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Report

Late Triassic radiolarians and conodonts from a chert pebble within the Lower Pleistocene Higashihigasa Formation of the Kazusa Group, Boso Peninsula, Japan

ITO Tsuyoshi[1,*], MUTO Shun[1] and UTSUNOMIYA Masayuki[1]

ITO Tsuyoshi, MUTO Shun and UTSUNOMIYA Masayuki (2022) Late Triassic radiolarians and conodonts from a chert pebble within the Lower Pleistocene Higashihigasa Formation of the Kazusa Group, Boso Peninsula, Japan. *Bulletin of the Geological Survey of Japan*, vol. 73(3), p. 93–101, 6 figs and 1 table.

Abstract: Radiolarians and conodonts were obtained from a chert pebble within the conglomerate of the Higashihigasa Formation, Kazusa Group, Boso Peninsula, Japan. Based on the occurrence of radiolarians (*Praemesosaturnalis* sp. cf. *P. heilongjiangensis*) and conodonts (*Mockina* sp.), the chert pebble is considered to be Late Triassic (middle to late Norian) in age. This chert pebble is presumably derived from a Jurassic accretionary complex distributed in its provenance.

Keywords: radiolarian, conodont, Triassic, Pleistocene, Kazusa Group, conglomerate, provenance, Jurassic accretionary complex, Boso Peninsula, Chiba Prefecture

1. Introduction

Clasts within sediments, such as conglomerate, are supplied from the surrounding geologic units and record information of the provenance. Microfossils including radiolarians and conodonts can assign the age of the clasts, even if they are small clasts.

Radiolarian-bearing clasts have been reported from the Paleozoic to Cenozoic (Table 1) and compiled (e.g. Ishida *et al.*, 2003; Ito *et al.*, 2017a, e), but radiolarian-bearing clasts within the Quaternary are poorly investigated: only by Ito *et al.* (2020) as far as we know. Ito *et al.* (2020) indicated the presence of a water system different from the present one in the Nishi-Mikawa region, central Japan, based on microfossil-bearing clasts. Accumulation of the data of microfossil-bearing clasts within the Quaternary in several areas and horizons will contribute to reconstruction of changes of provenances and water systems.

The Pleistocene Kazusa Group is distributed in the Boso Peninsula (Fig. 1). Some formations of the group include conglomerate layers. We investigated the conglomerate for the accumulation of data of microfossil-bearing clasts within the Quaternary. We consequently discovered radiolarians and conodonts from a chert pebble within the conglomerate of the Higashihigasa Formation of the Pleistocene Kazusa Group, Boso Peninsula (Fig. 1). In this article, we note the microfossils as the first report of microfossil-bearing clasts within the Quaternary in the Boso Peninsula.

2. Geologic setting

The Kazusa Group is mainly composed of shallow- to deep-marine successions (>3,000 m in total thickness). The group generally comprises the Kurotaki, Katsuura, Namihana, Ohara, Tomiya, Kiwada, Otadai, Umegase, Higashihigasa, Kokumoto, Kakinokidai, Ichijiku, Chonan, Mandano, Kasamori and Kongochi formations (Tokuhashi and Endo, 1984; Nakajima and Watanabe, 2005; Utsunomiya and Ooi, 2019) (Fig. 2).

The microfossil-bearing pebble dealt with in this study was collected from the conglomerate of the Higashihigasa Formation. The Higashihigasa Formation is considered as a canyon-fill deposit which interfingers with the submarine-fan deposits defined as the Otadai and Umegase formations (Yamauchi *et al.*, 1990). Chronostratigraphy based on magneto-, tephro- and bio-stratigraphy suggests the Otadai and Umegase formations were deposited during the Early Pleistocene (Calabrian) (Kazaoka *et al.*, 2015). The clast-bearing conglomerate is intercalated above the U10 tephra bed, which is near the Marine Isotope Stage 24 (Pickering *et al.*, 1999), at about 0.9 Ma.

The sample locality is along a tributary of the Obitsu River, north of Mt. Otsuka (Fig. 3). It is located in Otomi, Kimitsu City, Chiba Prefecture in administrative division. The chert clasts occur at the basal part of a conglomerate (2 m in thickness), associated with bioclasts (e.g. mollusks) and other kinds of gravels such as sedimentary rocks and volcanic rocks (Fig. 4A).

[1] AIST, Geological Survey of Japan, Research Institute of Geology and Geoinformation
[*] Corresponding author: ITO, T., Central 7, 1-1-1 Higashi, Tsukuba, Ibaraki 305-8567, Japan. Email: ito-t@aist.go.jp

Table 1 Major previous studies of radiolarian-bearing clasts.

Erathem	System	Series	Reference
Cenozoic	Quaternary	Pleistocene	Ito *et al.* (2020)
			Ito *et al.* (2022) [this study]
	Neogene	Pliocene?	Matsuoka (1998)
			Yamamoto *et al.* (2012)
		Pliocene	Kawajiri and Kashiwagi (2012)
			Kashiwagi *et al.* (2013)
			Utagawa *et al.* (2017)
		Miocene	Umeda *et al.* (1992)
			Kashiwagi (2012)
			Ito and Nakamura (2021)
			Yabuta *et al.* (2021)
	Paleogene	Oligocene	Umeda (1997)
		Eocene?	Kamemura and Okamura (1994)
		Paleocene?	Kishu Shimanto Research Group (2017)
Mesozoic	Cretaceous	Upper	Suzuki *et al.* (1996)
			Inose *et al.* (2018)
		Lower	Kojima (1986)
			Takeuchi *et al.* (1991)
			Umeda *et al.* (1995)
			Ishida and Hashimoto (1997)
			Ishida (1999)
			Umeda and Sugiyama (1998)
			Matsukawa and Takahashi (1999)
			Nikaido and Matsuoka (2004)
			Tomita *et al.* (2007)
			Ito *et al.* (2012)
			Ito *et al.* (2014)
			Ito *et al.* (2015)
			Kashiwagi and Isaji (2015)
			Takeuchi *et al.* (2015)
			Ozeki *et al.* (2021)
	Jurassic	Upper	Saida (1987)
		Middle?	Ito *et al.* (2016)
			Ito *et al.* (2017b)
		Lower	Kumazaki and Kojima (1996)
			Ito *et al.* (in press)
	Triassic	Upper	Kametaka (1997)
	Triassic?		Saito and Tsukamoto (1993)
			Kamata (1997)
Paleozoic	Permian	Gudalupian–Lopingian	Matsuoka and Kuwahara (2021)
			Takemura *et al.* (1996)
	Carboniferous	Mississippian	Uchino and Kurihara (2019)
Paleozoic?			Ito *et al.* (2017c)
			Ito *et al.* (2017d)

3. Method

Four pebbles collected from the conglomerate were processed with the following method to extract microfossils. They were crushed into some fragments to create more surface area. The crushed pebbles were soaked in 5 % hydrofluoric acid at room temperature, about 20–25 °C, for 24 h. The residues were collected by a sieve with a mesh opening of 0.054 mm. This process was repeated four times. Fossil specimens in the residues were picked up and mounted on stabs. The specimens on the stabs were photographed by scanning electron microscopy. Part of the residues was enclosed within a slide prepared with a photocrosslinkable mounting medium (GJ-4006, Gluelabo Ltd.). The slides were photographed using a transmitted light microscope.

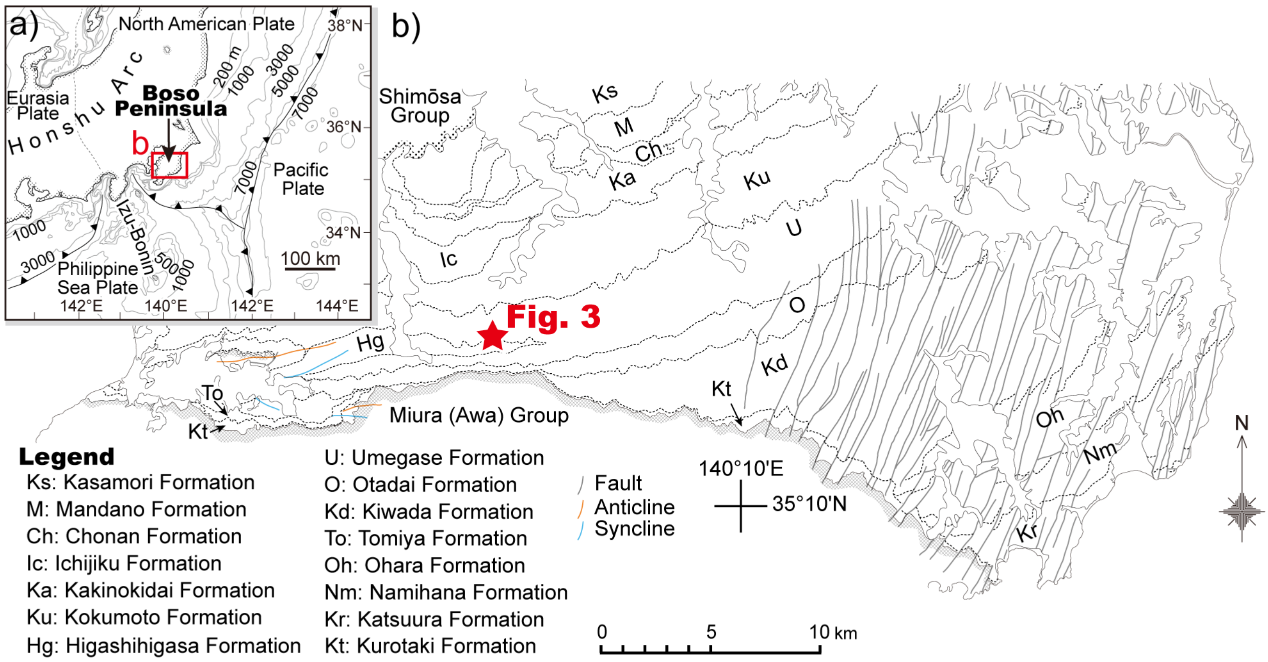

Fig. 1 Index and simplified geologic maps of Boso Peninsula (modified after from Utsunomiya *et al.*, 2019).

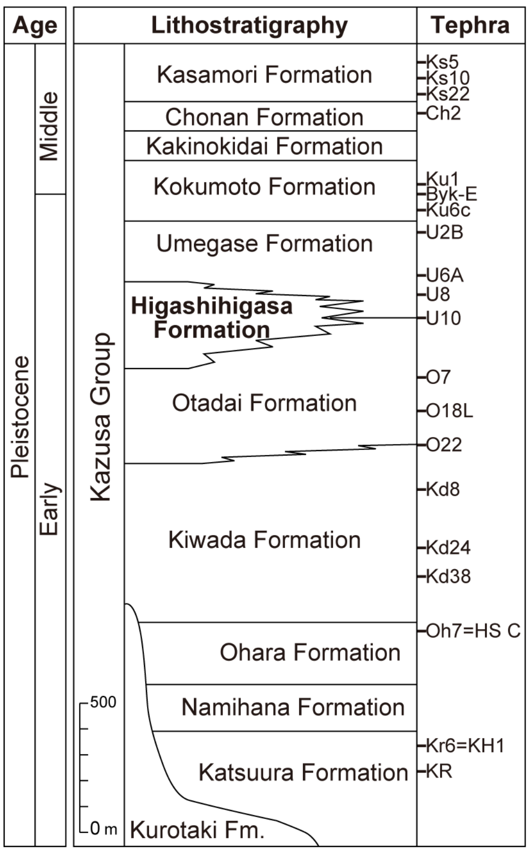

Fig. 2 Stratigraphy of the Kazusa Group in the Boso Peninsula (modified after from Utsunomiya *et al.*, 2019).

4. Microfossil occurrences

Among the four pebbles, only one pebble (sample 21112309a) yielded radiolarians and conodonts. The pebble is a rounded reddish chert, and its diameter is about 3 cm (Fig. 4B). The radiolarian and conodont specimens are shown in Fig. 5.

Some radiolarians, *Praemesosaturnalis* sp. cf. *P. heilongjiangensis* Yang and Mizutani, *Praemesosaturnalis*? sp., *Paroertlispongus*? sp., Poulpidae? gen. et sp. indet. and Spumellaria gen. et sp. indet. were extracted. The specimens identified as *Praemesosaturnalis* sp. cf. *P. heilongjiangensis* (Figs. 5.1–5.5) seem to have spines with an elevated margin and bifurcated end. Such a spine is known in a broken specimen of *Praemesosaturnalis heilongjiangensis* (Yang and Mizutani, 1991).

Two specimens of conodonts were extracted. One specimen (Fig. 5.33) can be identified as *Mockina* sp. due to the following characters: a carina extending to the posterior end, a platform with only one sharp denticle on the lateral margin and an anteriorly shifted basal pit, at which the basal margin is upturned.

5. Age assignment

Praemesosaturnalis heilongjiangensis was originally described in the Norian (Upper Triassic) in the Nadanhada Terrane, Northeast China (Yang and Mizutani, 1991). The species has also been reported from the Norian in other areas (e.g. Yao, 1982; Yoshida, 1986; Tekin, 2002). According to Sugiyama (1997), *Praemesosaturnalis*

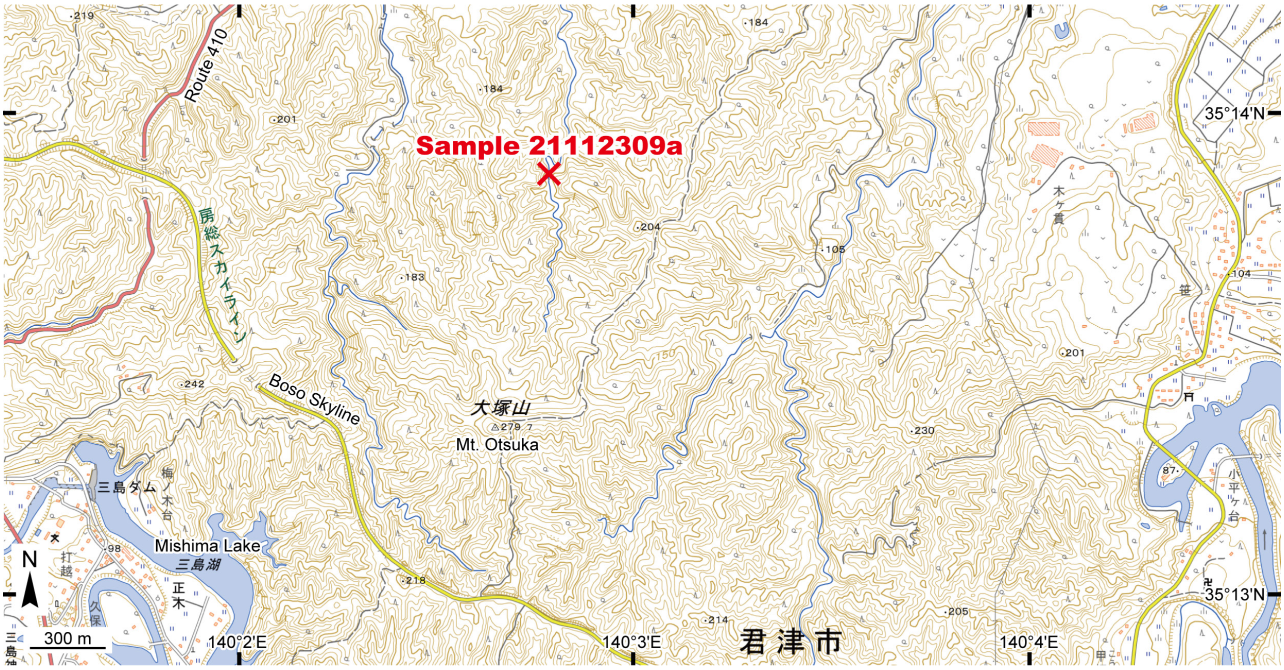

Fig. 3 Locality map. The map is modified from the topographic map published by Geospatial Information Authority of Japan (https://maps.gsi.go.jp/).

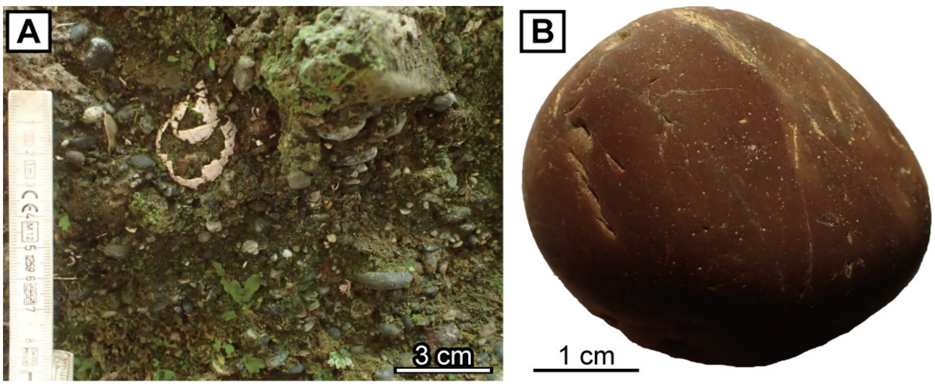

Fig. 4 Photographs of conglomerate and pebble. (A) Conglomerate of the Higashihigasa Formation of the Kazusa Group, Boso Peninsula. (B) Microfossil-bearing red chert pebble (sample 21112309a).

heilongjiangensis group mainly occurs in TR8A to TR8C, Norian, Upper Triassic.

The genus *Mockina* occurs in the middle to upper Norian (upper Alaunian to lower Sevatian) (Mazza *et al.*, 2012; Rigo *et al.*, 2018). The updated integrated biostratigraphy of radiolarians and conodonts by Yamashita *et al.* (2018) showed the co-occurrence of *Praemesosaturnalis heilongjiangensis* group and species of *Mockina* in the middle to upper Norian.

Based on the above-mentioned radiolarian and conodont occurrences, the sample is middle to late Norian in age.

6. Implication

In Southwest Japan, Triassic chert is a component rock of Jurassic accretionary complexes of the Tamba–Mino–Ashio and Chichibu belts (e.g. Nakae, 2000; Matsuoka *et al.*, 1998; Kojima *et al.*, 2016). Consequently, the chert pebble dealt with in this study must be derived from one of these Jurassic accretionary complexes. Meanwhile, the Jurassic accretionary complex is not exposed near the Boso Peninsula (Fig. 6). The nearest-exposed Jurassic accretionary complexes are those in the Yamizo Mountains (Ashio Belt), Ashio Mountains (Ashio Belt) and Kanto

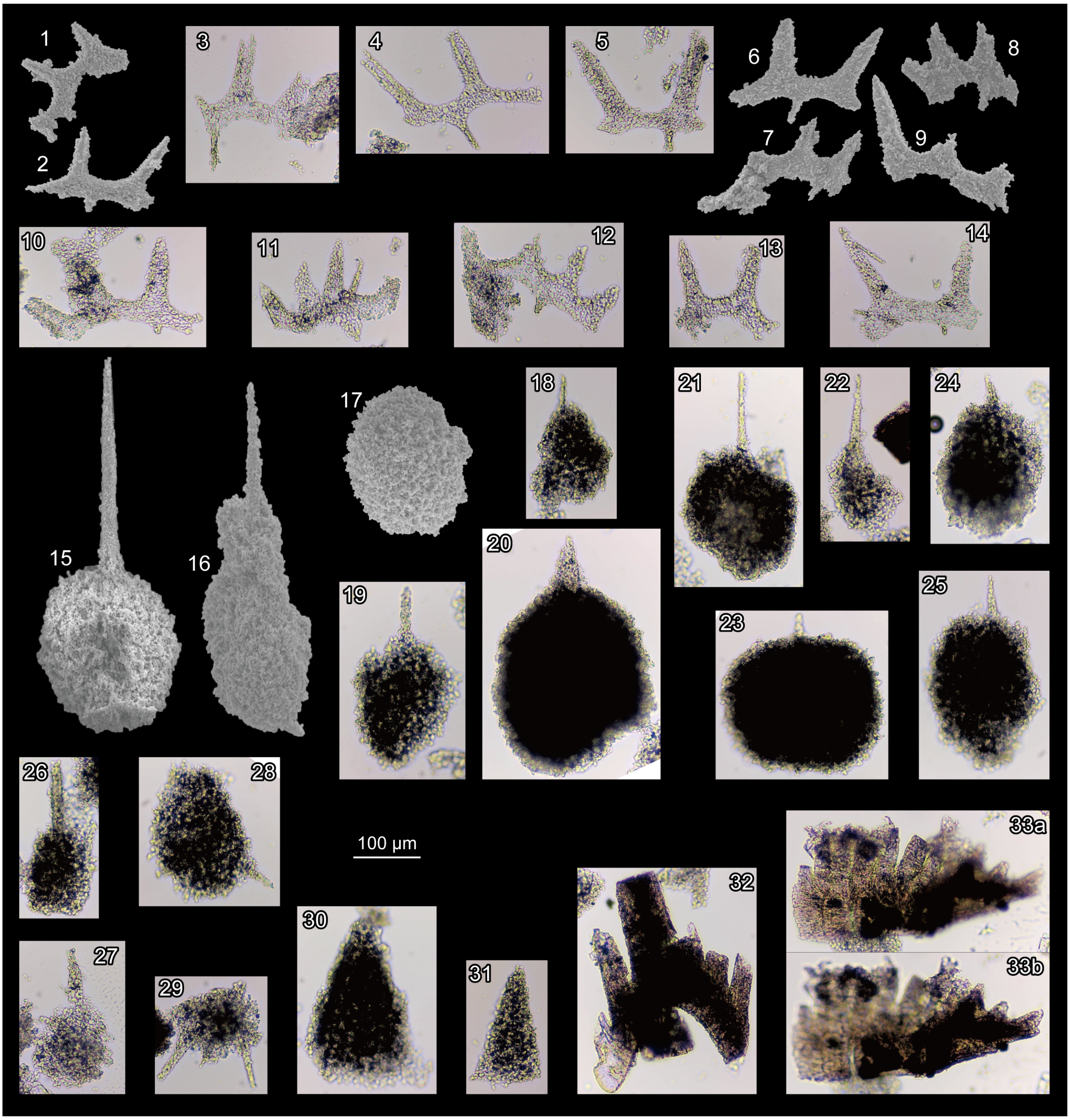

Fig. 5 Late Triassic radiolarians (1–31) and conodonts (32, 33) from the chert pebble (sample 21112309a). (1–5) *Praemesosaturnalis* sp. cf. *P. heilongjiangensis* Yang and Mizutani. (6–14) *Praemesosaturnalis*? sp. (15) *Paroertlispongus*? sp. (16–28) Spumellaria gen. et sp. indet. (29) Poulpidae? gen. et sp. indet. (30, 31) Nassellaria gen. et sp. indet. (32) Breviform digyrate conodont element (M element?). (33) *Mockina* sp.

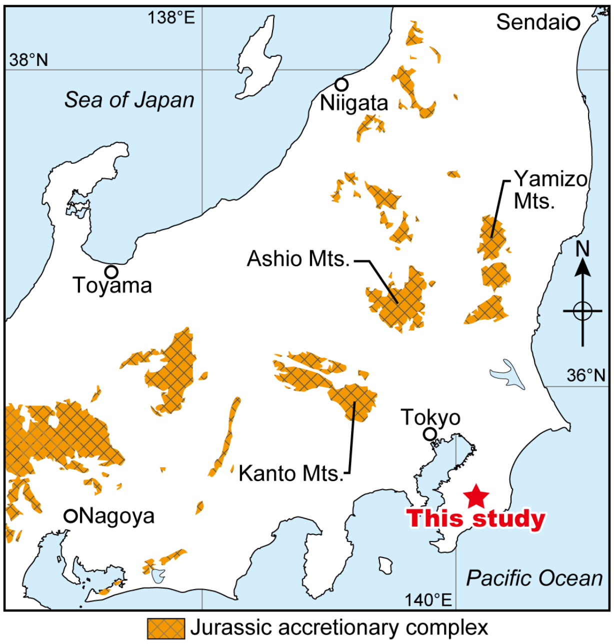

Fig. 6 Distribution of Jurassic accretionary complexes in central Japan. The distribution is based on Geological Survey of Japan, AIST (2020).

Mountains (Chichibu Belt). The Jurassic accretionary complex in one of these mountains is the presumable origin of the chert pebble. Triassic chert pebbles have also been reported from the Neogene in the Boso Peninsula (Yamamoto *et al.*, 2012), so the chert pebble might be secondarily derived from such strata.

In the current knowledge, the origin of the pebble is not conclusive. Triassic chert is found throughout most of the Jurassic accretionary complex, whereas some lithologies (e.g. limestone, Permian chert, Upper Jurassic mudstone) are unevenly distributed in the complex. If clasts of these lithologies can be found, their origin can be determined in more detail. Further accumulation of the data of the Quaternary in and near the Boso Peninsula will clarify its origin more accurately.

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References

Geological Survey of Japan, AIST (2020) Seamless digital geological map of Japan 1: 200,000. Geological Survey of Japan, AIST. https://gbank.gsj.jp/seamless/v2.html [Accessed: Aug. 8th, 2021].

Inose, H., Furuuchi, K., Ito, T., Sashida, K. and Agematsu, S. (2018) Radiolarian fossils from conglomerate layers of the Upper Cretaceous Nakaminato Group exposed along the Pacific coast of Ibaraki Prefecture, central Japan: Staged denudation of the mid-Mesozoic accretionary complexes in the Kanto District. *Paleontological Research*, **22**, 307–325.

Ishida, K. (1999) Radiolarians as tracers for provenance of gravels in Lower Cretaceous molasse (Outer Zone of SW Japan). *Geodiversitas*, **21**, 637–656.

Ishida, K. and Hashimoto, H. (1997) Mesozoic and Paleozoic radiolarians from the chert pebbles and fine clastics of the Ryoseki and Monobegawa groups in East Shikoku. *News of Osaka Micropalaeotologist (NOM), Special Volume*, no. 10, 217–235 (in Japanese with English Abstract).

Ishida, K., Kozai, T., Park, S. O. and Mitsugi, T. (2003) Gravel bearing radiolarian as tracers for erosional events: a review of the status of recent research in SW Japan and Korea. *Journal of Asian Earth Sciences*, **21**, 909–920.

Ito, T. and Nakamura, Y. (2021) Radiolarians from Jurassic accretionary complex of the Chichibu belt in the western Akaishi Mountains and chert pebbles of the Miocene Wada Formation in Minami-Shinano, central Japan. *Fossils (Kaseki)*, no. 110, 3–16. (in Japanese with English abstract)

Ito, T., Sakai, Y., Ibaraki, Y., Yoshino, K., Ishida, N., Umetsu, T., Nakada, K., Matsumoto, A., Hinohara, T., Matsumoto, K. and Matsuoka, A. (2012) Radiolarian fossils from siliceous rock pebbles within conglomerates in the Mizukamidani Formation of the Tetori Group in the Itoigawa area, Niigata Prefecture, central Japan. *Bulletin of Itoigawa City Museums*, no. 3, 13–25. (in Japanese with English abstract)

Ito, T., Sakai, Y., Ibaraki, Y. and Matsuoka, A. (2014) Middle Jurassic radiolarians from a siliceous mudstone clast within conglomerate of the Tetori Group in the Itoigawa area, Niigata Prefecture, central Japan. *Science Reports of Niigata University (Geology)*, no. 29, 1–11.

Ito, T., Sakai, Y., Feng, Q. L. and Matsuoka, A. (2015) Middle Jurassic radiolarians from chert clasts in conglomerates of the Tetori Group in the Taniyamadani valley, Fukui Prefecture, central Japan. *Science Reports of Niigata University (Geology)*, no. 30, 1–13.

Ito, T., Kitagawa, Y. and Matsuoka, A. (2016) Middle and Late Permian radiolarians from chert blocks within conglomerates of the Kamiaso Unit of the Mino terrane in Gifu Prefecture, central Japan. *The Journal of the Geological Society of Japan*, **122**, 249–259. (in Japanese with English abstract)

Ito, T., Ibaraki, Y. and Matsuoka, A. (2017a) Outline and history of the Itoigawa UNESCO Global Geopark in Niigata Prefecture in central Japan, with radiolarian occurrences in Itoigawa. *Science Reports of Niigata University (Geology)*, no. 32 (supplement), 71–90.

Ito, T., Kitagawa, Y. and Matsuoka, A. (2017b) An aberrant bi-apical Follicucullus (Albaillellaria) from the late Guadalupian (Middle Permian), with the possible oldest evidence on double malformation in radiolarians. *Journal of Micropalaeontology*, **36**, 222–223.

Ito, T., Kurihara, T., Hakoiwa, H., Ibaraki, Y. and Matsuoka, A. (2017c) Late Silurian radiolarians from a radiolarite pebble within a conglomerate, Kotaki, Itoigawa, Niigata Prefecture, central Japan. *Science Reports of Niigata University (Geology)*, no. 32, 1–14.

Ito, T., Kurihara, T., Hakoiwa, H., Ibaraki, Y. and Matsuoka, A. (2017d) Discovery of the oldest fossil in Niigata Prefecture of central Japan from the Kotaki area, Itoigawa: A report on collaboration research of Itoigawa City, Niigata University, and Geological Survey of Japan, AIST. *Bulletin of Itoigawa City Museums*, no. 4, 23–31. (in Japanese with English abstract)

Ito, T., Sakai, Y., Feng, Q. L. and Matsuoka, A. (2017e) Review of microfossil-bearing clasts within Late Mesozoic strata in East Asia: staged denudation of mid-Mesozoic accretionary complexes. *Ofioliti*, **42**, 39–54.

Ito, T., Abe, T. and Miyakawa, A. (2020) Paleozoic and Mesozoic radiolarian fossils from siliceous rock pebbles of the Pleistocene in sediment core from Nishimikawa Plain, central Japan: Estimation of a source of the pebbles. *The Quaternary Research (Daiyonki-Kenkyu)*, **59**, 105–116. (in Japanese with English abstract)

Ito, T., Kawajiri, T. and Matsuoka, A. (in press) Permian radiolarians and spicules from conglomerate of the Lower Jurassic Kuruma Group in Itoigawa, Niigata Prefecture, central Japan. *Paleontological Research*.

Kamata, Y. (1997) Late Permian to Late Triassic radiolarians obtained from a float of the sandstone and chert breccia on the Ashio Mountains (preliminary report). *News of Osaka Micropalaeotologist (NOM), Special Volume*, no. 10, 97–107. (in Japanese with English abstract)

Kamemura, T. and Oakmura, M. (1994) Geologic age and it's source of radiolarites from the Paleogene formations, eastern Hokkaido. *Abstracts of the 101st Annual Meeting of the Geological Society of Japan*, 142. (in Japanese)

Kametaka, M. (1997) Radiolarian fossils from conglomerate of the Upper Triassic Nariwa Group, and their geological significance. *News of Osaka Micropalaeotologist (NOM), Special Volume*, no. 10, 127–131. (in Japanese with English abstract)

Kashiwagi, K. (2012) Sedimentary environment of the Nirehara Formation (Lower Miocene) in the Yatsuo area, Toyama Prefecture of central Japan and Paleozoic and Mesozoic radiolarian fossils from chert pebbles and cobbles. *Memoir of the Fukui Prefectural Dinosaur Museum*, **11**, 27–47. (in Japanese with English abstract)

Kashiwagi, K. and Isaji, S. (2015) Paleozoic and Mesozoic radiolarians from chert pebbles and cobbles of the Lower Cretaceous Choshi Group, Japan. *Natural History Research (Natural History Museum and Institute, Chiba)*, **14**, 35–46.

Kashiwagi, K., Isaji, S. and Asai, H. (2013) Latest Late Jurassic to early Late Cretaceous radiolarians extracted from a gravel of the calcareous nodule originated from the basal conglomerate of the Pliocene Naarai Formation, Choshi area of Kanto Region, central Japan. *The Journal of the Geological Society of Japan*, **119**, 647–652. (in Japanese with English abstract)

Kawajiri, K. and Kashiwagi, K. (2012) Triassic and Jurassic radiolarians from the chert pebbles of the Plio–Pleistocene Nakatsu Group in the central part of Kanagaw Prefecture, central Japan. *Bulletin of the Sagamihara City Museum*, no. 20, 65–74. (in Japanese)

Kazaoka, O., Suganuma, Y., Okada, M., Kameo, K., Head, M.J., Yoshida, T., Sugaya, M., Kameyama, S., Ogitsu, I., Nirei, H., Aida, N. and Kumai, H. (2015) Stratigraphy of the Kazusa Group, Boso Peninsula and highly-resolved marine sedimentary record from the Lower and Middle Pleistocene of central Japan. *Quaternary International*, **383**, 116–135.

Kishu Shimanto Research Group (2017) Discovery of the Paleocene radiolarian fossils from mudstone gravels in the Nyunokawa Formation of the Shimanto Superbelt in the Kii Peninsula—The Study of the Shimanto Terrain in the Kii Peninsula, Southwest Japan (Part 16)—. *Earth Science (Chikyu Kagaku)*, **71**, 167–184. (in Japanese with English abstract)

Kojima, S. (1986) Occurrence of Permian radiolarians from chert pebbles in conglomerate at Yokoo, Nyukawa Village, Gifu prefecture, central Japan. *News of Osaka Micropalaeotologist (NOM), Special Volume*, no. 7, 175–179. (in Japanese with English abstract)

Kojima, S., Hayasaka, Y., Hiroi, Y., Matsuoka, A., Sano, H., Sugamori, Y., Suzuki, N., Takemura, S., Tsujimori, T. and Uchino, T. (2016) Pre-Cretaceous accretionary complexes. *In* Moreno, T., Wallis, S. and Gibbons, W., eds., *The Geology of Japan, Geological Society of London*, London, 61–100.

Kumazaki, N. and Kojima, S. (1996) Depositional history and structural development of the Kuruma Group (Lower Jurassic) on the basis of clastic rock composition. *The Journal of the Geological Society of Japan*, **102**, 285–302. (in Japanese with English abstract)

Matsukawa, M. and Takahashi, O. (1999) Radiolarian fossils occurred from the Itoshiro Subgroup of the Tetori Group and its geological significance. *Abstracts of the 106th Annual Meeting of the Geological Society of Japan*, 165. (in Japanese)

Matsuoka, A., Yamakita, S., Sakakibara, M. and Hisada, K. (1998) Unit division for the Chichibu Composite Belt from a view point of accretionary tectonics and geology of western Shikoku Japan. *The Journal of* *the Geological Society of Japan*, **104**, 634–653. (in Japanese with English abstract)

Matsuoka, K. (1998) Cretaceous radiolarian red shale pebbles from the Hannou Gravel in the eastern margin of Kanto Mountains, Japan. *Earth Science (Chikyu Kagaku)*, **52**, 324–328. (in Japanese with English abstract)

Matsuoka, K. and Kuwahara, K. (2021) Discovery of Capitanian (Permian) radiolarians and occurrence of conglomerate in volcaniclastic rocks in the Sumaizuku Unit of the Northern Chichibu Belt in the Kanto Mountains, Central Japan. *Earth Science (Chikyu Kagaku)*, **75**, 119–124. (in Japanese with English abstract)

Mazza, M., Rigo, M. and Gullo, M. (2012) Taxonomy and biostratigraphic record of the Upper Triassic conodonts of the Pizzo Mondello section (western Sicily, Italy), GSSP candidate for the base of the Norian. *Rivista Italiana di Paleontologia e Stratigrafia*, **118**, 85–130.

Nakae, S. (2000) Regional correlation of the Jurassic accretionary complex in the Inner Zone of Southwest Japan. *The Memoirs of the Geological Society of Japan*, no. 55, 73–98. (in Japanese with English abstract)

Nakajima, T. and Watanabe, M. (2005) *Geology of the Futtsu District.* Quadrangle Series, 1:50,000, Geological Survey of Japan, AIST, 102p. (in Japanese with English abstract)

Nikaido, T. and Matsuoka, A. (2004) Middle Jurassic radiolarian fossils from clasts of the Raga Formation and provenance of Raga Formation, Miyako Group in Iwate Prefecture. *Abstracts of the 111st Annual Meeting of the Geological Society of Japan*, 34. (in Japanese)

Ozeki, M., Shimizu, N., Agematsu, S. and Sashida, K. (2021) Microfossils from siliceous rock pebbles contained in the Lower Cretaceous Ishido Formation of the Sanchu Group, central Japan. *Journal of Geography (Chigaku Zasshi)*, **130**, 311–329. (in Japanese with English abstract)

Pickering, K. T., Souter, C., Oba, T., Taira, A., Schaaf, M. and Platzman, E. (1999) Glacio-eustatic control on deep-marine clastic forearc sedimentation, Pliocene–mid-Pleistocene (c. 1180–600 ka) Kazusa Group, SE Japan. *Journal of the Geological Society*, London, **256**, 125–136.

Rigo, M., Mazza, M., Karádi, V. and Nicora, A. (2018) New Upper Triassic conodont biozonation of the Tethyan realm. *In* Tanner, L., ed., *The Late Triassic World*. *Topics in Geobiology*, **46**. 189–235.

Saida, T. (1987) Triassic and Jurassic radiolarians in chert clasts of the Tetori Group in Tamodani area of Izumi Village, Fukui Prefecture, central Japan. *The Journal of the Geological Society of Japan*, **93**, 57–59. (in Japanese)

Saito, M. and Tsukamoto, H. (1993) Chert breccia, its occurrence and radiolarian fossils in the Hichiso-Mugi area, central Mino Terrane, central Japan. *The Journal of the Geological Society of Japan*, **99**, 117–133. (in Japanese with English abstract)

Sugiyama, K. (1997) Triassic and Lower Jurassic radiolarian biostratigraphy in the siliceous claystone and bedded chert units of the southeastern Mino terrane, central Japan. *Bulletin of the Mizunami Fossil Museum*, no. 24, 79–193.

Suzuki, N., Takashima, R., Nishi, H. and Saito, T. (1996) Triassic and Jurassic Polycystine (Radiolaria) from the siliceous shale pebbles of the Lowest Middle Ezo Group, Soushunai Area, Hokkaido. *Abstracts of the 103rd Annual Meeting of the Geological Society of Japan*, 140. (in Japanese)

Takemura, S., Umeda, M., Yao, A. and Suzuki, S. (1996) Middle and Late Permian radiolarian fossils yielding from siliceous rock pebbles in the Middle and Upper Permian Maizuru Group, Southwest Japan. *The Journal of the Geological Society of Japan*, **102**, 820–823. (in Japanese with English abstract)

Takeuchi, M., Saito, M. and Takizawa F. (1991) Radiolarian fossils obtained from conglomerate of the Tetori Group in the upper reaches of the Kurobegawa River, and its geologic significance. *The Journal of the Geological Society of Japan*, **97**, 345–359. (in Japanese with English abstract)

Takeuchi, M., Takenouchi, K. and Tokiwa, T. (2015) Range Metamorphic Rocks and the Mesozoic terrigenous strata. *The Journal of the Geological Society of Japan*, **121**, 193–216. (in Japanese with English abstract)

Tekin, U. K. (2002) Late Triassic (Late Norian–Rhaetian) radiolarians from the Antalya Nappes, Central Taurides, Southern Turkey. *Rivista Italiana di Paleontologia e Stratigrafia*, **108**, 415–440.

Tokuhashi, S. and Endo, H. (1984) *Geology of the Anesaki District*. Quadrangle Series, scale 1:50,000, Geological Survey of Japan, 136 p. (in Japanese with English abstract)

Tomita, S., Takeuchi, M. and Kametaka, M. (2007) Radiolarian fossils obtained from conglomerate of the Tetori Group in the northeastern part of Toyama Prefecture and its geological significance. *Abstracts of the 114th Annual Meeting of the Geological Society of Japan*, 243. (in Japanese)

Uchino, T. and Kurihara, T. (2019) Middle Devonian–early Carboniferous radiolarian fossils extracted from the conglomerate in the Nedamo Complex, Nedamo Terrane, Northeast Japan. *Bulletin of the Geological Survey of Japan*, **70**, 109–115. (in Japanese with English abstract)

Umeda, M. (1997) Petrography of orthoquartzite clasts and radiolarian fossils in chert clasts in the Late Oligocene conglomerate on the Mesozoic complex of the Nanjo Massif in the Mino Terrane, Central Japan. *Earth Science (Chikyu Kagaku)*, **51**, 199–211. (in Japanese with English abstract)

Umeda, M. and Sugiyama, K. (1998) Paleozoic and

Mesozoic radiolarians from pebbles of siliceous rocks of the Upper Jurassic Shiranezaki Formation in the Toba area, Mie Prefecture, Southwest Japan. *The Journal of the Geological Society of Japan*, **104**, 454–461. (in Japanese with English abstract)

Umeda, M., Kugimiya, Y. and Ishiga, H. (1992) Late Triassic–Early Jurassic Radiolarians from chert pebbles of the Middle Miocene in northern part of Ooda City, Shimane Prefecture, Japan. *Geological Reports of Shimane University*, **11**, 71–76. (in Japanese with English abstract)

Umeda, M., Takemura, S. and Yao, A. (1995) Mesozoic and Paleozoic radiolarians from the chert pebbles of the Lower Cretaceous Sasayama Group in the eastern part of Hyogo Prefecture, Southwest Japan. *The Journal of the Geological Society of Japan*, **101**, 937–939. (in Japanese with English abstract)

Utagawa, F., Sashida, K., Agematsu, S. and Kozu, S. (2017) Triassic and Jurassic radiolarian fossils from siliceous rock pebbles contained in the Nojimazaki Conglomerate Member of the upper Pliocene Shirahama Formation, Chikura Group, Central Japan. *The Journal of the Geological Society of Japan*, **123**, 969–976. (in Japanese with English abstract)

Utsunomiya, M. and Ooi, S. (2019) Geology of the Kazusa-Ohara District. Quadrangle Series, 1:50,000, Geological Survey of Japan, AIST, 127p. (in Japanese with English abstract)

Utsunomiya, M., Mizuno, K. and Tamura, I. (2019) Stratigraphic positions and characteristics of tephra beds in the lower to middle Kiwada Formation (lower Pleistocene), Kazusa Group. *Bulletin of the Geological Survey of Japan*, **70**, 373–441. (in Japanese with English abstract)

Yabuta, S., Takeuchi, M. and Saito, M. (2021) Conglomerate in the Kuroze Formation of the Miocene Shidara Group, eastern Aichi Prefecture, central Japan: Change in the provenance during the deposition of the Hokusetsu Subgroup. *The Journal of the Geological Society of Japan*, **127**, 689–700. (in Japanese with English abstract)

Yamamoto, Y., Chiyonobu, S., Kurihara, T., Yamaguchi, A., Hina, S., Hamahashi, M., Raimbourg, H., Augier, R. and Gadenne, L. (2012) Unconformity between a Late Miocene–Pliocene accretionary prism (Nishizaki Formation) and Pliocene trench-slope sediments (Kagamigaura Formation), central Japan. *Island Arc*, **21**, 231–234.

Yamauchi, S., Mitsunashi, T. and Okubo, S. (1990) Growth pattern of the Early Pleistocene Higashihigasa Submarine Channel, Boso Peninsula, central Japan. *The Journal of the Geological Society of Japan*, **96**, 523–536.

Yamashita, D., Kato, H., Onoue, T. and Suzuki, N. (2018) Integrated Upper Triassic conodont and radiolarian biostratigraphies of the Panthalassa Ocean. *Paleontological Research*, **22**, 167–197.

Yang, Q. and Mizutani, S. (1991) Radiolaria from the Nadanhada Terrane, Northeast China. *The Journal of Earth Sciences, Nagoya University*, **38**, 49–78.

Yao, A. (1982) Middle Triassic to Early Jurassic Radiolarians from the Inuyama Area, Central Japan. *Journal of Geosciences, Osaka City University*, **25**, 53–70.

Yoshida, H. (1986) Upper Triassic to Lower Jurassic radiolarian biostratigraphy in Kagamigahara City, Gifu Prefecture, central Japan. *The Journal of Earth Sciences, Nagoya University*, **34**, 1–21.

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房総半島，上総層群の下部更新統東日笠層のチャート礫から産出した後期三畳紀放散虫及びコノドント

伊藤　剛・武藤　俊・宇都宮正志

要　旨

房総半島の上総層群の下部更新統東日笠層に挟在する礫岩中のチャート礫から，放散虫及びコノドントが産出した．放散虫（*Praemesosaturnalis* sp. cf. *P. heilongjiangensis*）とコノドント（*Mockina* sp.）の同定に基づくと，このチャート礫は後期三畳紀（中期～後期ノーリアン期）の年代を示す．本チャート礫は当時後背地に分布していたジュラ紀付加体に由来すると考えられる．