

Carboniferous to Jurassic (especially Permian) radiolarians recovered from the Chugoku region (a review)

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(Received September 5, 1987)

Abundant reports dealing with radiolarians and conodonts from the Carboniferous to Jurassic formations of the Akiyoshi-Nishiki Belt, Maizuru Belt, Kamigori Belt, Ultra-Tamba Belt, Sangun metamorphic belt, Nagato tectonic zone and Jurassic terranes in the Chugoku region of the Inner Zone of Southwest Japan are listed in this paper. Permian radiolarian localities are shown on a geological map of this region, and specific names, assemblage names, ages and lithofacies are summarized. The Permian radiolarian biostratigraphy and geologic setting of each terrane are briefly discussed.

Introduction

Recently, radiolarians and conodonts have been reported from various localities in Carboniferous to Jurassic rocks of the Chugoku region, Southwest Japan. Their discovery has produced drastic changes in the understanding of the age, stratigraphy and tectonic significance of these rocks. Many students who have interests in the stratigraphy and tectonostratigraphic analysis of the terranes of Southwest Japan, need basic data concerning the micro-fossils, including localities, specific names, assemblage names and the lithology of fossil-bearing beds. Although reports dealing with radiolarians and conodonts are abundant, they have often appeared only in abstracts of the meeting of the societies (or in some cases of meetings of a branch of the societies). Descriptions are insufficiently detailed for complete understanding of the studies and often it is difficult to obtain the abstracts.

This paper provides so far as possible the opportunity to obtain information from reports on radiolarians and conodonts from the Chugoku region that appeared up until April, 1987.

Acknowledgement The authors would like to thank Dr M. MUSASHINO of Kyoto University of Education, Mr K. NISHIMURA of Shimane University, Mr H. TAKESHITA of Kobe University and Miss D. D. L. PILLAI of Shimane University for providing valuable informations on Permian radiolarian localities in the Chugoku region. Special thanks are due to Dr E. C. LEITCH of the New South Wales Institute of Technology, for his critical reading of the manuscript. They are grateful to Professor T. TOKUOKA of

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Shimne University and Dr T. WATANABE of Hokkaido University for much encouragement.

Reports on Permian Radiolarians and Tectonostratigraphic Division in the Chugoku Region

Permian radiolarian localities and tectonostratigraphic division based on WATANABE *et al.* (1987), are shown in Fig. 1. Triassic and Jurassic shallow marine facies are not shown in this figure. Where specific name of radiolarians given in the original text were wrong, correct or revised names derived from later observations are given.

Reports dealing with Carboniferous to Jurassic radiolarians and conodonts and localities, assemblages, and specific contents are discussed and listed for each terrane.

On the basis of radiolarian biostratigraphy, the terranes of the Chugoku region can be divided into two geologic units, namely, a Permian-Triassic composite terrane and a Jurassic olistostromal terrane. On the basis of geological evolution and lithofacies, the Permian-Triassic composite terrane is subdivided into three belts, the Akiyoshi-Nishiki Belt, the Maizuru Belt and the Ultra-Tamba Belt. A brief outline of their geology is given below.

A. Akiyoshi-Nishiki Belt (Figs. 2, 3)

Two contrasting lithofacies can be recognized in the Akiyoshi-Nishiki Belt, namely, a calcareous (limestone) facies and a non-calcareous (chert-acidic tuff-mudstone-sandstone) facies. In areas of the former facies, such as the Akiyoshi area, many biostratigraphic studies have been made on the basis of fusulinids and other microfossils (OKIMURA, 1966; HASE *et al.*, 1974; OTA, 1977 etc.). Within the area of the latter facies, results of radiolarian biostratigraphy have appeared only recently (MIYAKE, 1985; UCHIYAMA *et al.*, 1986; NAKA *et al.*, 1986). The Nishiki Group (typical of the non-calcareous facies) shows an upward coarsening sequence (NAKA *et al.*, 1986; NAKA, 1987). It should be emphasized that Permian formations in the Akiyoshi-Nishiki Belt show uniform sequential changes from pelagic materials (mainly from the *Pseudoalbaillella globosa* to the *Follicucullus monacanthus* Assemblage-zone) to terrigenous materials. Concerning the characteristic lithology, acidic tuffs are common in the Middle Permian radiolarian zones (Fig. 13). Olistostrome units containing greenstone, limestone and chert blocks occur in the upper Middle to Upper Permian (KANMERA and NISHI, 1983; MIYAKE, 1985; UCHIYAMA *et al.*, 1986; NAKA, 1987).

The calcareous facies of the nearly identical sequences in the Akiyoshi, Atetsu, Taishaku, and Katsuyama areas are lithologically very similar. The Akiyoshi Limestones Group, which is composed of a reef complex of early Carboniferous to late Middle Permian age, overlies greenstones belonging to the alkalic rock series (HASE and NISHIMURA, 1979). Twenty one fusulinacean zones have been discriminated within the

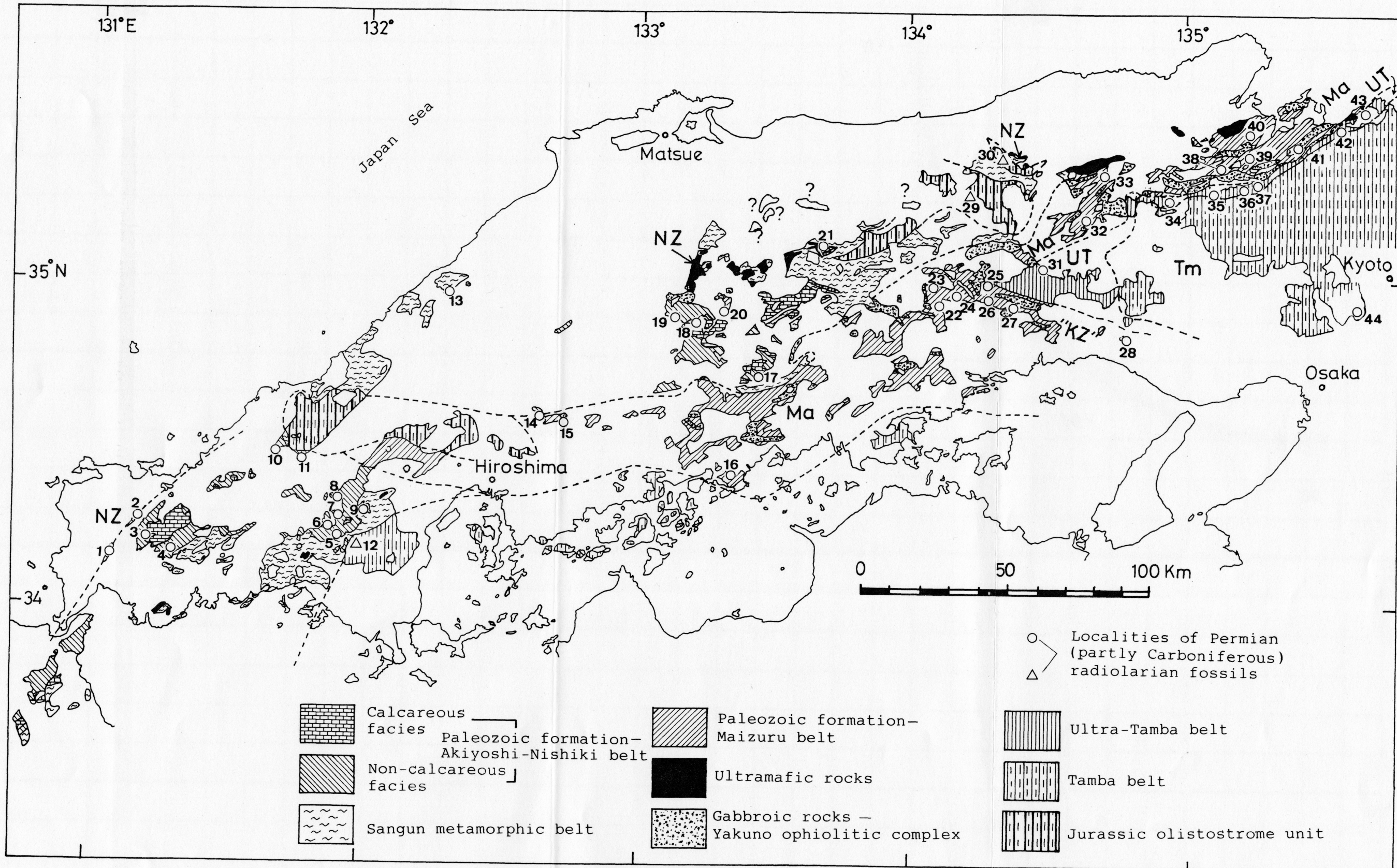


Fig. 1. Geologic map of the Pre-Cretaceous rocks of the Chugoku region. Localities of Permian (and some Carboniferous) radiolarian fossils are indicated. Abbreviation: NZ, Nagato Tectonic Zone; Ma, Maizuru Belt; UT, Ultra-Tamba Belt; Tm, Tamba Belt. Δ ; radiolarians from the bedded chert masses in Jurassic olistostrome. Where localities are crowded, they are shown as one symbol.

No.	References	Areas	Fossils								Remarks
			C R	P R	T R	J R	C C	P C	T C		
1	Igo & Koike (1965)	Akiyoshi						●			Limestone
2	Koike (1967)	Atetsu						●			"
3	Igo (1973)	Akiyoshi						●			"
4	Igo (1974)	Akiyoshi						●			"
5	Sano <i>et al.</i> (1983)**	Akiyoshi		●							
6	Isozaki (1983)**	Taishaku		●							
7	Naka & Muikaichi Research Group (1984)**	Nishiki		●							
8	Nishimura & Isozaki (1984)**	Nishiki		●							
9	Naka <i>et al.</i> (1984)**	Muikaichi		●							
10	Okada (1984)**	Oga		●				●	●		
11	Miyake (1984)**	Katsuyama		●							
12	Isozaki (1984)**	Taishaku		●							
13	Watase <i>et al.</i> (1985)**	Muikaichi		●							
14	Kanmera & Sano (1985)**	Akiyoshi & Oga		●							
15	Nishimura <i>et al.</i> (1985)**	Nishiki		●							8
16	Naka & Ishiga (1985)**	Nishiki & Muikaichi		●							7,9
17	Miyake (1985)*	Katsuyama		●							11
18	Oho <i>et al.</i> (1985)*	Taishaku						●	●		Chert
19	Sada <i>et al.</i> (1985)*	Taishaku						●	●		18
20	Fukutomi & Isozaki (1986)**	Tsuwano		●							
21	Goto, N. (1986)**	Taishaku		●							
22	Naka (1986)**	Nishiki		●							
23	Uchiyama <i>et al.</i> (1986)	Akiyoshi		●							14
24	Ishiga <i>et al.</i> (1986)	Muikaichi		●							13
25	Naka <i>et al.</i> (1986)*	Muikaichi		●					?		
26	Higashimoto <i>et al.</i> (1986)*	Hongo		●							
27	Kanmera & Sano (1986)	Akiyoshi		●							
28	Naka (1987)**	Nishiki		●							22
29	Fukutomi (1987)**	Tsuwano		●							20

* in Japanese with English abstract
 ** in Japanese

CR: Carboniferous radiolaria, PR: Permian radiolaria
 TR: Triassic radiolaria, JR: Jurassic radiolaria
 CC: Carboniferous conodont, PC: Permian conodont
 TC: Triassic conodont

Fig. 2. List of reports on Carboniferous to Jurassic radiolarian and conodont fossils from the Akiyoshi-Nishiki Belt. Remarks: Numbers refer to other data sources included in the report.

Akiyoshi Limestone Group (OTA, 1977). It is inferred that the group accumulated on the basaltic pedestal of an isolated oceanic seamount which was widely encircled by coeval deep-sea pelagic sediments including bedded chert (KANMERA and NISHI, 1983). Bedded chert of Early to Middle Permian age, showing the contemporaneous heterotopic facies to the Akiyoshi Limestone Group, is distributed around the group and was overlain by volcanoclastic materials (UCHIYAMA *et al.*, 1986).

B. Maizuru Belt (Figs. 4, 5)

The Maizuru Belt consists of the Permian Maizuru Group, Triassic overlapping sediments, and the Late Paleozoic Yakuno ophiolitic complex. The Maizuru Group is mainly composed of, in ascending order, greenstone, mudstone, and alternating beds of mudstone and sandstone with intercalations of conglomerate. Although the change

Number (see Fig. 2)	Area	Locality (see Fig. 1)	Lithology		Radiolarian Fossils												Remarks			
			chert siliceous shale acidic tuff alt./ mudstone & acidic tuff mudstone alt./ mudstone & sandstone		<i>Fo. scholasticus</i> morphotype I <i>Fo. scholasticus</i> morphotype II <i>Fo. monacanthus</i> <i>Fo. sp.</i> <i>Ps. globosa</i> <i>Ps. fusiformis</i> <i>Ps. lanceolata</i> <i>Ps. scalarata</i> <i>Ps. sp. C</i> <i>Ps. sp. aff. Ps. longicornis</i> <i>Ps. sp.</i> <i>A. asymmetrica</i> <i>A. sinuata</i> <i>A. sp.</i>															
			Radiolarian Assemblage-Zone (Ishiga, 1986b)																	
			Fo. : <i>Follicucullus</i> Ps. : <i>Pseudoalbaillella</i> A. : <i>Albaillella</i>																	
5	Akiyoshi	(4)	●																<i>Ps. lomentaria</i> - <i>A. sinuata</i>	5
6	Taishaku	(18) (19) (20)	●	●															<i>Ps. globosa</i> - <i>Fo. monacanthus</i> <i>A. sinuata</i> ?	
7	Nishiki	(7)	●	●															<i>Fo. monacanthus</i>	
8	Nishiki	5,7	●	●															<i>Fo. scholasticus</i>	1
9	Muikaichi	(8)	●	●															<i>Fo. monacanthus</i>	3
11	Katsuyama	(21)	●	●															<i>Fo. monacanthus</i>	1
12	Taishaku	18 19 20	●	●															<i>A. sinuata</i> - <i>Ps. globosa</i> <i>Ps. sp. C</i> - <i>Fo. monacanthus</i>	2 3 3
13	Muikaichi	(8)	●	●															<i>A. sinuata</i> <i>Ps. globosa</i> , <i>Fo. monacanthus</i> ?	
14	Akiyoshi	(4)	●	●															<i>Fo. scholasticus</i>	
14	Oga	(17)	●	●															<i>Ps. lomentaria</i> - <i>Fo. scholasticus</i> <i>Fo. monacanthus</i> - <i>Fo. scholasticus</i>	
15	Nishiki	5,7	●	●															<i>Ps. lomentaria</i> - <i>Fo. scholasticus</i> <i>Fo. monacanthus</i> , <i>Fo. scholasticus</i>	2
16	Nishiki	7	●	●															<i>Fo. scholasticus</i>	2
16	Muikaichi	8	●	●															<i>Fo. scholasticus</i>	2
17	Katsuyama	21	●	●															<i>Fo. monacanthus</i>	1
20	Tsuwano	(10,11)	●	●															?	1
21	Taishaku	(18) (19) (20)	●	●															<i>Ps. sp. C</i> - <i>Fo. scholasticus</i> <i>Fo. monacanthus</i> , <i>Fo. scholasticus</i> <i>Ps. lomentaria</i> , <i>A. sinuata</i>	10
22	Nishiki	(5) (7)	●	●															<i>Ps. globosa</i> <i>Ps. globosa</i> ?	
23	Akiyoshi	4	●	●															<i>Fo. scholasticus</i> <i>Fo. scholasticus</i>	
24	Muikaichi	8	●	●															<i>Ps. lomentaria</i> - <i>Fo. scholasticus</i> <i>A. sinuata</i> - <i>Ps. sp. C</i>	35 7
26	Hongo	9	●	●															<i>Ps. sp. C</i> - <i>Fo. scholasticus</i> <i>Fo. scholasticus</i>	36 2
27	Akiyoshi	3	●	●															<i>Fo. monacanthus</i> <i>Ps. globosa</i> ?	2 1
28	Nishiki	(5) (6) (7)	●	●															<i>Fo. monacanthus</i> <i>A. sinuata</i> - <i>Ps. sp. C</i> ?	4
29	Tsuwano	(10) (11)	●	●															<i>Fo. monacanthus</i> ?	
																			<i>Fo. scholasticus</i>	
																			<i>Ps. sp. C</i>	
																			<i>Ps. globosa</i> , <i>Fo. monacanthus</i>	13
																			<i>Fo. monacanthus</i>	

(): Locality uncertain ● : aff.

Fig. 3. Permian radiolarian fossils from the Akiyoshi-Nishiki Belt. Remarks column shows the number of radiolarian occurrences at each locality.

from oceanic basic volcanics to terrigenous strata is similar to that in the Akiyoshi-Nishiki Belt, bedded cherts are not present. The lower part of the Maizuru Group, which is characterized by greenstones, is regarded as Lower Permian on the basis of radiolarians from overlying mudstone (NISHIMURA and ISHIGA, 1987).

C. Kamigori Belt (Kozuki-Tatsuno Belt) (Figs. 6, 12)

The Kamigori Belt, trending WNW-ESE in Hyogo Prefecture differs from the Maizuru Belt in stratigraphy, structure and lithology. This belt was recently subdivided into two geotectonic units, the Kozuki unit and the Tatsuno unit, collectively called the Kozuki-Tatsuno Belt (see Goro, 1987). Recently, the former unit consisting of the Kozuki Formation, has been considered the third unit of the Ultra-Tamba Belt (ISHIGA, 1987), and the latter unit composed of the Tatsuno Group, as the same as the Maizuru Group. The Tatsuno unit is regarded as an isolated part of the Maizuru Nappe. Radiolarian study has been attempted in the Kozuki unit (see PILLAI and ISHIGA, 1987).

No.	References	Areas	Fossils							Remarks
			C R	P R	T R	J R	C C	P C	T C	
44	Goto & Hori (1985)**	Kouzuki		●						
45	Ishiga (1986a)	Fukusaki		●						
46	Otoh (1987)**	Kouzuki		●						
47	Pillai (1987)	Kouzuki		●						

** in Japanese

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 CC: Carboniferous conodont, PC: Permian conodont
 TC: Triassic conodont

Fig. 6. List of reports on Carboniferous to Jurassic radiolarian and conodont fossils from the Kamigori Belt. Remarks: Numbers refer to other data sources included in the report. (Kouzuki refers to Kozuki as used in the text)

D. Ultra-Tamba Belt (Figs. 7, 8)

The Ultra-Tamba Belt is a tectonic unit lying between the Maizuru Belt and the Tamba Belt. It consists of three tectonically separated units: UT 1, UT 2 and UT 3

No.	References	Areas	Fossils							Remarks
			C R	P R	T R	J R	C C	P C	T C	
30	Ishiga <i>et al.</i> (1983)**	Akaguri-saki		●						
48	Caridroit & De Wever (1984)***	Sayo		●						
49	De Wever & Caridroit (1984)***	Sayo		●						
50	Ishiga (1985)	Akaguri-saki & Oi		●						48
36	Caridroit <i>et al.</i> (1985)	Ayabe							●	
37	Kurimoto & Kimura (1985)**	Fukuchiyama		●						
51	Kurimoto (1986)**	Fukuchiyama		●						37
45	Ishiga (1986a)	Ayabe & others		●						30,48,49,50,51
52	An'yoji <i>et al.</i> (1987)**	Shimamoto		●						
53	Musashino <i>et al.</i> (1987)**	Ayabe & Aogaki		●						

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*** in French with English abstract

CR: Carboniferous radiolaria, PR: Permian radiolaria
 TR: Triassic radiolaria, JR: Jurassic radiolaria
 CC: Carboniferous conodont, PC: Permian conodont
 TC: Triassic conodont

Fig. 7. List of reports on Carboniferous to Jurassic radiolarian and conodont fossils from the Ultra-Tamba Belt. Remarks: Numbers refer to other data sources included in the report.

Number (see Fig. 7)	Area	Locality (see Fig. 1)	Lithology		Radiolarian Fossils										Radiolarian Assemblage-Zone (Ishiga, 1986b) Ne. : Neobaillella Fo. : Follicucullus Ps. : Pseudoabaillella A. : Abaillella	Remarks					
			chert	siliceous shale	acidic tuff	alt./ mudstone & acidic tuff	mudstone	alt./ mudstone & sandstone	Ne. grypus	Ne. optima	Ne. gracilis	Fo. scholasticus morphotype I	Fo. scholasticus morphotype II	Fo. charveti			Fo. bipartitus	Fo. sp.	Ps. sp. aff. Ps. longicornis	Ps. sp.	A. triangularis
30	Akagurisaki	(43)	●																?		
48	Sayo	31	●																	Fo. bipartitus-Fo. charveti	1
50	Akagurisaki	43	●																	Fo. bipartitus-Fo. charveti	6
	Oi	42	●																	Fo. bipartitus-Fo. charveti	5
36	Ayabe	37	●																	Fo. bipartitus-Fo. charveti	5
37	Fukuchiyama	35,36	●																	?	7
51	Fukuchiyama	35	●																	?	5
	Ayabe	36	●																	?	3
	Fukuchiyama	35	●																	Fo. bipartitus-Fo. charveti	1
45	Ayabe	37	●																	Ne. ornithoformis	2
	Aogaki	34	●																	Fo. bipartitus-Fo. charveti	2
52	Shimamoto	(44)	●																	Ne. ornithoformis	
	Ayabe	37	●																	Ne. ornithoformis	1
53	Aogaki	34	●																	Ne. ornithoformis	1

(): Locality uncertain ● : aff.

Fig. 8. Permian radiolarian fossils from the Ultra-Tamba Belt. Remarks column shows the number of radiolarian occurrences at each locality.

(Kozuki unit), in tectonically ascending order. UT 2 consists of bedded siliceous rocks, pelitic rocks and olistostromes in ascending order, which is similar to the lithologic sequence of the Akiyoshi-Nishiki Belt. The Late Permian *F. bipartitus*-*F. charveti* Assemblage that occurs in the Ultra-Tamba Belt is different from the radiolarian assemblage in bedded chert of the same age in the Tamba Belt (ISHIGA, 1985, 1986a, 1987; CARIDROIT *et al.*, 1985).

E. Sangun metamorphic belt (Figs. 9, 10)

The "Sangun metamorphic belt" includes three geologic units, recently called the

No.	References	Areas	Fossils							Remarks	
			C	P	T	J	C	P	T		
54	Takeshita <i>et al.</i> (1986)**	Gotsu		●							
55	Takeshita <i>et al.</i> (1987)**	Gotsu		●							54

** in Japanese

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CC: Carboniferous conodont, PC: Permian conodont
TC: Triassic conodont

Fig. 9. List of reports on Carboniferous to Jurassic radiolarian and conodont fossils from the Sangun metamorphic belt. Remarks: Numbers refer to other data sources included in the report.

No.	References	Areas	Fossils						Remarks
			C R	P R	T R	J R	C C	P C	
6	Isozaki (1983)**	Dai	●						
56	Igi <i>et al.</i> (1986)**	Toyogatake	●						

** in Japanese

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 TR: Triassic radiolaria, JR: Jurassic radiolaria
 CC: Carboniferous conodont, PC: Permian conodont
 TC: Triassic conodont

Fig. 10. List of reports on Carboniferous to Jurassic radiolarian and conodont fossils from the Nagato Tectonic Zone. Remarks: Numbers refer to other data sources included in the report.

Sangun Terrane (s.s.), the Chizu Terrane (Jurassic Terrane) and the Suou Terrane (Permian Terrane) (HAYASAKA *et al.*, 1987). The Chizu Terrane, which includes the Hatto and Chizu Formations, yielded Jurassic radiolarians, while the Suou Terrane yielded Permian *Follicucullus?* sp. (TAKESHITA *et al.*, 1986). The Sangun Terrane is regarded as the eastern extension of the Nagato tectonic zone mentioned below.

No.	References	Areas	Fossils						Remarks
			C R	P R	T R	J R	C C	P C	
57	Toyohara (1974a)**	Kuga						●	
58	Toyohara (1974b)**	Yoshiwa						●	
59	Toyohara (1976a)*	Kuga						●	57
60	Toyohara (1976b)**	Nichihara						●	
61	Murakami (1976)**	Nichihara						●	
62	Toyohara (1977)	Kuga, Tsuyama & others						●	57,58,59,60
63	Tanaka (1980)*	Nichihara						●	
64	Hara <i>et al.</i> (1980)**	Wakasa						●	
65	Tsusansyo-Shigenenerugicho (1981)**	Kuga						●	
66	Hayasaka & Hara (1981)**	Wakasa						●	64
67	Isozaki & Matsuda (1982)**	Nichihara				●			
68	Hayasaka & Hara (1982)**	Nichihara, Kuga & others				●			
69	Hayasaka <i>et al.</i> (1983a)**	Nichihara & Kuga				●			67,68
70	Hayasaka <i>et al.</i> (1983b)**	Nichihara, Kuga & Wakasa				●			69
71	Goto <i>et al.</i> (1984)**	North of Himeji				●			
72	Takata & Isozaki (1985)**	Kuga				●			
15	Nishimura <i>et al.</i> (1985)**	Kuga				●			72
73	Tateishi (1985)**	Kuga			●				
74	Wakita (1985a)**	Kuga			●	●			
20	Fukutomi & Isozaki (1986)**	Tsuwano			●	●			
26	Higashimoto <i>et al.</i> (1986)*	Kuga			●	●			62,65,70
75	Takata & Isozaki (1986)**	Kuga			●				72
76	Hayasaka (1986)**	Wakasa	●		●			●	
77	Goto (1986)*	Tatsuno			●				
78	Yogoro <i>et al.</i> (1986)**	Wakasa	●	●				●	
79	Ishiga & Kusu (1986)*	Yamasaki				●			
80	Takata (1987)**	Kuga	●		●	●	●	●	75

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 CC: Carboniferous conodont, PC: Permian conodont
 TC: Triassic conodont

Fig. 11. List of reports on Carboniferous to Jurassic radiolarian and conodont fossils from the Jurassic olistostromal unit. Remarks: Numbers refer to other data sources included in the report.

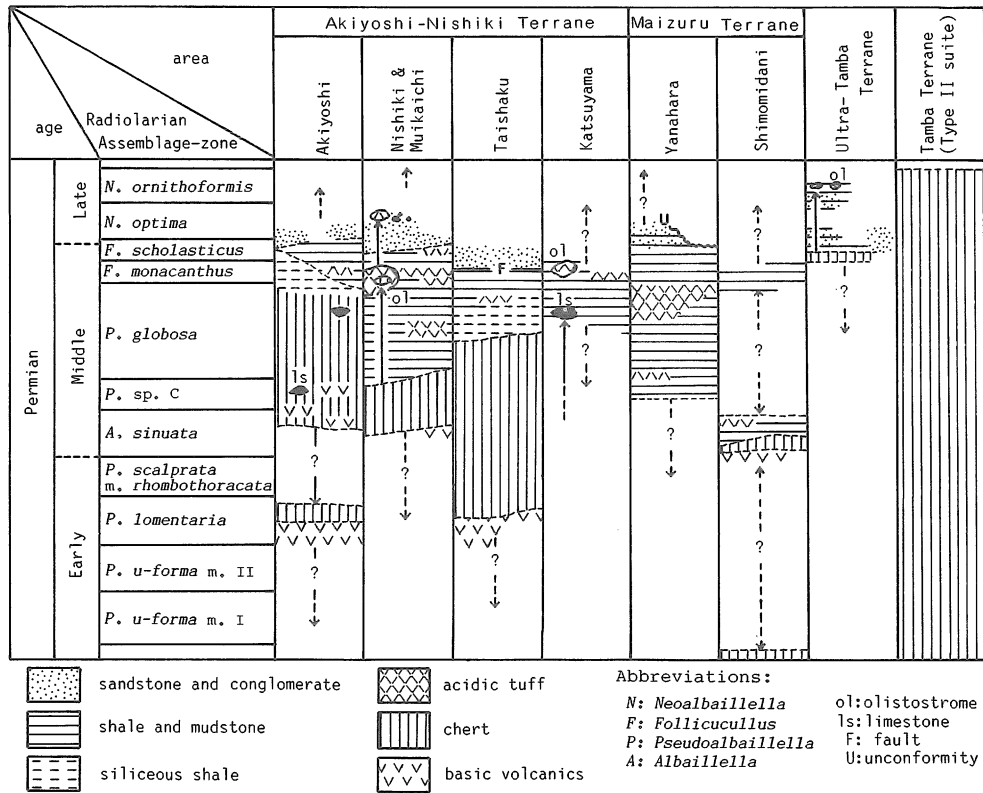


Fig. 13. Permian stratigraphic columns for the non-calcareous facies after WATANABE *et al.* (1987) (originally T. NAKA compiled).

References

- AN'YOJI, T., TANAKA, K., KUSUNOKI, T., KIRIMURA, S. and MUSASHINO, M., 1987: Takatsuki Formation, greenish sandstone distributed in the western Hills (Nishiyama) of Kyoto, Southwest Japan. *Abst. 94th Ann. Meet. Geol. Soc. Japan*, 241 (J) (52).
- CARIDROIT, M. and DE WEVER, P., 1984: Description de quelques nouvelles especes de Follicucullidae et d'Entactinidiidae (Radiolaires Polycystines) du Permian du Japon. *Geobios*, 17, 639-644 (F, E) (48).
- , ICHIKAWA, K. and CHARVET, J., 1985: The Ultra-Tamba Zone, a new unit in the Inner Zone of Southwest Japan-its importance in the nappe structure after the examination of the Maizuru area-. *"Earth Sci." (Chikyu Kagaku)*, 39, 210-219 (36).
- DE WEVER, P. and CARIDROIT, M., 1984: Description de quelques nouveaux Latentifistulidae (Radiolaires Polycystines) Paleozoiques du Japon. *Revue de Micropaleontologie*, 27, 98-106 (F, E) (49).
- FUKUTOMI, T., 1987: Permian complex and Yakuno ophiolitic rocks discriminated in "Kanoashi Group", western part of Shimane Prefecture, Southwest Japan. *Abst., 94th Ann. Meet. Geol. Soc. Japan*, 273, (J) (29).
- , ISOZAKI, Y., 1986: Relationship among Mesozoic rocks, Paleozoic rocks and crystalline

- schists in the "Kanoashi Group", Shimane Prefecture, Southwest Japan. *Abst. 93th Ann. Meet. Geol. Soc. Japan*, 227 (J) (20).
- GOTO, H., 1986: Reconsideration of the Permian Tatsuno Group in the southern part of the Kozuki-Tatsuno Belt, Hyogo Prefecture, Southwest Japan. *Jour. Geol. Soc. Japan*, 92, 663-674 (J, E) (77).
- , 1987MS: Geology of Paleozoic and Mesozoic strata in the Kozuki-Tatsuno belt, Southwest Japan. *Doctor thesis of Osaka City University* (J, E).
- and HORI, R., 1985: Geology of northern part of the Kozuki-Tatsuno Belt (Kamigori Belt), Southwest Japan. *Abst. 92nd Ann., Meet. Geol. Soc. Japan*, 189 (J) (44).
- , INOUE, G. and YAMAMOTO, N., 1984: Unclassified Paleozoic formations distributed in and around Kasai City, Hyogo Prefecture, Southwest Japan. *Abst. 91th Ann. Meet. Geol. Soc. Japan*, 193 (J) (71).
- GOTO, N., 1986: Stratigraphy of Permian-Carboniferous siliceous rock and its relation to coarse-grained clastic rocks, Taishaku district, Hiroshima Prefecture, Southwest Japan. *Abst. 93th Ann. Meet. Geol. Soc. Japan*, 245 (J) (21).
- HARA, I., HIDE, K. and NISHIMURA, Y., 1980: Some problems on tectogenesis of Meso-Paleozoic formation of Southwest Japan. *Kozochishitsu kenkyukaishi*, 25, 1-12 (J) (64).
- HASE, A. and NISHIMURA, Y., 1979: Greenstones in the Chugoku district. *Jour. Geol. Soc. Japan*, 85, 401-412 (J, E).
- , OKIMURA, Y. and YOKOYAMA, T., 1974: The Upper Paleozoic formations in and around Taishaku-dai, Chugoku Massif, Southwest Japan; with special reference to the sedimentary facies of limestone. *Geol. Rep. Hiroshima Univ.*, 19, 1-39 (J, E).
- HAYASAKA, Y., 1986: Discovery of Triassic conodonts and Jurassic radiolarians from the Hatto Formation (Sangun metamorphic rocks). *Abst. 93th Ann. Meet. Geol. Soc. Japan*, 465 (J) (76).
- and HARA, I., 1981: Structural and geological significance of Triassic formation in the Wakasa district, Tottori Prefecture, Southwest Japan. *Abst. 88th Ann. Meet. Geol. Soc. Japan*, 484 (J) (66).
- and ———, 1982: Discovery of Jurassic radiolarians from the Chugoku Belt and its significance. *Abst. 89th Ann. Meet. Geol. Soc. Japan*, 476 (J) (68).
- , ISOZAKI, Y. and HARA, I., 1983a: Discovery of Late Jurassic radiolarians from the Kuga Group, Southwest Japan. *Proc. Nishinohon Branch, Geol. Soc. Japan*, 77, 7 (J) (69).
- , ——— and ———, 1983b: Discovery of Jurassic radiolarians from the Kuga and Kanoashi Group in the western Chugoku district, Southwest Japan. *Jour. Geol. Soc. Japan*, 89, 527-530 (J) (70).
- , NISHIMURA, Y. and HARA, I., 1987: Forming process of "Sangun metamorphic rocks". *Abst. 94th Ann. Meet. Geol. Soc. Japan*, 62-63 (J).
- HIGASHIMOTO, S., TAKAHASHI, Y., MAKIMOTO, H., WAKITA, K. and TSUKUDA, E., 1986: Geology of the Otake district. *Quadrangle series, scale 1:50,000, Geol. Surv. Japan*, 70 p. (J, E) (26).
- IGI, S., KIMINAMI, K., SHIBUYA, G., NISHIMURA, Y., and ISOZAKI, Y., 1986: Serpentine melange zone and geologic structure of related Paleozoic-Mesozoic groups in the western part of Chugoku region. *Report of Grants-in-Aid for Scientific Research* (No. 59460045), 16 p. (J) (56).
- IGO, H., 1973: Lower Carboniferous conodont from the Akiyoshi Limestone Group, Southwest Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 92, 185-199 (3).
- , 1974: Some Upper Carboniferous conodonts from the Akiyoshi Limestone Group, Southwest Japan. *Bull. Tokyo Gakugei Univ.*, 26, 230-238 (4).
- and KOIKE, T., 1965: Carboniferous conodonts from Yobara, Akiyoshi Limestone, Japan (Studies of Asiatic conodonts, Part 2). *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 59, 83-91 (1).
- ISHIGA, H., 1984a: Discovery of Permian radiolarians from the Shimomidani Formation and the

- Maizuru Group of the Maizuru Belt, Southwest Japan. *Abst. 91st Ann. Meet. Geol. Soc. Japan*, 232 (J) (31).
- , 1984b: *Follicucullus* (Permian radiolaria) from the Maizuru Group in Maizuru Belt, Southwest Japan. "*Earth Sci.*" (*Chikyu Kagaku*), 38, 427-434 (33).
- , 1985: Discovery of Permian radiolarians from the Katsumi and Oi Formations along south of Maizuru Belt, Southwest Japan. "*Earth Sci.*" (*Chikyu Kagaku*), 39, 175-185 (50).
- , 1986a: Ultra-Tamba Zone of Southwest Japan. *Jour. Geosci., Osaka City Univ.*, 29, 45-88 (45).
- , 1986b: Late Carboniferous and Permian radiolarian biostratigraphy of Southwest Japan. *Jour. Geosci., Osaka City Univ.*, 29, 89-100.
- , 1986c: Reexamination of the Maizuru Group in Ichinomiya and Akenobe areas, Hyogo Prefecture, Southwest Japan. *Proc. Kansai Branch, Geol. Soc. Japan.*, 100, 39-40 (J) (42).
- , 1986d: Re-examination of Shimomidani Formation, western part of Maizuru district, Kyoto Prefecture, Southwest Japan. *Proc. Kansai Branch, Geol. Soc. Japan*, 101, 2 (J) (41).
- , 1987: Paleozoic radiolaria. In ICHIKAWA K. (ed.), *Pre-Cretaceous Terranes of Japan. IGCP Project 224 Special Publication*.
- , KIRO, T. and SUZUKI, S., 1983: Permian radiolarians from Shimomidani area, Maizuru City and Akaguri area, Ooi-cho, Fukui Prefecture, Southwest Japan. *Abst. 90th Ann. Meet. Geol. Soc. Japan*, 206, (J) (30).
- , and KUSU, T., 1986: Ultra-Tamba zone in the western part of Hyogo Prefecture, Southwest Japan. *News of Osaka Micropaleontologists. Spec. Vol.*, 7, 167-174 (J, E) (79).
- and SATO, M., 1985: Paleozoic clastic formation in Numakuma Peninsula, Southeastern part of Hiroshima Prefecture. *Proc. Kansai Branch, Geol. Soc. Japan*, 98, 2-3 (J) (34).
- , and SUZUKI, S., 1984: Discovery of Permian radiolarians and conodonts from the Shimomidani Formation in the "Maizuru Belt", Southwest Japan and its significance. "*Earth Sci.*" (*Chikyu Kagaku*), 38, 197-206 (32).
- , WATASE, H. and NAKA, T., 1986: Permian radiolarians from Nishiki Group in Sangun-Chugoku Belt, Southwest Japan. "*Earth Sci.*" (*Chikyu Kagaku*), 38, 197-206 (24).
- ISOZAKI, Y., 1983: Occurrence of Paleozoic radiolarians from Nagato Tectonic Zone in Yamaguchi Prefecture and Taishakudai area in Hiroshima Prefecture, Southwest Japan. *Proc. Nishinihon Branch, Geol. Soc. Japan*, 77, 7-8, (J) (6).
- , 1984: Occurrence of Permian radiolarians from the clastic formation in Taishaku-dai area in Hiroshima Prefecture and re-examination of its stratigraphy. *Report of Co-operative Research on DESK*, 28-34. (J) (12).
- , MATSUDA, T., 1982: Conodonts biostratigraphy of Triassic bedded chert in the Mino and Tamba Belts and its significance. *Abst. 89th, Ann. Meet. Geol. Soc. Japan*, 213, (J) (67).
- KANMERA, K. and NISHI, H., 1983: Accreted oceanic reef complex in the Southwest Japan. In HASHIMOTO, M. and UYEDA, S. (eds.), *Accretion Tectonics in the Circum-Pacific Regions*, 195-206, Terrupub, Tokyo.
- and SANO, H., 1985: Sedimentary and tectonics in the Inner Zone of Southwest Japan. *Abst. 92th. Ann. Meet. Geol. Soc. Japan*, 28-29 (J) (14).
- and ———, 1986: Stratigraphy and structural relationship among pre-Jurassic accretionary and collision systems in the Akiyoshi Terrane. *IGCP Project 224 (pre-Cretaceous evolution of Eastern Asia). Guidebook for Excursion*, 51-88. (27).
- KOIKE, T., 1967: A Carboniferous succession of conodont faunas from the Atetsu limestone in Southwest Japan. *Sci. Rep. Tokyo Kyoiku Daigaku*, 9, 279-318 (2).
- KURIMOTO, C., 1986: Ultra-Tamba zone in Fukuchiyama area, Kyoto Prefecture-its constituent rocks and distribution-. "*Earth Sci.*" (*Chikyu Kagaku*), 40, 64-67 (J) (51).

- and KIMURA, K., 1985: Permian formations of the Maizuru and Ultra-Tamba Belts in the Fukuchiyama and Ayabe Districts, Southwest Japan. *Proc. Kansai Branch, Geol. Soc. Japan*, 99, 9–10 (J) (37).
- MIYAKE, K., 1984: Straigraphy and structure of Paleozoic formations in northern part of Katsuyama-cho, Maniwa-gun, Okayama Prefecture. *Abst. 91st Ann. Meet. Geol. Soc. Japan*, 545 (J) (11).
- , 1985: Permian olistostrome complex in the Katsuyama area, Okayama Prefecture, Southwest Japan. *Jour. Geol. Soc. Japan*, 91, 463–475 (J, E) (17).
- MUSASHINO, M., KIRIMURA, S. and ISHIGA, H., 1987: Discovery of *Neobailiella* (Late Permian radiolaria) from Oi Formation of Ultra-Tamba zone, Southwest Japan. *"Earth Sci." (Chikyu Kagaku)*, 41, 194–197 (J) (53).
- MURAKAMI, A., 1976: Discovery of Triassic conodonts from the Kanoashi Group, Southwest Japan. *Jour. Geol. Soc. Japan*, 82, 143–144 (J) (61).
- NAKA, T., 1986: Permian Nishiki Group in the Kidanikyō River area, Yamaguchi Prefecture. *Abst. 93rd Ann. Meet. Geol. Soc. Japan*, 246 (J) (22).
- , 1987: Permian Nishiki Group in the Nishiki-cho area, Yamaguchi Prefecture, Southwest Japan. *Abst. 94th Ann. Meet. Geol. Soc. Japan*, 272 (J) (28).
- and ISHIGA, H., 1985: Discovery of Permian radiolarians from Nishiki Group in western part of Sangun-Chugoku Belt, Southwest Japan. *"Earth Sci." (Chikyu Kagaku)*, 39, 229–233 (J) (16).
- and Muikaichi Research Group, 1984: Paleozoic and Mesozoic formations in Muikaichi-cho of Shimane Prefecture, Southwest Japan. *Proc. Nishinon Branch, Geol. Soc. Japan*, 95, 10–11. (J) (7).
- , TOKUOKA, T., IIZUMI, S., WATANABE, T. and TAMAKI, A., 1984: Paleozoic and Mesozoic formations in Muikaichi-cho, Shimane Prefecture, and Nishiki-cho, Yamaguchi, Prefecture, Southwest Japan. *Abst. 91st Ann. Meet. Geol. Soc. Japan*, 182 (J) (9).
- , WATASE, H. and TOKUOKA, T., 1986: Permian Nishiki Group in the Muikaichi-cho, western part of the Sangun-Chugoku Belt, Shimane Prefecture, Southwest Japan. *"Earth Sci." (Chikyu Kagaku)*, 40, 160–170 (J, E) (25).
- NISHIMURA, K., 1987: Permian radiolarian assemblages in the Yanahara area, western part of Maizuru Belt, Southwest Japan. *Abst. 94th Ann. Meet. Geol. Soc. Japan*, 277 (J) (43).
- and ISHIGA, H., 1987: Radiolarian biostratigraphy of the Maizuru Group in the Yanahara area, Southwest Japan. *Mem. Fac. Sci., Shimane Univ.*, 21 169–188.
- , NAKA, T., TOKUOKA, T. and ISHIGA, H., 1985: Permian formations and Triassic Fukumoto Group in the Yamahara area, Okayama Prefecture, Southwest Japan. *Abst. 93rd Ann. Meet. Geol. Soc. Japan*, 244 (J) (35).
- and TOKUOKA, T. 1986: Permian rocks and Triassic Fukumoto Group in the Yanahara area, Okayama Prefecture, Southwest Japan. *Abst. 93rd Ann. Meet. Geol. Soc. Japan*, 244 (J) (40).
- NISHIMURA, Y. and ISOZAKI, Y., 1984: Radiolarian and radiometric age of the Nishiki Group in eastern part of Yamaguchi Prefecture, Southwest Japan. *Report Co-operative Research on High Pressure Metamorphism in Inner Zone of Southwest Japan*, 2, 37–40 (J) (8).
- , ——— and NUREKI, Y., 1985: Sangun-Chugoku Belt and Ryōke Belt in eastern part of Yamaguchi Prefecture. *Abst. 92nd Ann. Meet. Geol. Soc. Japan, Field Guide Report*, 17–49 (J) (15).
- OHO, Y., INOUE, M. and SADA, K., 1985: Stratigraphy and structure of the Carboniferous and Permian in the Yoshiki area of the Hiroshima Prefecture, Southwest Japan. *Jour. Geol. Soc. Japan*, 91, 771–778. (J, E) (18).
- OTOH, S., 1987: Paleogeography in Late Paleozoic time of the western part of Chugoku Mountainland. *Abst. 94th Ann. Meet. Geol. Soc. Japan*, 564 (J) (46).
- OKADA, T., 1984: Stratigraphical relationship between "limestone rocks" and "non-limestone rocks" in

- the Kibi Plateau, Southwest Japan. *Abst. 91st Ann. Meet. Geol. Soc. Japan*, 231 (J) (10).
- OKIMURA, Y., 1966: Microbiostratigraphical studies on the foraminiferal faunas of the Lower Carboniferous formations of the Chugoku region, Southwest Japan. *Geol. Report, Hiroshima Univ.*, 15, 1-46 (J, E).
- OTA, M., 1977: Geologic studies of Akiyoshi, Part I. General geology of Akiyoshi Limestone Group. *Bull. Akiyoshi Mus. Nat. Hist.*, 12, 1-33.
- PILLAI, D. D. L., 1987: Some aspects of sedimentary and tectonics in the Permian Kozuki Formation, Hyogo Prefecture, Southwest Japan. *Abst. 94th Ann. Meet. Geol. Soc. Japan*, 274 (47).
- and ISHIGA, H., 1987: Discovery of Late Permian radiolarians from the Kozuki Formation, Kozuki-Tatsuno belt, Southwest Japan. *Jour. Geol. Soc. Japan*, 93, 847-850.
- SADA, K., INOUE, R. and OHO, H. Y., 1985: The conodont discovered from the Paleozoic in Yuki area, Hiroshima Prefecture, Southwest Japan. *Fossil (Kaseki)*, 39, 28-31 (J) (19).
- SANO, H., UCHIYAMA, T. and KANMERA, K., 1983: Re-examination of stratigraphy of the Ohta Group, south of Akiyoshi-dai, Southwest Japan. *Abst. 90th Ann. Meet. Geol. Soc. Japan*, 205 (J) (5).
- TAKATA, M., 1987: Reexamination of Jurassic complex, Kuga Group, in eastern part of Yamaguchi Prefecture—distinction of two kinds of geologic units and its significance-. *Report Co-operative Research on High Pressure Metamorphism in Inner Zone of Southwest Japan*, 4, 27-37 (J) (80).
- and ISOZAKI, Y., 1985: Occurrence of Jurassic radiolaria. *Proc. Nishinohon Branch, Geol. Soc. Japan*, 82, 8-9 (J) (72).
- and ISOZAKI, Y., 1986: Occurrence of Jurassic radiolarians from the "Mikawa Group" in eastern Yamaguchi Prefecture. *Jour. Geol. Soc. Japan*, 92, 447-450 (J) (75).
- TAKESHITA, H., ISHIGA, H. and WATANABE, T., 1986: Discovery of Permian radiolarians from the Sangun metamorphic rocks (Tanoharagawa Formation) in Gotsu City, Shimane Prefecture. *Proc. Kansai Branch, Geol. Soc. Japan*, 100, 38 (J) (54).
- , WATANABE, T. and ISHIGA, H., 1987: Discovery of Permian radiolarians from the Tanoharagawa Formation (the Sangun metamorphic rocks), Gotsu, Shimane Prefecture, Japan. *Jour. Geol. Soc. Japan*, 93, 435-438. (J) (55).
- TANAKA, K., 1980: Kanoashi Group, an olistostrome, in the Nichihara area, Shimane Prefecture. *Jour. Geol. Soc. Japan*, 86, 613-628 (J, E) (64).
- TATEISHI, T., 1985: Relationship between geology and bedded manganese ore deposits in the Rengesan area, eastern part of Yamaguchi Prefecture, Southwest Japan. *Proc. Nishinohon Branch, Geol. Soc. Japan*, 83, 8 (J) (73).
- TOKUOKA, T., NISHIMURA, K. and NAKA, T., 1986: Paleozoic rocks and Triassic Fukumoto Group in Yanahara area, Okayama Prefecture, Southwest Japan. *Proc. Nishinohon Branch, Geol. Soc. Japan*, 84, 21 (J) (39).
- TOYOHARA, F., 1974a: On the age of the Kuga Group and Ryoike metamorphic rocks in eastern Yamaguchi Prefecture, Southwest Japan. *Jour. Geol. Soc. Japan*, 80, 51-53 (J) (57).
- , 1974b: Upper Paleozoic and Lower Mesozoic rocks in the western part of the Chugoku Mountailand, Southwest Japan. *Abst. 81st Ann. Meet. Geol. Soc. Japan*, 386 (J) (58).
- , 1976a: Geologic structure from Sangun-Yamaguchi Zone to "Ryoike Zone" in eastern Yamaguchi Prefecture, Southwest Japan. *Jour. Geol. Soc. Japan*, 82, 99-111 (J, E) (59).
- , 1976b: Permian-Triassic dekens in Nichihara, Shimane Prefecture and their tectonic evolution. *Abst. 83rd Ann. Meet. Geol. Soc. Japan*, 148 (J) (60).
- , 1977: Early Mesozoic tectonic development of the northeastern Chichibu geosyncline in west Chugoku, Japan. *Jour. Fac. Sci. Univ. Tokyo, II*, 19, 253-336 (62).
- Tsusansyo Shigenenerugicho, 1981: Regional Geologic Report of Nishikigawa River area, Southwest Japan. 150 p. (J) (65).
- UCHIYAMA, F., SANO, H. and KANMERA, K., 1986: Depositional and tectonic setting of cherts around

- the Akiyoshi Limestone Group, Southwest Japan. *Mem. Fac. Sci. Kyushu Univ.*, D, 26, 51-68 (23).
- WAKITA, K., 1985a: Kuga and Mikawa Groups in the western part of Yamaguchi Prefecture, Southwest Japan. *Abst. 92nd Ann. Meet. Geol. Soc. Japan*, 148 (J) (74).
- , 1985b: Discovery of Middle-Late Permian radiolarians in the Karita and Hachimandai Formations in the northeast environs of Hiroshima, Japan. *"Earth Sci."(Chikyu Kagaku)*, 39, 237-240 (J) (38).
- WATANABE, T., TOKUOKA, T. and NAKA, T., 1987: Complex fragmentation of Permo-Triassic and Jurassic accreted terrances in the Chugoku district, SW Japan and Formation of the Sangun metamorphic rocks. In E. C. LEITCH and E. SCHEIBNER (eds.) *Geodynamics Series, 19, Terrane Accretion and Orogenic Belts*, 275-289.
- WATASE, H., NAKA, T., TOKUOKA, T. and ISHIGA, H., 1985: Biostratigraphic study of the Nishiki Group in Muikaichi, Shimane Prefecture, Southwest Japan. *Proc. Kansai Branch, Geol. Soc. Japan*, 98, 2 (J) (13).
- YOGORO, T., WATANABE, T., HARADA, Y., FUJIE, S., TAKAMATSU, M., KOSUGE, Y. and Research Group of the Chizu Formation, 1986: Mesozoic nassellaria (radiolaria) from the Chizu Formation of the Sangun metamorphic belt in Wakasa area, Tottori, Prefecture, Southwest Japan. *Proc. Kansai Branch, Geol. Soc. Japan*, 101, 2-3 (J) (78).

(F, E): in French with English abstract

(J, E): in Japanese with English abstract

(C, E): in Chinese with English abstract

(J): in Japanese

(): Numbers refer to text numbers in the Figs. 2, 3, 6, 7, 9, 10 and 11.