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ORTHOQUARTZITIC ROCKS AS PRECAMBRIAN BASEMENTS OF THE JAPANESE ISLANDS

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Abstract Orthoquartzitic clasts have been discovered since 1967 in various places in the Japanese Islands, of which horizons range in age from Carboniferous to Quaternary. Texturally and mineralogically, they belong to the supermature sandstones distributing extensively in cratonic areas of the world. They are supposed to have been supplied from pre-Silurian (probably Precambrian) basement rocks, whether directly or secondarily. This is inferred from textural and mineralogical peculialities of orthoquartzitic rocks themselves because of the reason that there had been no chance in and around the Japanese Islands of producing such supermature sandstones since the Silurian. This is also supported from the geochronologic studies on orthoquartzitic clasts. Generally, orthoquartzitic clasts are very small in amount, however, there are known several sequences in which they are commonly found as a major constituent of the conglomerates in the Kitakami-Abukuma, Hida, Mino-Tamba and Shimanto Belts. The maximum size of the clast sometimes attains to several tens centimeters. The provenances of orthoquartzitic clasts in these belts are assumed to be or to have been in the Abukuma Mountains, Oyashio Paleoland in Off-Sanriku area, Hida Mountains, Missing Ryoke along the Median Tectonic Line, and the Kuroshio Paleoland to the south of the Shimanto Belt, respectively. It is likely in pre-Silurian, or Proterozoic, time that the Japanese Islands had long been a cratonic area where orthoquartzitic rocks were extensively formed. The hypothesis that Precambrian rocks are involved in younger orogenic belts is supported in the case of the Japanese Islands from the study on orthoquartzitic clasts.

Introduction

Whether Precambrian rocks are involved in younger orogenic belts or not is a problem that has long been debated among geologists. As the Japanese Islands are one of the places where the most precise geologic work has been performed in the cirum-Pacific Orogenic Belt, the most valuable informations on this problem should be obtained from these regions. It is well-known that the Japanese Islands entered into the first geosynclinal stage called the Honshu Geosyncline, or the Chichibu Geosyncline, since middle Paleozoic time. Therefore, the basement rocks of the Japanese Islands are defined as the materials underlying the Honshu Geosyncline. It is a matter of course that the rocks suffered through the Caledonian Orogeny, if present, are assigned to be a part of the basements as well as Precambrian rocks. Concerning the orogenic cycles in the Japanese Islands, KOBAYASHI (1941) insisted for the first time that the Japanese Islands has been floating on "*SIMA*", the oceanic crust in the present expression, since the earliest time of the known history of the islands. After World War II, a plenty of work have been made in the Japanese Islands, offering many evidences for the existence of the basement rocks, although most of them occupy small and scattered places. Referring to these data, MINATO *et al.* (1965) insisted that the Japanese Islands was born on a craton which must have been a part of the Asiatic Continent. Thereafter the data supporting the above opinion have been increasing so much. Nowadays, the Japanese Islands are interpreted on the basis of the Plate-Tectonics Theory, and the basement rocks ever found are often assigned to be large exotic blocks or remnants of collided

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microcontinents. In this paper, the writers will not refer to such points, because the most important problem now facing is not the interpretation but the detailed examination of the basement rocks themselves.

According to NOZAWA (1975), the possibility of the basement rocks in the Japanese Islands is itemized in the following ways: first, metamorphic rocks overlain by Paleozoic formations; secondly, isolated masses of metamorphic and plutonic rocks along tectonic zone; thirdly, relicts of presumably pre-Silurian metamorphic rocks retained in younger rocks; and fourthly, fragments of presumably pre-Silurian rocks in younger sedimentary and igneous rocks. Concerning the last one, many contributions have been made especially on igneous and metamorphic clasts in sedimentary sequences from petrographic and geochronologic viewpoints (KANO, 1971; SHIBATA *et al.,* 1971; etc.). On sedimentary clasts, however, there have scarcely been performed any contributions except those on clasts of orthoquartzite (quartz arenite) owing to the difficulty of affirming their origin. As to the orthoquartzitic clasts occurred in the Japanese Islands, their origin can safely be assigned to a part of certain basement rocks on accounts of their textural and mineralogical peculialities. The above estimation was supported from the geochronologic studies by SHIBATA (1979) and SHIBATA *et al.* (1979). Orthoquartzite is widely distributed in the cratonic areas in the world and a plenty of work on it have been reported and still now it is a most interesting problem in sedimentary petrology (for instance, see DOTT and BYERS, 1980). Unfortunately, orthoquartzitic rocks are unfamiliar to the Japanese geologists living in a belt of evercontinuing severe orogenic movements, and their occurrences as clasts in conglomerates had not become aware of before 1967. In Southwest Japan, the author (T. T.) discovered orthoquartzitic clasts from the Paleogene strata in the Shimanto Terrain for the first time and discussed their bearing as the basement rock of the Japanese Islands (TOKUOKA, 1967), because they closely resemble in appearence to the Sinian quartzite of the Proterozoic, being distributed extensively in China and Korea (for instances, LIU *et al.,* 1973; Chinese Academy of Geological Sciences, 1980). Almost simultaneously in Northeast Japan, the author (K. O.) discovered them and reported in 1973. Thereafter, many discoveries have been reported from various places in Japan, although they mostly occur very rare in amount. The strata containing them range in age from Carboniferous to Quaternary.

In this paper, the writers will mention their occurrences briefly and discuss about their bearings as basement rocks of the Japanese Islands.

Occurrence of orthoquartzitic clasts in the Japanese Islands

Orthoquartzitic clasts have been known to occur in conglomerates of various places in Japan, of which horizons are from Carboniferous to Quaternary in age. Fig. 1 and Table 1 show their occurrences, the data of which are derived from a review by the authors (TOKUOKA and OKAMI, 1979) with several new additions. Generally, orthoquartzitic clasts are small in size, well-rounded in shape, and very small in amount. Larger clasts and less-rounded ones are very rarely found in some sequences. It is of particular interest that there exist several sequences in which orthoquartzitic clasts are commonly found as a major constituent of the conglomerates. In the discussion on the basement rocks of the Japanese Islands, these sequences seem to have very important roles, and are mentioned briefly as follows.

A. Kitakami-Abukuma Belt

The occurrence of orthoquartzitic clasts in the Kitakami-Abukuma Belt has become apparent by OKAMI (1973), OKAMI *et al.* (1976), etc. in six localities, whose horizons are from Carboniferous to Paleogene in age.

In the Abukuma Mountains, the amount of orthoquartzitic clasts of the Somanakamura Group (Loc. 4), Sarukubo Conglomerate* (Loc. 6), and Oginohama-Ayukawa Subgroup (Loc. 3), all

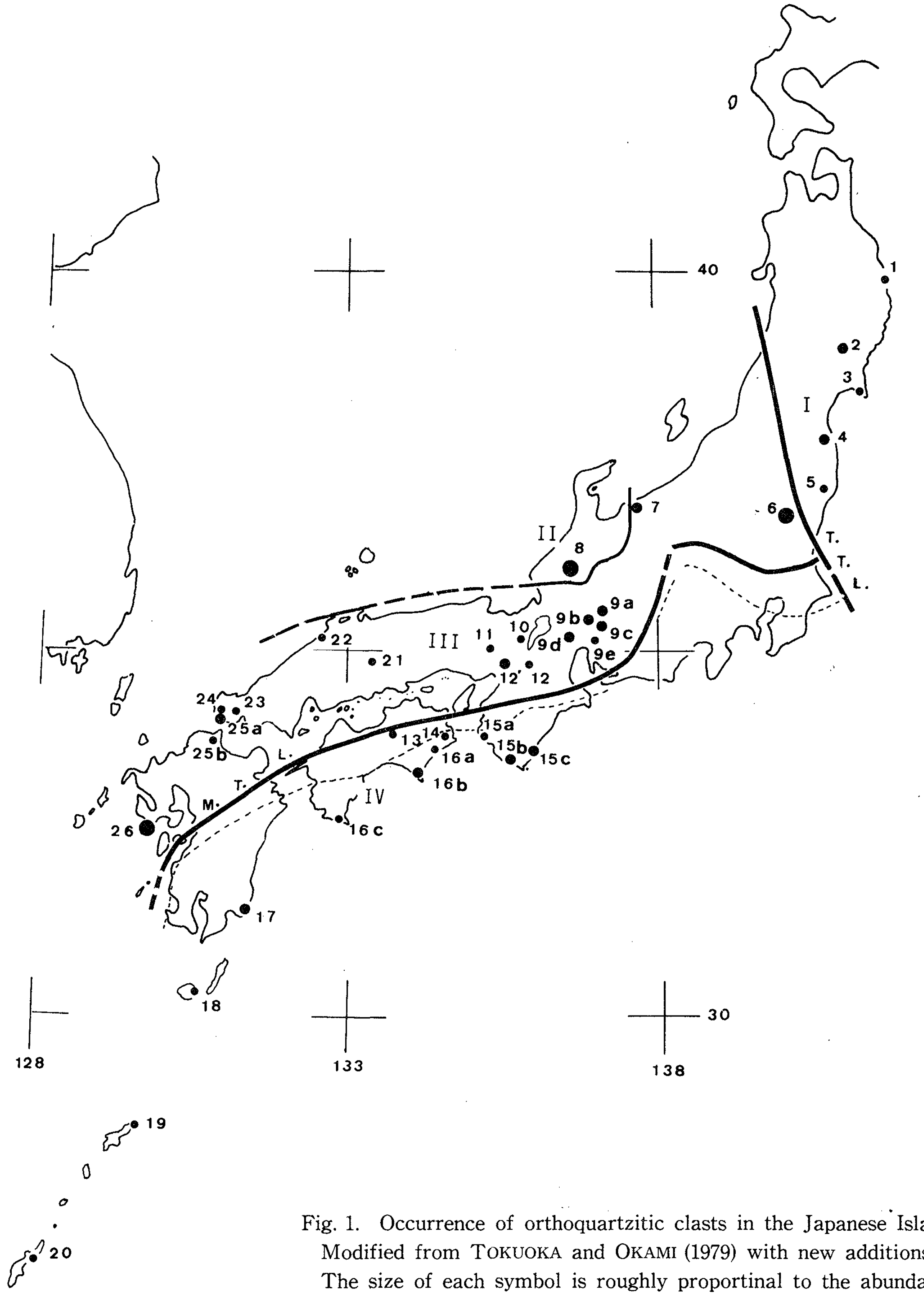

Fig. 1. Occurrence of orthoquartzitic clasts in the Japanese Islands. Modified from TOKUOKA and OKAMI (1979) with new additions. The size of each symbol is roughly proportinal to the abundance of orthoquartzitic clasts. Details see Table 1.

I Kitakami-Abukuma Belt
II Hida Belt
III Mino-Tamba Belt
IV Shimanto Belt (south of broken line)
T.T.L. Tanakura Tectonic Line
M.T.L. Median Tectonic Line

* The Sarukubo Conglomerate locates in the Ashio Belt, southwest of the Tanakura Tectonic Line, however, its hinterland is assumed to have been in the Abukuma Mountains. Then, it is treated in the present section.

Table 1. Occurrence of orthoquartzitic clasts in the Japanese Islands. Modified from TOKUOKA and OKAMI (1979) with new additions. References are partly omitted.

Loc. No.	Formation or Group	Age	Occurrence	Max.size in cm	Supply	K-Ar Age* (Ma)	Remarks
1	Harachiyama	L. Cret.	1	pebble	SE		TOKUOKA, 1973
2	Karaumedate	L. Carb.	3	pebble	N		OKAMI *et al.*, 1973
3	Oginohama & Ayukawa	Jurassic	2	13	SW & E		OKAMI (in TOKUOKA & OKAMI, 1979)
4	Somanakamura	Jurassic	3,4	20	NW & W	518±16	OKAMI *et al.*, 1976
5	Iwaki	Paleogene	1	7	W		OKAMI, 1973; OKAMI & MORI, 1976
6	Sarukubo	Jurassic	4	30	SE or E	553	OKAMI, 1973
7	Kurobishiyama	Cretaceous?	3	7		478±16	TOKUOKA *et al.*, 1969
8	Tetori	Cretaceous	5	45	N	778 555±21 551±18 468	*ibid.*; SOMA & OHSETO, 1977
9-a	Kamiaso	Tr. - J.	3	10	N	324 265	ADACHI, 1971
9-b	Sakahogi	Tr. -J.	3,4	cobble	SW	266±16	KONDO & ADACHI, 1975
9-e	Mizunami	M.Miocene	1	pebble			TENPAKU *et al.*, 1981
10	Tamba	Perm. - Tr.	1	pebble	S		TAMBA R.G., 1971
11	Sasayama	L. Cret.	2	13	S?		IMOTO *et al.*, 1977
12	Tsuzuki	M. Miocene	1	cobble			ISHIGA *et al.*, 1977
12'	Osaka	Pliocene	4	13			YAMASHIRO Research Gr., 1980a, b
13	Oboke	Paleozoic?	1	pebble	S?		KOJIMA, 1973
14	Nakagawa	U. Triassic	1	10-15			ISHIDA, 1977
15-a	Hidakagawa	U. Cret.	1	pebble			NAKAYA (unpublished)
15-b,c	Muro	Olig. - L. Mio.	3,4	26	S	309±13	TOKUOKA, 1967; TOKUOKA & BESSHO, 1980
16-a	Hiwasa	U. Cret.	1	pebble			KUMON (1981)
16-b	Naharigawa	Oligocene	3	pebble	SE		KUMON & INOUCHI, 1976
16-c	Shimizu	Oligocene	1	pebble			HARATA *et al.*, 1970
17	Nichinan	Oligocene	2,3	pebble	E		*ibid.*
18	Isso	Oligocene	1	pebble	E?		*ibid.* NAGAHAMA & SAKAI, 1972
19	Wano	Eocene	1	pebble	SE		HARATA *et al.*, 1970
20	Kayo	Eocene	1	pebble			KONISHI *et al.*, 1973; FUKUDA *et al.*, 1978
21	Nariwa	U. Triassic	2,3	pebble			MIKAMI & KIYA, 1978
22	Fujina	Miocene	3	8			INOUE, 1981
23	Mine	U. Triassic	1	pebble			MURAKAMI & IMAOKA, 1980
24	Toyonishi	U. Jurassic	3	6		202±7	TAKAGI, 1979
25-a	Hatabu	M. Miocene	3	17	NE	216±15	*ibid*
25-b	Ideyama	Tertiary	1,2	pebble			*ibid*
26	Kayagi	U. Cretaceous	5	cobble			NISHIMURA, 1979

* K-Ar ages by SHIBATA (1979) and SHIBATA *et al.* (1979)

The frequencies of occurrence are: 1. *very rare* (less than 1%); 2. *rare* (less than 1%); 3. *rare but easy to find* (1-7%); 4. *common* (7-20%); 5. *abundant* (more than 20%), respectively.

of which are of Jurassic in age, are 6 to 22, 4.2 to 6.9, and 3 percent, respectively. The maximum diameter of the clast attains to 30cm in the Sarukubo Conglomerate. The sequences containing these clasts are fluviatile sediments, and are inferred to have been supplied from the Abukuma Mountains and, partly from the Off-Sanriku area (OKAMI *et al.*, 1976; TAKIZAWA, 1977). In the Paleogene Iwaki Formation (Loc. 5), orthoquartzitic clasts are less than one percent in amount, and the maximum size of which is about 7cm in diameter.

In the Kitakami Mountains, orthoquartzitic clasts have been detected in the Carboniferous Karaumedate Formation (Loc. 2) and the Cretaceous Harachiyama Formation (Loc. 1). In both formations, they are less in quantity and smaller in size. The former formation has been known as the lowest horizon accompanied with orthoquartzitic clasts in the Japanese Islands.

Orthoquartzitic clasts in the Kitakami-Abukuma Belt are inferred to have been reworked secondarily from underlying conglomerates from the sedimentary petrographic studies by OKAMI and MORI (1976) and OKAMI *et al.* (1976).

B. Hida Belt

Orthoquartzitic clasts are abundantly contained in the upper part of the Tetori Group (strictly, in the Cretaceous Akaiwa Subgroup, Loc. 8). They sometimes exceed more than 70 percent in amount, and the biggest one is larger than 45cm in diameter. The upper part of the group is of fresh-water origin, and clastic materials are regarded to have been transported from nearby surrounding areas. In the Kurobishiyama Conglomerate (Loc. 7), which is correlatable with the Tetori Group, orthoquarzitic clasts are commonly found, although their amount is less than in the Terori Group. Sometimes orthoquartzitic clasts are also found in the Miocene and younger sediments in the Hida Belt. It is obvious that they were derived secondarily from the conglomerates of the Tetori Group (SOMA and OHSETO, 1977).

C. Mino-Tamba Belt

The occurrence of orthoquartzitic clasts in the geosynclinal sediments of the Mino-Tamba Belt has become apparent by Tamba Research Group (1971; Loc. 10) and by ADACHI (1971 and 1976; Loc. 9a-d), although their amount is less in quantity. In the Mino Belt, they are accompanied with Precambrian metamorphic clasts (SHIBATA *et al.*, 1971; SHIBATA and ADACHI, 1974). In the Pliocene Osaka Group, orthoquartzitic gravels occur quite restrictedly in one place, occupying more than 15 percent of the total gravels (Yamashiro Research Group, 1980b; Loc. 12'). They occur at the base of the group of fresh-water origin, and are assumed to have been supplied from a very near local source. Orthoquartzitic gravels from the other localities of the Cenozoic seem to have derived secondarily from pre-existing conglomerate beds (Yamashiro Research Group, 1980a).

D. Shimanto Belt

Orthoquartzitic clasts have been discovered in the geosynclinal sequences of the Shimanto Belt, although they mostly occur rare in amount. Especially they occur more in the Paleogene Muro Group in the Kii Peninsula (Loc. 15b and c) than in the other regions, and have been studied in detail (TOKUOKA, 1967 and 1970; TOKUOKA and BESSHO, 1980). It has become apparent from sedimentologic studies that these were supplied from the Kuroshio Paleoland situated to the south of the Shimanto Geosyncline (HARATA *et al.*, 1979). Orthoquartzitic clasts also occur commonly in the Paleogene strata of Loc. 16-b and 17, where clastic materials are also known to have been supplied from oceanic side (KUMON and INOUCHI, 1976).

Properties of orthoquartzitic rocks occurring as clasts in conglomerates

The properties of orthoquartzitic rocks occurring as clasts in conglomerates were examined in detail in the Muro Group (TOKUOKA, 1970; TOKUOKA and BESSHO, 1980), Sarukubo Conglomerate (OKAMI, 1973), and the Somanakamura Group (OKAMI, *et al.*, 1976). TAKAGI (1979) also studied petrographically the orthoquartzitic clasts from the Miocene Hatabu Formation in westernmost Honshu (Loc. 25a). In this chapter orthoquartzitic rocks in the Muro and the Somanakamura Groups are treated as the representatives. It is likely that orthoquartzitic rocks in the other groups or formations are not so different from those mentioned here.

A. Rock types and colors

All orthoquartzitic rocks belong to the so-called sedimentary quartzite in which all of the quartz grains have been submitted to a secondary overgrowth of quartz. Generally two types are discernible in them microscopically. One is the quartzite consisting of worn grains that have long or tangential, and sometimes concavo-convex, contacts to surrounding grains (*Type* I). The other are composed of quartz grains that have been deformed and pressolved due to thermal and/or regional metamorphism, showing interlocking texture (*Type* II). In the Muro Group, Type I occupies two-thirds and Type II one-third of the total amount, and in the Somanakamura Group *vice versa*. Macroscopically, orthoquartzitic rocks are divisible into two types, that is, the *granular type* in which the grains are visible to the naked eye, regardless to their secondary overgrowth of silica; and the *aphanitic type* in which grains are difficult to identify, looking glassy as a whole. These two types roughly correspond to the above-mentioned Types I and II, respectively.

Orthoquartzitic clasts are variable in color. Most abundant are white rocks, and there are found commonly those tinged with pink or deeper red, and even deep green. These tinged clasts occupy about 10 percent in the conglomerates of the Muro Group and 5 percent in those of the Somanakamura Group.

B. Mineral composition

Modal analysis of mineral composition of orthoquartzites was collectively reported in TOKUOKA and OKAMI (1979). The data of the Muro Group were newly added by TOKUOKA and BESSHO (1980). It is a matter of course that most specimens are characterized by high percentage of quartz content (mostly, more than 95 percent of the composition consist of detrital quartz and secondary overgrown quartz, Fig. 2). As minor constituents, tourmaline, zircon, potash-feldspar, and acidic tuff (or chert) are sometimes contained in them. There are a few specimens which contain these constituents of more than five percent. Strictly, these cannot be called orthoquartzite but feldspathic quartzite or protoquartzite, however, these have been included in the orthoquartzite clan for convenience. It is worthy to mention that there are many clasts that belong to feldspathic quartzite in the Tetori Group.

The quartz grains are largely strain-free monocrystalline quartz which occupies more than 95 percent of quartz grains in the case of the Muro Group (TOKUOKA, 1970). The rest of them belong to monocrystalline quartz with undulatory extinction and polycrystalline quartz of probably metamorphic origin. Mineralogically, most orthoquartzites are safely assigned to supermature sandstones.

C. Textural properties

The quartz grains of most orthoquartzitic rocks range in size from coarse to fine sand. Most of them are highly rounded and well sorted. In the Muro Group fine- to medium-grained orthoquartzites are predominant, whereas coarse-grained ones are common in the Somanakamura Group, although no difference in sorting degree is observable between the two (TOKUOKA and OKAMI, 1979). Other constituents such as tourmaline, zircon, acid tuff (or chert), etc., though insignificant in volume, are also highly rounded. In several specimens, double dust rings around worn quartz grains are observable, indicating obviously their polycyclic origin (TOKUOKA, 1970; TOKUOKA and BESSHO, 1980). Texturally as well as mineralogically these are assigned to typical supermature sandstones as defined by FOLK (1951).

Grain-size distribution was examined in detail on sixty-four specimens of the Muro Group by

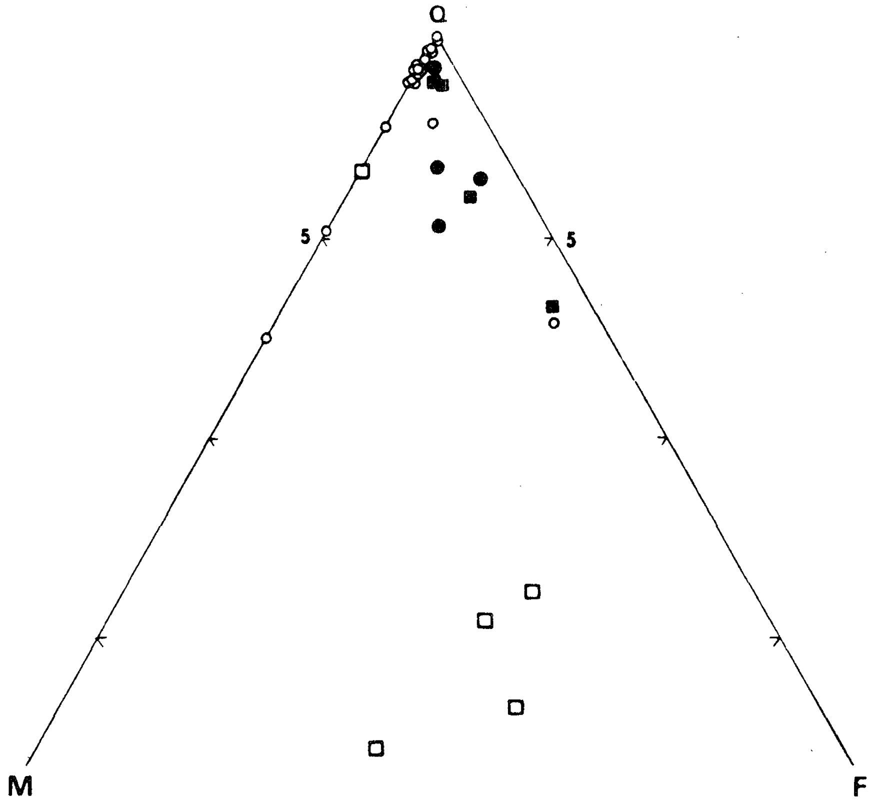

Fig. 2. Mineral composition of orthoquartzites (TOKUOKA and OKAMI, 1979).
heavy square: Somanakamura Group,
heavy circle: Sarukubo Conglomerate,
open square: Tetori Group,
open circle: Muro Group,
Q Quartz, F Feldspar, M Matrix.

TOKUOKA and BESSHI (1980) after FRIEDMAN's method (FRIEDMAN, 1958 and 1962). It has become apparent that they are quite similar texturally with typical cratonic sandstones such as the St. Peter Sandstone in North America (FRIEDMAN, 1958; AMARAL and PRYOR, 1977). Furthermore, these must have been formed originally under beach and/or dune environments on the basis of grain-size parameters (TOKUOKA and BESSHO, 1980).

Discussion

As mentioned in the previous chapter, most of the orthoquartzitic clasts belong to supermature sandstone not only mineralogically but also texturally. These are safely inferred to have been originated from certain pre-Silurian (probably Precambrian) sequences by the reason that such supermature rocks have never been produced in and around the Japanese Islands since the Silurian. SHIBATA (1979) indicated that the K-Ar ages for the orthoquartzite clasts, all of which are shown in Table 1, are roughly grouped into three: definite Precambrian (778 Ma), early Paleozoic (470-550 Ma), and late Paleozoic (260-310 Ma). He inferred that these groups probably indicate the times of some important events in which the source areas of the orthoquartzite clasts have been involved and that all orthoquartzite clasts originated in the Precambrian time. Several metamorphic clasts accompanied with orthoquartzitic clasts have been dated as Precambrian, that is, 1700-1500 Ma for those in the Kamiaso conglomerate of the Mino Belt (SHIBATA et al., 1971; SHIBATA and ADACHI, 1972 and 1974) and 1770 Ma as a model age for a gneiss clast of the Miocene Hatabu Formation in western-most Honshu (SHIBATA and TAKAGI, 1981).

These data also support the above estimation as insisted by SHIBATA (1979).

Concerning the provenance of the orthoquartzitic clasts, although many of them are expected to be of secondary origin because of their higher rounding than the other kinds of gravels, the following discussion can be made. In the Abukuma Mountains orthoquartzitic clasts in the Somanakamura Group (Loc. 4) and the Sarukubo Conglomerate (Loc. 6) are assigned to be of secondary origin. In connection with this, it is of special interest that in the Paleogene Iwaki Group (Loc. 5) they are accompanied with abundant chert clasts of Upper Triassic (OKAMI *et al.*, 1978). Then, it is reasonably inferred that orthoquartzitic rocks once came into existence in the Abukuma Mountains in early Triassic and that their clasts occurred in Jurassic and younger sequences must have been derived secondarily from the unknown lower Triassic conglomerates which, thereafter, have been eroded completely. After reviewing his long continuing study on conglomerates, KANO (1980) insisted that Precambrian "Orthoquartzite Series", which had once overlain the Gosaisho-Takanuki Metamorphic Series in the Abukuma Mountains, had been eroded before the Cretaceous. In relation to the basement rocks in the Abukuma Mountains, the discovery of orthoquartzite-like rock bodies in the Marumori Metamorphic Rocks by KANO (1980) is also interesting. They are described by the author (K. O.) and KANO in the same volume. This may be the first discovery of orthoquartzitic basement in the Japanese Islands, although more detailed investigation should be made. In the Kitakami Mountains, pre-Silurian granitic basement is known (MURATA *et al.*, 1975). However, it seems to the writers there is no possibility of finding orthoquartzitic basement there. TAKIZAWA (1977) insisted from the sedimentologic study on Mesozoic formations that a tectonic land might have existed to the east of the Kitakami Mountains, Off-Sanriku area. In this respect, it is interesting that orthoquartzitic clasts are found in the Jurassic strata in the Ojika Peninsula (Loc. 3). It is possible that they were transported from the above-mentioned source area. Recently, the *Oyashio Ancient Landmass* was assumed by IPOD Leg 57 (VONHUENE and NASU *et al.*, 1978) under the Tertiary sediments, Off-Sanriku area. This may be a remnant of the same provenance.

In the Hida Mountains, abundant orthoquartzitic clasts are found in the Tetori Group (Loc. 8). Obviously, these have been supplied directly from a neighbouring source area situated to the north. KANO (1980) insisted that the upper Proterozoic (Sinian in China) including orthoquartzite group had once overlain the lower Proterozoic to Archean metamorphic rocks in the Hida Mountains and imagined that they had been eroded completely before the Tertiary. Although we cannot detect any remnant of orthoquartzitic rocks in the Hida Mountains, his estimation seems to be reasonable.

In the Mino-Tamba Belt, orthoquartzitic clasts are found mainly in the Triassic-Jurassic formations. In the Mino Belt, these are known to be accompanied with gneiss clasts of Precambrian (SHIBATA and ADACHI, 1974). ADACHI (1979) insisted sedimentologically that the major source area had existed not only to the north but also to the south, and that orthoquartzitic clasts were supplied from the southern one. In the Tamba Belt, orthoquartzitic clast-bearing formation is known to have been supplied from a southern source (Tamba Research Group, 1971). The above-mentioned sources must be parts of the *Missing Ryoke* proposed by ICHIKAWA (1970), which had once existed along the Median Tectonic Line. Pre-Ryoke basements were also discussed from petrologic viewpoint by NUREKI (1979). Furthermore, an abundant occurrence of orthoquartzitic gravels in the Pliocene Osaka Group is interesting (Yamashiro Research Group, 1980b; Loc. 12'). They occur in only one place near the base of the group, occupying more than 15 percent of the total composition. If a local fresh-water basin for the Osaka Group is taken into consideration, it seems probable that these gravels must have been supplied from a very near local source as suggested by Yamashiro Research Group (1980b). This may be a remnant of the

Missing Ryoke.

In the Shimanto Belt, orthoquartzitic clasts occur in various places, among which they are more predominant in the Kii Peninsula (Loc. 15b, c). Many sedimentologic evidences have been known that they were supplied from the south. Their southern origin is also supported by the fact that no orthoquartzitic clast has ever been found in the Cretaceous marine sequences distributed narrowly but lengthly along the Median Tectonic Line. In the Shimanto Belt, these clasts have been discovered rarely in the Cretaceous, whereas they occur frequently in the Paleogene. These phenomena indicate evidently that orthoquartzitic rocks had exposed widely in the *Kuroshio Paleoland* situated to the south of the geosyncline during the Paleogene time (HARATA *et al.*, 1979). Pre-Silurian basement rocks underlying the Outer Zone of Southwest Japan including the Shimanto Belt has long been considered by many geologists as illustrated in a deep crustal profile by Working Group for Tectonics of the C Zone (1973). Re-

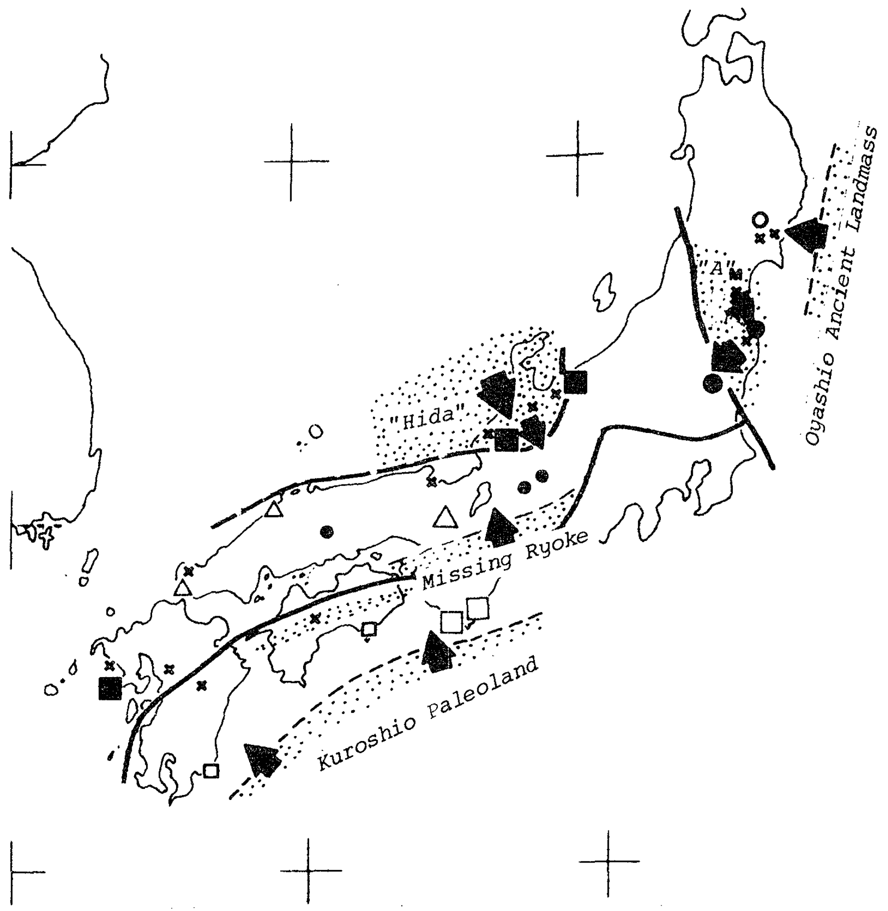

Fig. 3. Main Occurrence of orthoquartzitic clasts and their supposed provenances (dotted). "A" Abukuma Mts. Main occurrences of the clasts are shown by *open circle* (Paleozoic), *heavy circle* (Triassic-Jurassic), *heavy square* (Cretaceous), *open square* (Paleogene), and *open triangle* (Miocene-Pliocene).
The size of these symbols is roughly proportional to the abundance of orthoquartzitic clasts. Crossed symbols mean the exposures of presumable basement rocks of the Japanese Islands of probably pre-Silurian in age (M: Marumori Metamorphic Rock accompanied with orthoquartzite-like rocks)

cently, the crust at the Kii Peninsula was reported to have a thickness of several tens kilometer (HURUKAWA and HIRAHARA, 1980). If we take into consideration that the geosynclinal rocks at the same place are of ten kilometer or a little more in maximum thickness, we cannot explain the thick continental crust without assuming the older rocks underlying them. The above assumption has partly been supported by several geologic evidences such as the existence of metamorphic rocks of granulite facies consisting of the lower crust of the Outer Zone of Southwest Japan (HAYAMA, 1976; SUWA, 1967; ISHIHARA and TERASHIMA, 1978; SATO, 1978). It is probable that these basement rocks are extending farther south and have once emerged as a part of the Kuroshio Paleoland.

Fig. 3 shows the major sites of occurrence of orthoquartzitic clasts together with their stratigraphic horizons. To our opinion, it seems a reasonable interpretation that the provenance of orthoquartzitic gravels is different from each other among these major regions. Sedimentologically, several source areas are safely inferred as shown in the figure. The occurrences of the metamorphic rocks regarded as the basement rocks of the Japanese Islands are also shown in the figure. It is interesting that they seem to have intimate relations in occurrence with orthoquartzitic clasts, especially in the Abukuma and Hida Mountains, and in western Kyushu as well. It is probable that during the Proterozoic the Japanese Islands had long been a cratonic area where orthoquartzitic sandstones were formed extensively, and that, thereafter, the Honshu Geosyncline began to subside along several major deep faults which were succeedingly followed by marginal-sea type spreading.

Many discussions have been undertaken concerning the basement rocks of younger orogenic belts. In Alpine Europe, previously cratonized materials (Variscan or older) have largely been accepted as the basement core (LEMOINE, 1978). On the other hand, they have rarely been evidenced in circum-Pacific orogenic belts, although the existence of Precambrian basements have been imagined or expected benearth geosynclinal rocks in several places (ZIEGLER, 1969; STAUFFER and SNELLING, 1977; SEARS and PRICE, 1978; AUDLEY-CHARLES, 1979; GASTIL, 1979; LEVI and AGUIRRE, 1981). In the Japanese Islands we have many evidences indicating the existence of Precambrian basements. Orthoquartzitic clast is one of them. It should be treated as a most usuful key to verify the Precambrian basements underlying the Japanese Islands. The existence of orthoquartzitic clasts indicate strongly that the Japanese Islands as a type of circum-Pacific orogenic belts might have passed through a cratonic stage preceding their geosynclinal developments.

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日本列島の先カンブリア基盤岩としての オーソコォーツァイト岩

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（要　旨）

若い造山帯のなかに先カンブリア代の岩石が存在するかどうかは重要な問題で，日本列島においても古くから議論されてきた．オーソコォーツァイト礫は1967年以降，日本の各地から発見されるようになり，その層準は石炭系から第四系に及ぶ．これらの組成的および組織的な特徴は大陸地域に広く発達する石英質砂岩に比較され，日本列島の地史を考慮すると，これらが先シルル系，おそらく先カンブリア系に由来するものであることが推定される．このことはオーソコォーツァイトの年代測定資料からも支持される．一般的にオーソコォーツァイト礫の産出は，量的に非常に少なく，径も小さいが，いくつかの地域では礫種構成の主要なものであり，径も数10cmに達することがある．これらの地域での産出を堆積学的に検討すると，再堆積と推定される場合も多いが，近くに存在した基盤岩類に由来すると考えるのが自然である．すなわち，阿武隈山地においてはオーソコォーツァイト様岩を含む丸森変成岩の分布域，北上山地においては三陸沖に推定される親潮古陸，飛騨帯では削剝されつくした基盤岩，美濃一丹波帯では中央構造線にそう失われた領家帯，四万十帯では黒潮古陸がオーソコォーツァイト礫の供給地であったであろう．日本列島の下底にはオーソコォーツァイト層を含む先カンブリア基盤が存在すると考えられる．