Omine Belt is called the Takafu Belt, and next to the east the Arakura Belt (KOSAKA, 1979).



b : Lower Uchu Member c : Upper Uchu Member
d : Middle Hosogai Member



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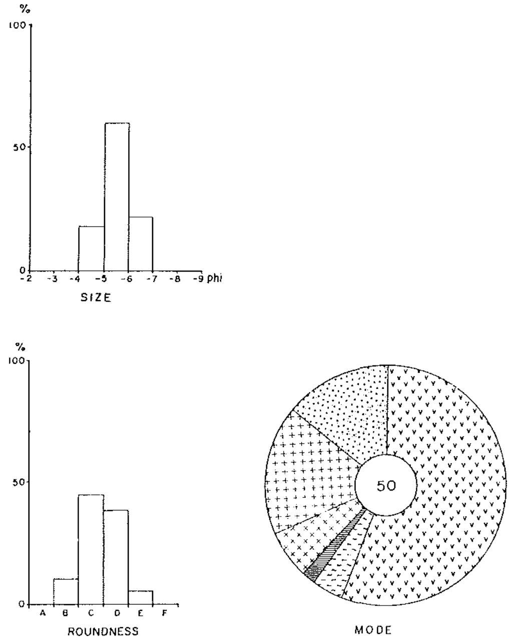

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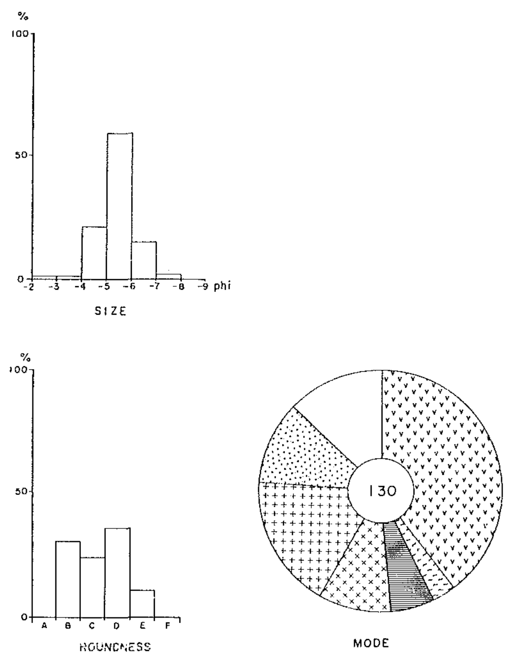

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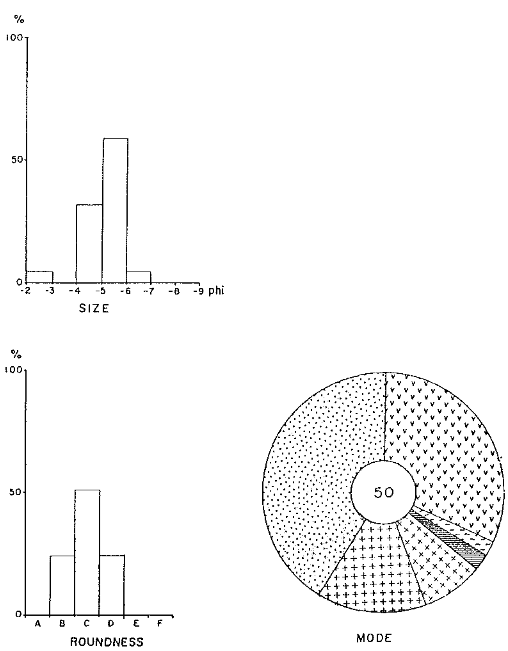
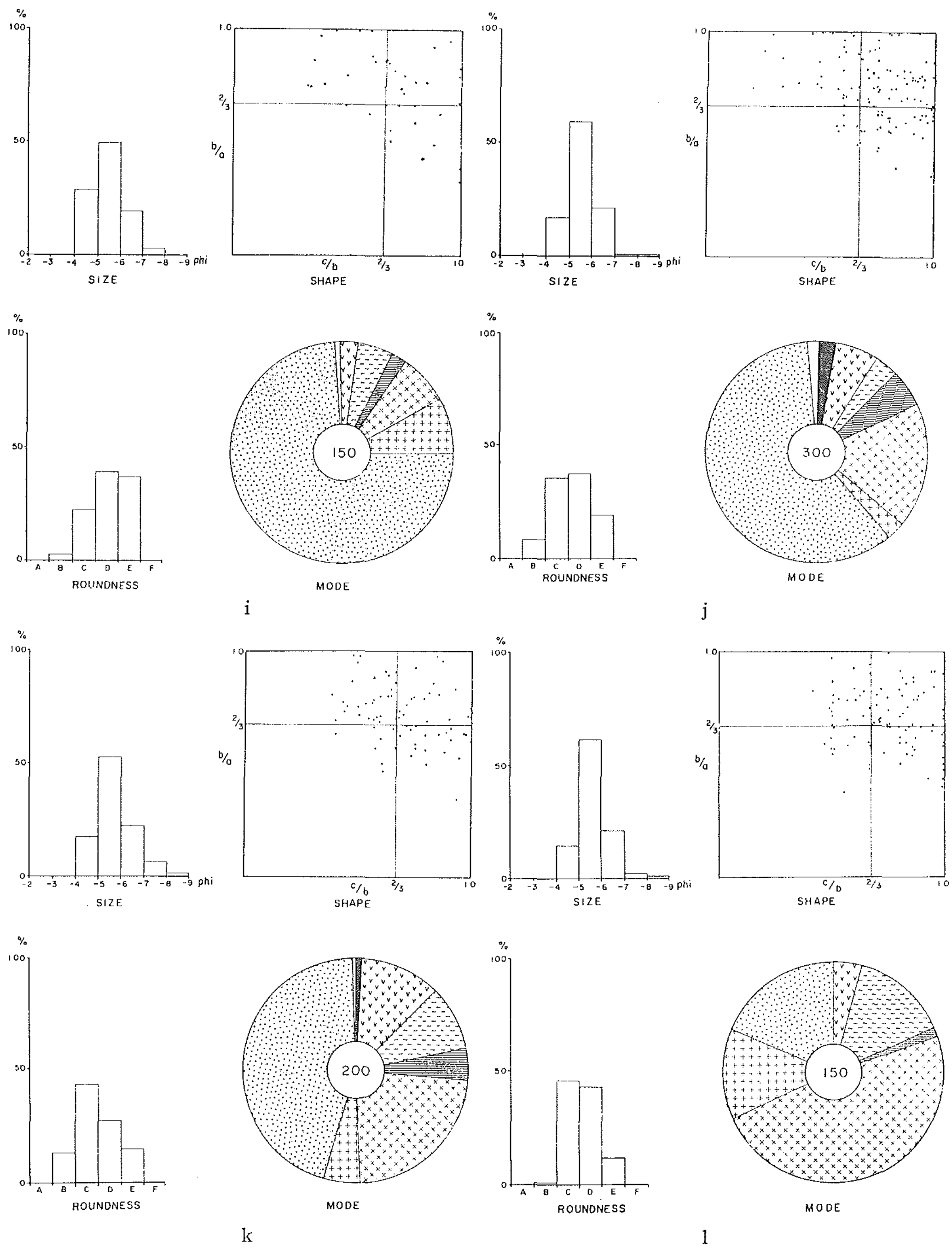


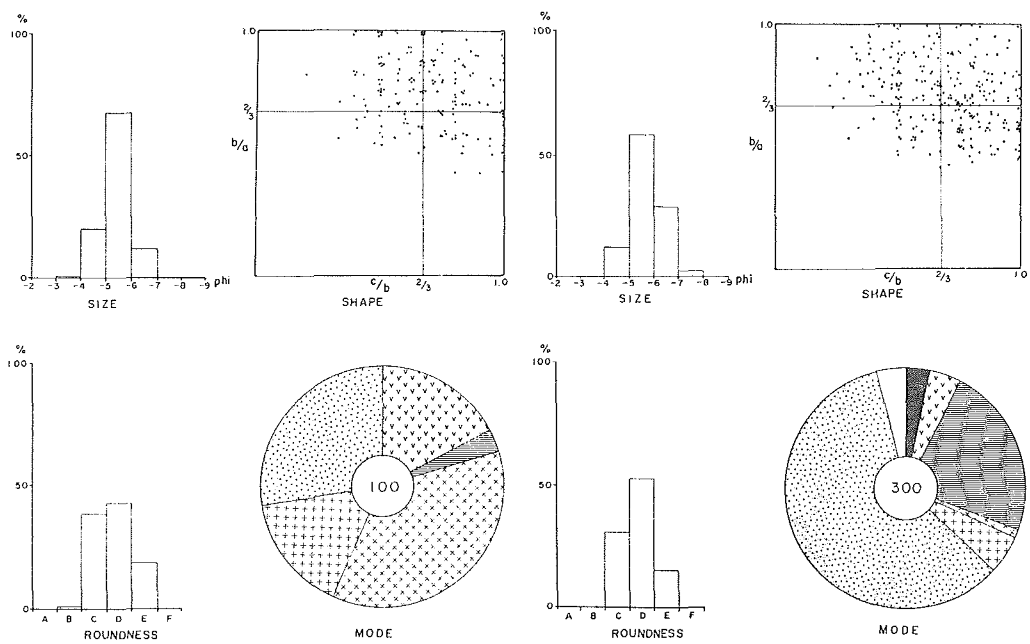
h

e : Uppermost Hosogai Member f : Kawauchi Formation

g : Hokujo Formation h : Kota Member



i : Toge Member
j : Shingyo Member (East limb of the Marukirizawa Syncline)
k : Shingyo Member (West limb of the Marukirizawa Syncline)
l : Lower Shinhikizawa Member



m

n

m : Upper Shinhikizawa Member

n : Oanayama Member

Fig. 4–a Scales and expressions of pebble analyses; size, shape, roundness and mode (pebble composition)

Figs. 4–b～n Data of pebble analyses from various parts within the Omine Belt

those of the lower horizons just introduced above. Namely, the older sedimentary rocks are rather rare (0%–16.3%), while pebbles of quartz–porphyry are very abundant (61.2%–82%) (Fig. 4–c).

2. Hosogai Tuff–Conglomerate Member

Six localities, M–08, –09, –10, –11, –12 and –13, are scattered in this member from the lower part to the upper part. The dominant classes of grain size are –5 phi to –6 phi. Pebbles of class numbers I and II of shape and of roundness class D (subrounded) are dominant. In pebble composition, they are composed mainly of quartz–porphyry (46.8%–68%), with some older sedimentary rocks (8.3%), granites (13.3%) and Tertiary volcanics (15.1%) (Fig. 4–d).

Locality M–14 is in the uppermost horizon of this member. The dominant classes of grain size are from –5 phi to –9 phi. Class number I in shape is dominant, while pebbles of roundness classes C to E are 30% or so in contents. In pebble composition, it is characterized by the abundance in pebbles of such Tertiary rocks as Tertiary sediments (10.2%), Tertiary dacitic to rhyolitic volcanics (20.4%) and welded tuff (12.2%) (Fig. 4–e).

B. Kawauchi Area

The Kawauchi Formation is subdivided into the lower, Chikuni and the upper, Sengenyama Member. They consist mostly of andesitic to dacitic pyroclastic rocks.

Locality K–01 is in the upper horizon of the Chikuni Member. The dominant classes of grain size are –5 phi to –6 phi, and roundness ranges from C to D. In pebble composition it is characterized by the abundance in Tertiary volcanics (58.3%), and by a lesser amount of older sedimentary rocks (10.5%) and also of quartzporphyry (6.3%) (Fig. 4–f).

C. Hokujo Area

The Hokujo Formation consists mostly of andesitic to dacitic pyroclastic rocks, but contains some intercalated conglomerates in its middle horizons.

In localities H–01 and –02, pebbles range in grain size from –2 phi to –8 phi, and the dominant classes are –5 phi and –6 phi. Roundness ranges from B so E. As a whole they are low–grade conglomerates in roundness and sorting.

In locality H–01, pebble composition is similar to that of M–14. Namely, Tertiary volcanics are rich attaining 60.9%, while quartz–porphyry and granite are 17.4% and 13% respectively. On the other hand, the pebble composition of locality H–02 is characterized by an abundance of gabbroic rocks, serpentinite and metamorphic rocks (22.4%), while granitic rocks (20.4%) and older sedimentary rocks (22.5%) are also significant. Pebbles of quartz–porphyry in this locality are rather rare being only 2% (Fig. 4–g).

D. Miasa Area

The Miasa Formation, which forms a NNE–SSW trending syncline (the Marukirizawa Syncline) with a plunge to the SSW, is subdivided into the Kota, Toge and the Shingyo Member in ascending order.

1. Kota Mudstone–Conglomerate Member

Massive mudstone facies with frequent intercalations of conglomerate beds are prevalent in this member.

Pebbles range in grain size from –2 phi to –7 phi, and the dominant classes are –5 phi to –6 phi. The dominant class of roundness is C. In pebble composition they are composed mainly of older sedimentary rocks (41.6%) and Tertiary volcanic rocks (31.3%), but quartz–porphyry (8.3%), diorites (6.3%), and granites (6.3%) are also present (Fig. 4–h).

2. Toge Sandstone–Mudstone Member

Localities Mi–01, –02 and –03 are in the west limb of the northern Marukirizawa Syncline. In these localities the dominant classes of grain size –5 phi to –6 phi. Spherical and disk–shaped pebbles (classes II and I) are dominant. Roundness classes

D to E are dominant.

In pebble composition they are composed mainly of older sedimentary rocks (31.6%–96%). Locality Mi–02 is characterized by the abundance of the pebbles of Tertiary sandstones and tuffs (Fig. 4–i).

3. Shingyo Conglomerate–Tuff Member

Localities Mi–05, –09, –10, –12, –17 and –19 are all situated in the east limb of the Marukirizawa Syncline. Pebbles range in grain size from –3 phi to –9 phi, and the dominant classes are –5 phi and –6 phi. Spherical pebbles (class II) are dominant. Roundness classes C and D are dominant. In pebble composition they are composed mainly of older sedimentary rocks (16%–86%), and quartz–porphyry and granites are less in amount (Fig. 4–j).

Localities Mi–06, –07, –08, –11, –13 and –15 are all in the western limb of the Marukirizawa Syncline.

The grade of roundness and sorting is lower than that in the eastern limb. Pebbles range in grain size from –4 phi to –9 phi, and they tend to increase in grain size from the eastern to the western limbs. The pebbles of classes I and IV (disk–shaped and rod–shaped) are abundant. There are some differences between Mi–07 and –16 on the one hand and Mi–08, –11, –13 and –15 on the other. In the former two localities the conglomerate is composed almost entirely of quartzporphyry pebbles, while the conglomerates of the latter four localities are similar to those of the eastern limb in pebble composition, roundness, shape and grain size (Fig. 4–k).

D. Omine Area

The Omine Formation is subdivided into the Shinhikizawa, Omine and the Oanayama Member in ascending order. The Omine Member is composed mostly of dacitic to rhyolitic pyroclastics. The other two members consist mainly of conglomerate and sandstone.

1. Shinhikizawa Conglomerate Member

Localities Om–01, –02, –03 and –04 are all in the lower horizons of this member. Pebble size ranges from –4 phi to –9 phi, and the dominant classes are –5 phi to –6 phi.

The dominant class numbers of shape are II and IV. Pebbles of roundness classes C and D are prominent. In pebble composition, they are composed mainly of older sedimentary rocks (21%), quartz–porphyry (36%–68%), granites (13%) and welded tuff (11,3%). In the locality Om–04, pebble composition is similar to that of the Oanayama Member (Fig. 4–l).

Localities Om–05, –06, –07, –08, –09 and –10 are all in the upper horizons of this member. Pebble size ranges from –3 phi to –9 phi, while the dominant classes are

–5 phi to –6 phi. The dominant class numbers of shape are I and II. Pebbles of roundness classes C to E are dominant.

In pebble composition, there are some differences between Om–05 and –07 on the one hand and Om–06, –08, –09 and –10 on the other. In the former two localities, quartz-porphyry attains 37%, granites 16%, older sedimentary rocks 29%, and Tertiary volcanics 18%. In the latter four localities, older sedimentary rocks are predominant (58%–76%), while Tertiary volcanics, quartz–porphyry and granites are very small in amount (Fig. 4–m).

2. Oanayama Member

The results of pebble analyses in nine localities, Om–11 to Om–19, indicate that the Oanayama Member consits mostly of coarse–grained sedimentary rocks with little lithofacies variation from the lower to the upper horizons.

Grain size ranges from –4 phi to –8 phi, and the dominant classes are –5 phi to –7 phi. The dominant class numbers of shape are I, II and IV. Pebbles of roundness classes C to D are predominant.

The Oanayama Member is characterized by the predominant older sedimentary rocks (50%–86%) and subordinate Tertiary sedimentary rocks (20%) (Fig. 4–n).

E. Other Areas

For the purpose of comparison conglomerates from several localities in the Takafu Belt of the highly folded, eastern, Tertiary area are examined.

Localities N–01 and –02 are in the Nakatsuchi Formation, and Kn–01, –02, –03 and –04 are in the Kinasa Formation. Exscept the locality N–01, all of the rest are characterized by the abundance of older sedimentary rocks (80%). These conglomerates bear a strong resembrance in lithology to that of the lower Minamiotari Formation (Uchu Member) in the Omine Belt.

IV. Paleocurrent and a Facies Model for the Sedimentation in the Area of Marukirizawa Syncline

A. Paleocurrent induced from the fabric of conglomerate

Attitudes (azimuths and dips) were measured in outcrops on pebbles, of which values of a/c were larger than 2. The diagrams, A–F, of Fig. 6 are constructed by plotting the azimuths and dips of c–axes on the lower (southern) hemisphere of a stereonet. The locations of observation, A–F, are shown in Fig. 5.

As is well known there are intimate relations between the attitudes of pebbles in conglomerates and the direction of streams under which the pebbles were transported and deposited. Two cases are known as they occur in general.

1) a–axis lies at right angles tothe direction of stream and b–axis inclines upstream.

2) a–axis lies parallel to the direction of stream, and inclines upsltream.

The former attitude is observed generally in the river gravel of land areas (TWENHOFEL, 1932 ; SEDIMENTARY PETROLOGY SEMINAR, 1965 ; RUST, 1972), while the latter, though it is uncommon, is said to be found in conglomerates that were formed under the deep sea by a process of turbidite formation (DAVIS and WALKER, 1974 ; WALKER, 1975, 1977, 1978).

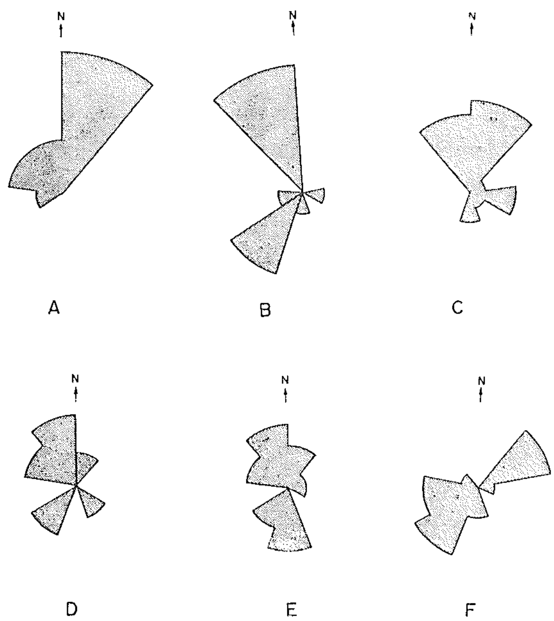


Fig. 6 Orientation of pebble axes, showing the directions or paleocurrents.

Fig. 5 Geological map of the Marukirizawa Syncline and its surroundings (after KOSAKA, 1982),

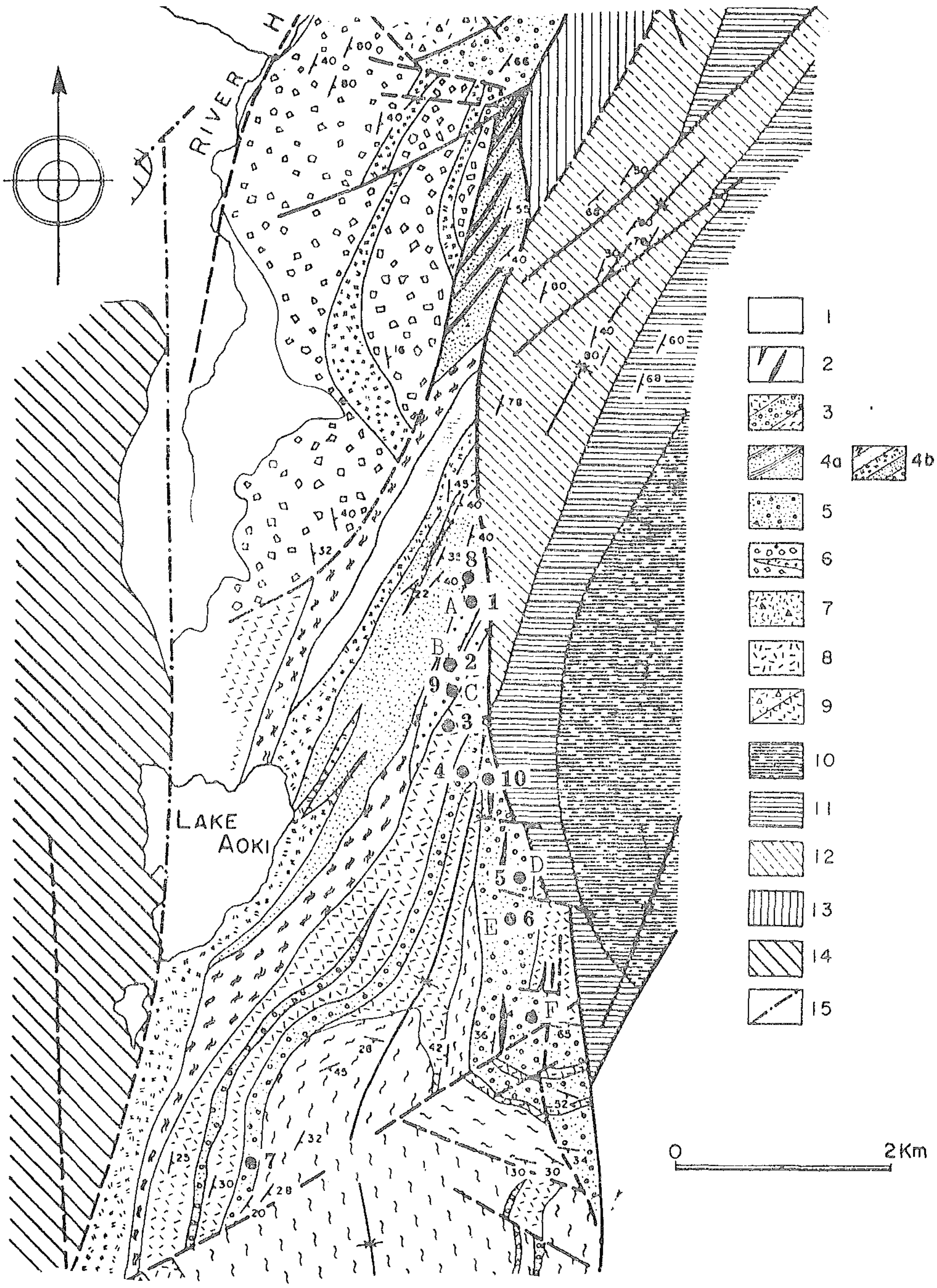
A～F and 1～11 in this figure indicate the localities of the examinations and observations that are illustrated in Figs. 6 and 7.

(Explanation)

1. Quaternary (Middle Pleistocene～Alluvium)
2. Andesitic～basaltic dikes
3. Shingyo conglomerate–tuff M.
4. Toge sandstone–mudstone M. (a : lower b : upper)
5. Kota mudstone–conglomerate M. (3～5 : Miasa F.)
6. Gosyakubo volcanic conglomerate–tuff M.
7. Kayo volcanic breccia–lava M.
8. Tatenoma tuff breccia–lava M.
9. Takatoyama tuff breccia–lava M./Suge tuff M. (6～9:Hokujyo F.)
10. Hiratokozawa sandstone–mudstone M.

11～13. Yanagisawa sandstone-mudstone M.

14. Older rocks (Pre–Tertiary)
15. Itoigawa-Shizuoka Tectonic Line


RIVER
LAKE AOKI
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B
C
D
E
F
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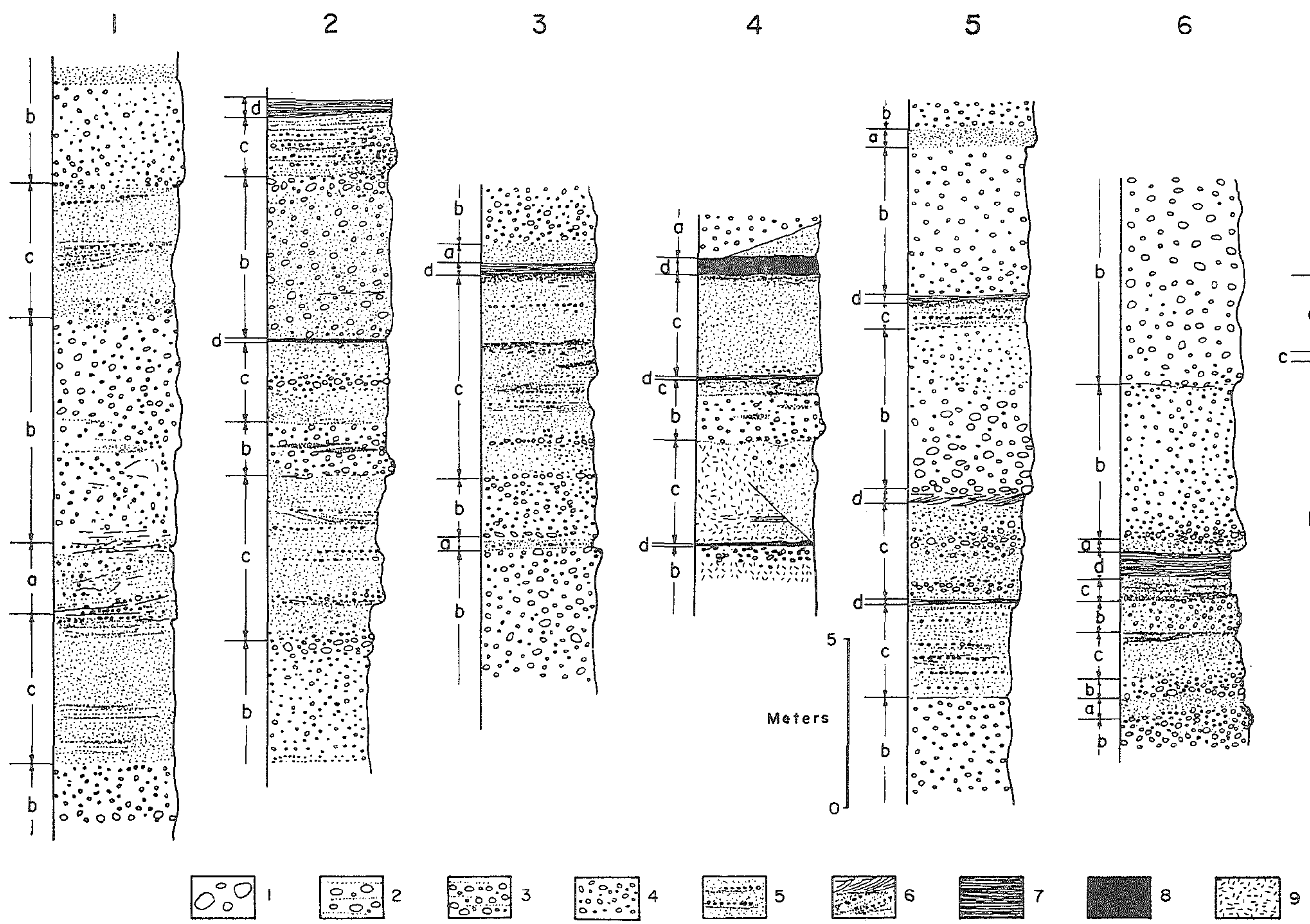

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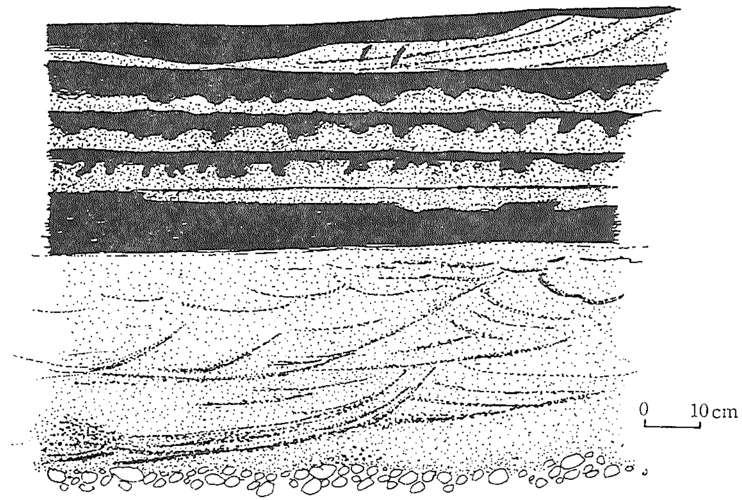

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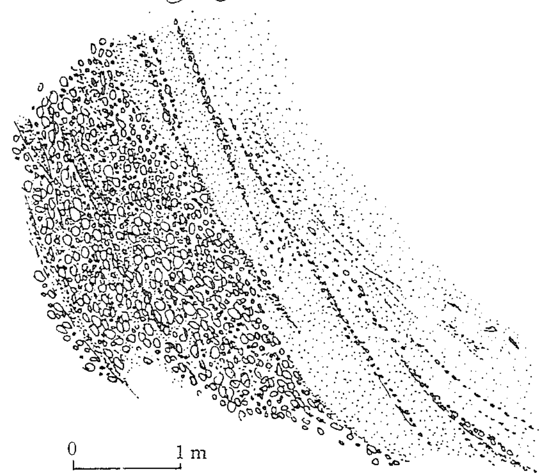

1 : Toge Member (Kawade) 2 : Toge Member (Toge)
3 : Toge Member (Ishiwara)
4 : Shingyo Member (Ishiwara)
5 : Shingy Member (Togezawa)
6 : Shingyo Member (Marukiri–zawa)
7 : Shingyo Member (Forest road, Chigusa Line)
8 : Toge Member (Ozo) 9 : Toge Mmeber (Toge)
10 : Toge Member (Shiokawa)

Fig. 7 Sedimentary facies or units of cyclothems of the coarse clastics observed in the northern part of the Marukirizawa Syncline. Symbols a～d in 1～7 sections indicate the subunit of schematic sequence model proposed in the Section B.

The diagrams of Fig. 6, except that of F (from Ikenotaira), show that many of a–axes lie in directions around E–W, and b–axes dip either toward N–NE or toward S–SW. It suggests that prevalent streams were parallel or subparallel to the elongation of the Omine Belt, and that flows were either from S to N–from SW to NE or from N to S–NE to Sw. It is consistent with the fact that welded textures are observed generally in the tuff beds of the Omine Belt, which suggests again the subaerial and terrestrial sedimentation of the conglomerates.

B. Facier Model

In this area a kind of small sedimentation cycle or a cyclothem is observed generally and frequently in the sequence of clastic sediments. The cycle is represented by a unit of sediments about 5–10 m thick, and fining upward. The unit is composed, when it is complete, of four subunits (Fig. 8) that are named tentatively a, b, c and d from bottom to top. A complete unit with all of the four subunits is rather infrequent, i. e. one or two subunits are often missing, and a unit is represented, in many cases, by only one or two subunits. The succession or the order of superposition from a to d, however, is invariable (Figs. 7–1—10). The characteristics of each subunit are as follows.

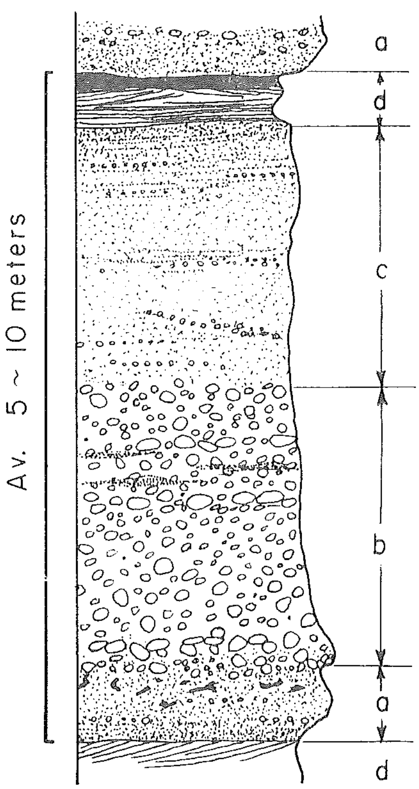

Fig. 8 Sedimentary sequence model or an idealized complete unit of cyclothem for the northern part of the Marukiri-zawa Syncline.

a : This is the lowermost part of one unit. It is from several tens of cm to one m thick, and consists of medium-grained sandstone. Inverse grading is frequent in this part. Thin layers of granule conglomerate are intercalated occasionally (Figs. 7–1, –3, –5, –7).

b : This is the thickest part of the sequence, and consists of cobble–boulder conglomerates. They are massive in general, and are devoid of distinct sedimentary structures. In some cases, however, imbricate structures of cobbles and boulders as well as normal grading are observed. Thin layers of boulders and/or medium–to coarse–grained sandstone are intercalated occasionally in the cobble conglomerate.

Fragments of mudstone from the underlying strata are found rarely (Figs 7–1, –5, –6, –7, –8, –10).

c : It is 1–4± m thick, and consists of medium to fine-grained sandstone. In some parts discontinuous parallel laminae or cross laminae are observed. Layers of cobble conglomerate are intercalated frequently (Figs. 7–1—3, –5—10).

d : This is the uppermost subunit in one unit, and is 20 cm to 1 m in thickness. Mudstone is the chief constituent of this subunit, but sandy or peaty mudstones are also present in some cases. Very fine parallel laminae and cross laminae are observed occasionally (Figs. 7–4—7, –9, –10).

V. Discussion --- Significance of the Sedimentary facies of the Marukirizawa Syncline

Two larger cycles of sedimentation and volcanism (volcano-sedimentary cycles) are evident in the Omine Belt, in which coarse clastic sediments mainly of conglomerates and pyroclastic rocks of intermediate–acidic rocks play important roles. One example of the coarse sediments is seen in the Uchu and Hosogai Member of the Minamiotari Formation forming the Iwatoyama Syncline, and the other in the Toge and Shingyo Member of the Miasa Formation which forms the Marukirizawa Syncline. Of these the sediments of the Marukirizawa Syncline are analysed above, and considered below.

The results of the analyses illustrated in Fig. 4 show that the clasts are coarser in the west and south, and finer in the north and east. On the other hand, volcanic rocks are richer in the west and south, and poorer in the north and east. It suggests that the main souce area was to the west or southwest. This is consistent with the hinterland estimated from the pebble composition (KOSAKA, 1980 b), and also with the paleocurrent induced from fabric of conglomerates. But it should be borne in mind that there are also much clasts that have been supplied from the eastern Tertiary areas and also from within the Omine Belt itself.

As noted above the unit of small sedimentation cycle illustrated in Fig. 8 is widespread in the Omine Belt, and especially frequent in the Marukirizawa Syncline. This facies of sedimentation, together with the welded textures of pyroclastics and the absence of marine fossils, show unquestionably that the clasts and pyroclasts were deposited under the subaerial and terrestrial conditions.

In these days nany papers are published that deal with alluvial fan deposits and the like of the present–day and geological examples. They are known to occur in connection with the formation of large faults and rift valleys (BLUCK, 1967 ; MCGOWEN & GROAT, 1971; STEEL, 1974 · 1976 ; WALKER, 1976a · b · c ; MIALL, 1977, 1978 a ; RUST, 1978 ; etc.).

MCGOWEN & GROAT (1971) distinguishes three facies, i. e. 1) proximal facies,

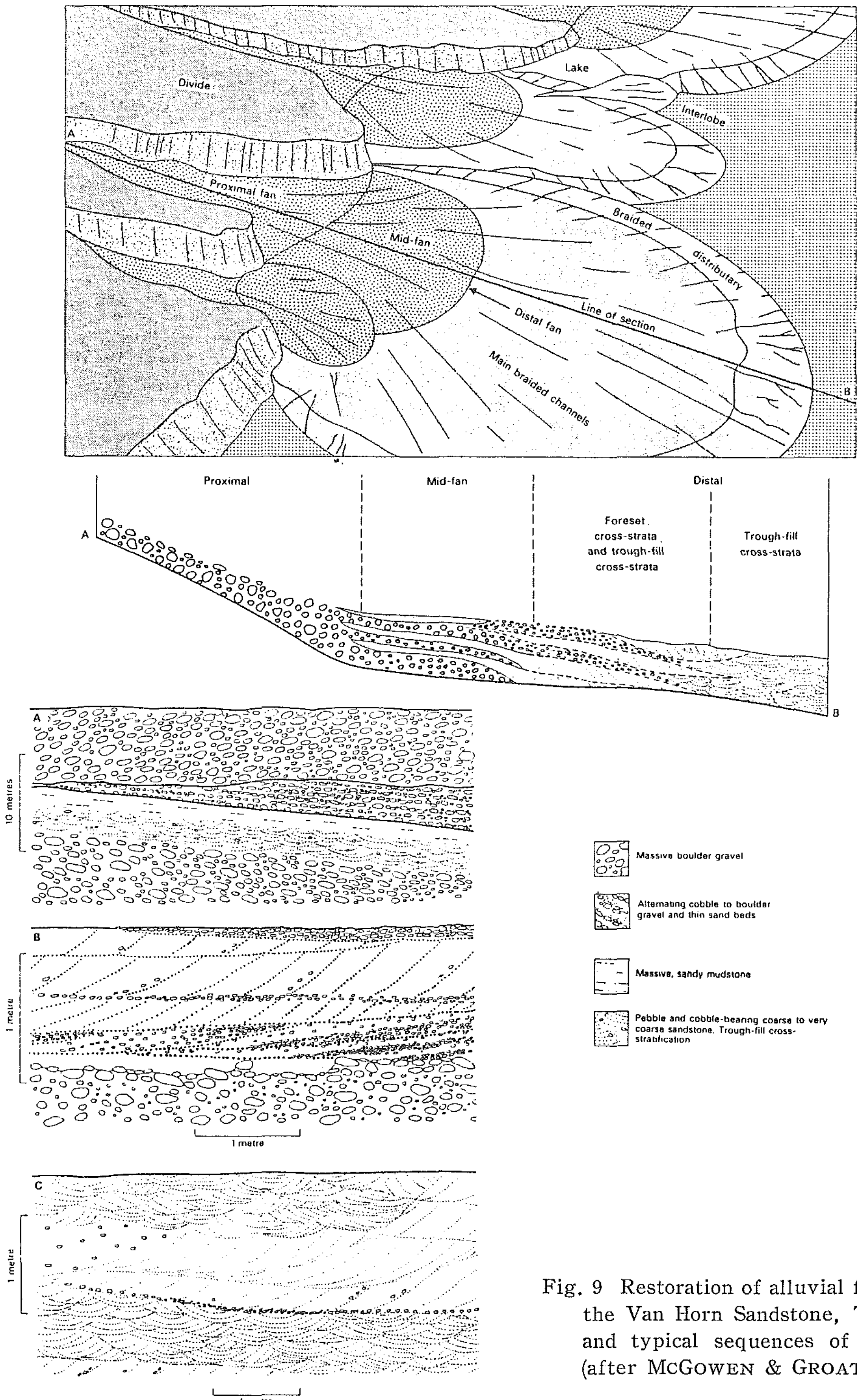

Fig. 9 Restoration of alluvial fans of the Van Horn Sandstone, Texas, and typical sequences of facies (after McGOWEN & GROAT, 1971).

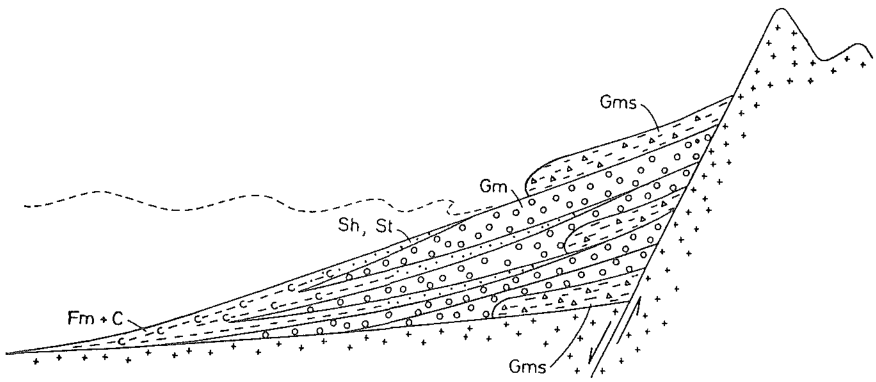

Fig. 10 Diagrammatic cross section of a alluvial fan (after RUST, 1979).

2) mid-fan facies, and 3) distal setting facies, in the alluvial-fan deposits of the Precambrian Van Horn Sandstone in Texas, and they illustrates the features and relations of these facies as shown in Fig. 9. RUST (1979), upon the basis of the facies model proposed by WALKER (1976 a) and MIALL (1977) for coarse-grained alluvial sediments, distinguishes four kinds of circumstances of sedimentation. These are, 1) alluvial fan, 2) proximal braided rivers and braidplains, 3) distal braided rivers and braidplains, and 4) meandering rivers (Fig. 10).

When compared with these instances, the coarse clastic sedimentsof the Marukirizawa Syncline, probably, are attributed either to the mid-fan facice of MCGOWEN & GROAT or to the proximal braided river-braidplain of RUST. In other words the coarse clastic sediments of the Marukirizawa Synclineare understood as forming a part or parts of a far larger alluvial fan. In this connection, significant is the occurrence of a sequence of coarse deposits to the south and southwest which shows a proximal fan facies. Also there is a sequence of deposits to the north of this area, which has distal fan facies.

A large fan was undoubtedly formed at the time of sedimentation of the Miasa Formation centering at the area of Marukirizawa Syncline, wherein a large amount of clasts were supplied from the western or southwestern mountains of older rocks The ancieut alluvial fans in the Omine Belt is illustrated schematically in Fig. 11.

Concluding Remarks : Sequences of alluvial fan deposits with intercalations of pyroclastic rocks occur in several horizons and in various parts within the Omine Belt, which is really a graben limited by large faults on both sides.

Several large fans are now found along the western margin of the present-day Matsumoto Basin just along the foot of the Japanese Alps. Many but tiny fans are now under construction along the eastern margin of the same Basin (YAMASHITA et al., 1982). The History of the Omine Belt extends into the development of the

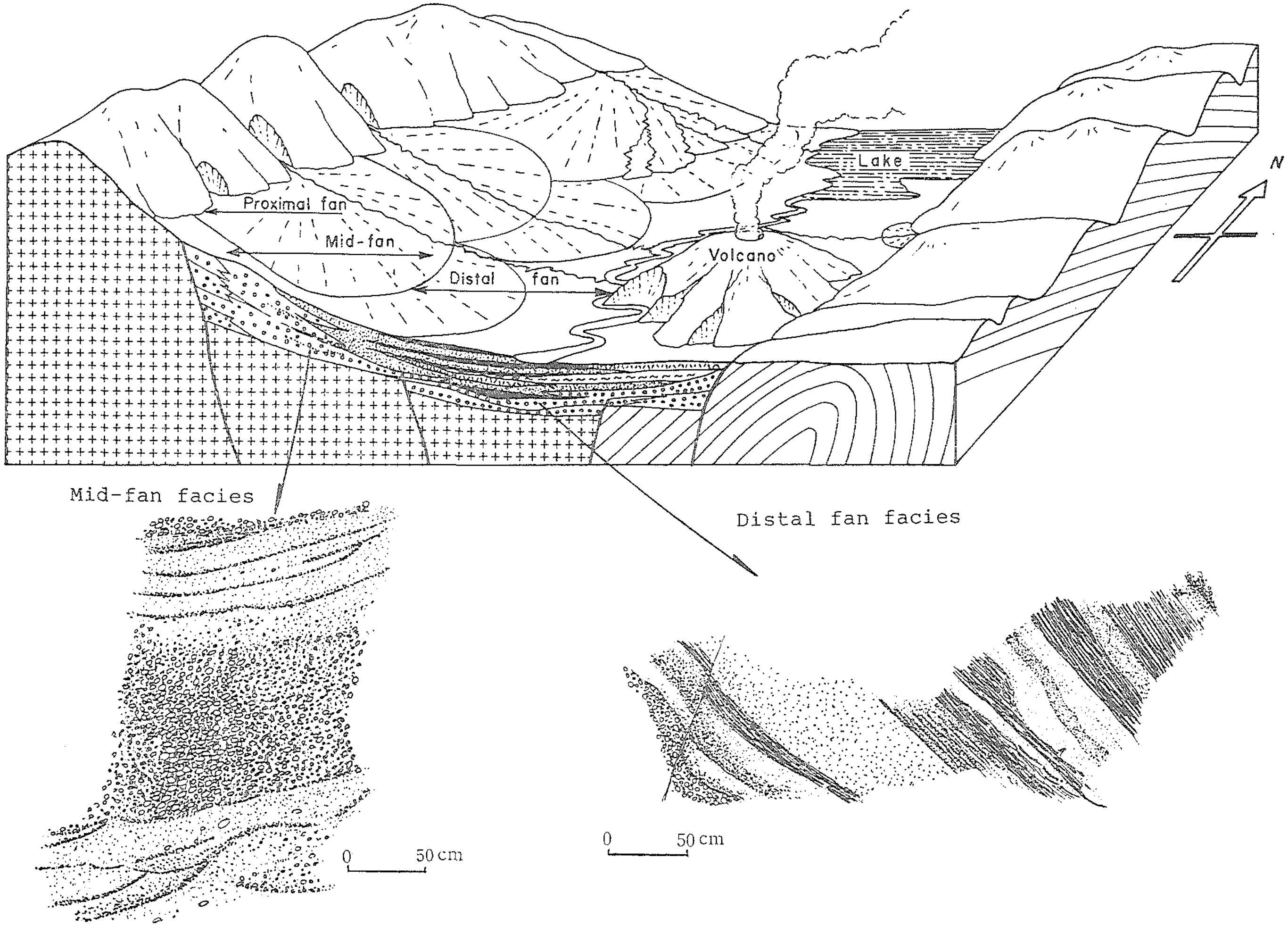

Fig. 11 Schematic presentation of alluvial fans, facies of fan deposits and a volcano in the ancient Omine Belt.

present–day Matsumoto Basin. It is a history of a graben–formation and, at the same time, a history of successive accumulation of alluvial fans.

Though the facies model or the unit of cyclothem here introduced represents only a part (mid–fan) of a large fan deposits, the remaining parts, i. e. the proximal and distal parts, will be revealed soon from other areas of the same Omine Belt.

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