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RADIOLARIAN AGE OF THE MANGANESE DEPOSITS OF THE TOKORO BELT, NORTHEAST HOKKAIDO

by

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(with 9 text-figures, 1 table and 2 plates)

Abstract

Radiolarian fossils of early Cretaceous (middle Barremian-early Aptian) were obtained from the country rock (bedded red chert) of the manganese deposit of the Hinode mine in the Tokoro Belt. By this discovery of radiolarians the geological age of the formation of the manganese deposit of the Hinode mine was determined for the first time to be formed during a short period of ca. 110-120 Ma. Radiolarian fossils of early Cretaceous in age were also extracted from bedded cherts of the Wakasa, Koryu, Syotosibetu, and Hokkaido mines which were similar masganese deposits to the Hinode mine. This fact suggests that manganese deposits in the Tokoro Belt were formed almost simultaneously during late early Cretaceous time.

Introduction

It has long been known that many manganese bearing deposits occur in the Nikoro Group of the Tokoro Belt, northeast Hokkaido. These deposits were formerly mined in small scales, and two types of the mangenese bearing deposits have been distinguished. One is a manganiferous iron deposit, and the other is a manganese deposit which lacks iron ores. The former is represented by the Kokuriki, Nikura, and Tokoro mines, and their ores are almost entirely included in the greenstone complexes. On the other hand, the latter is represented by the Kunneppu, Wakasa, Koryu, Hinode, Syotosibetu, and Hokkaido mines, and these deposits are usually accompanied with bedded red chert. These manganese deposits have been believed to be formed at the same geological age, but the accurate age of the formation of these manganese deposits have not yet been clarified. Therefore, we have made a radiolarian biostratigraphic investigation of the country rock of the Hinode mine in order to understand the age of formation of the manganese deposits. In addition, we have made a comparative biostratigraphic study of other manganese deposits including the Wakasa, Koryu, Hokkaido, and Syotosibetu mines, and also manganiferous iron deposits; the Kokuriki and Nikura mines. In this paper we would like to report the results of a radiolarian biostratigraphic study of the above-cited deposits in the Tokoro Belt. From a stratigraphic evidence stated below, these manganese deposits are considered to be formed syngenetically. Therefore, to determine the age of chert of these mines will serve

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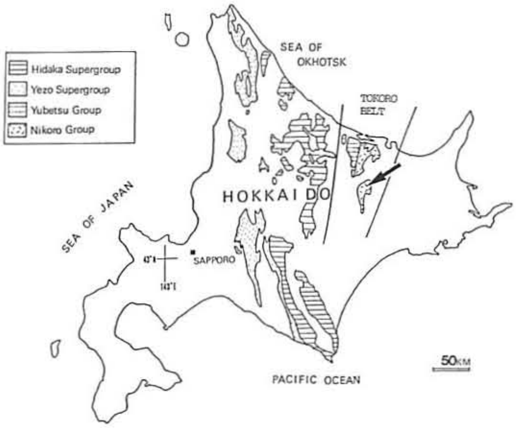
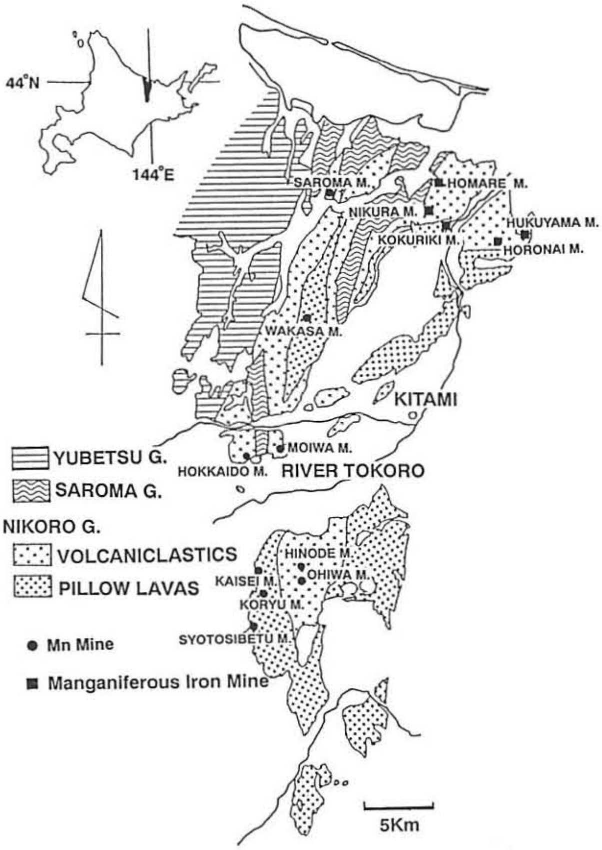


Text-Fig. 1 Distribution of Mesozoic System in central and northeast Hokkaido. An arrow indicates the main study area (after Tajika and Iwata, 1989).



Text-Fig. 2 Generalized geological map of the Tokoro Belt (after Sakakibara et al., 1986) and locality of manganese and manganiferous-iron deposits.

for understanding the geological age of formation of the manganese deposits.

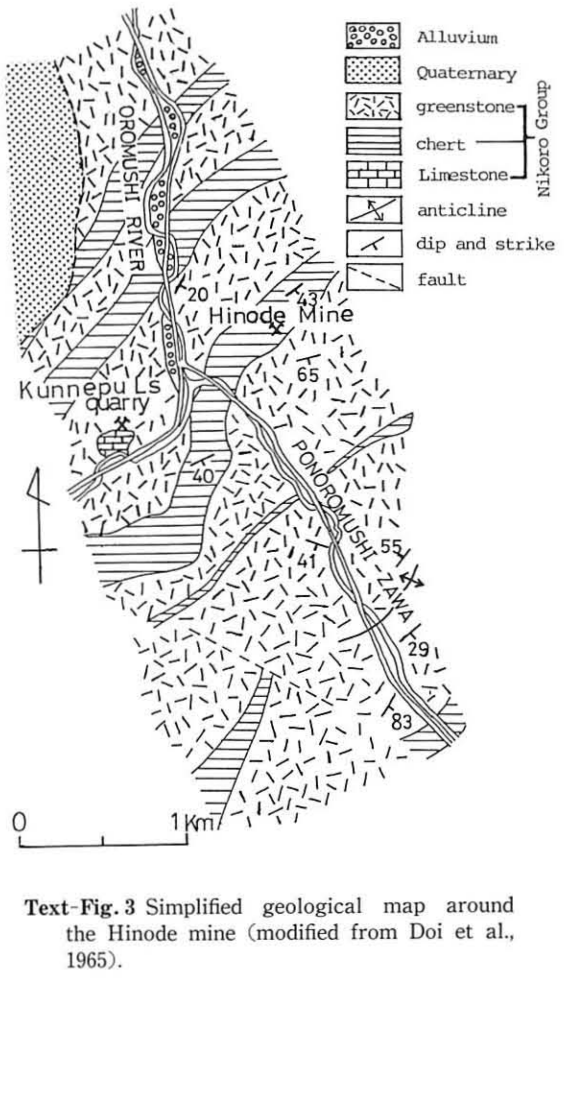
Geological setting

The study area belongs to the Tokoro Belt, where three principal stratigraphic units are distributed (Text-Figs. 1&2): Upper Jurassic to Lower Cretaceous greenstone complex (Nikoro Group) and Upper Cretaceous clastic sedimentary rocks (Yubetsu and Saroma Groups). The Saroma Group is mainly composed of conglomerate, sandstone, shale, and alternating beds of sandstone and shale. The Yubetsu Group consists of alternating beds of sandstone and mudstone. The Nikoro Group consists mainly of greenstone and chert, and often includes a small amount of limestone (Sakakibara et al., 1986; Tajika and Iwata, 1987).

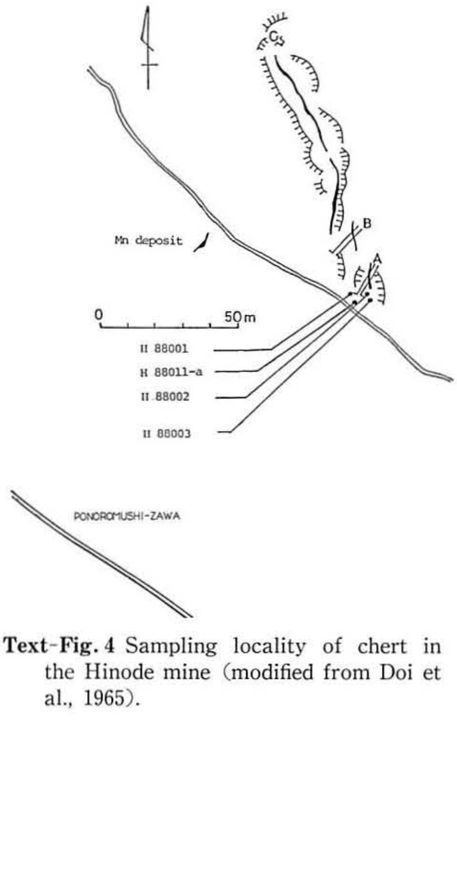
The manganese deposits occur in chert of the Nikoro Group. The manganiferous iron deposits lie between the chert and basaltic pillow lava. The chert usually forms hanging walls of the ore deposits. The manganese deposits are conformable, stratiform, and strata-bound within the cherts. The color of chert varies red to chocolate brown and is composed of microcrystalline quartz, opaque minerals and largely of radiolarian tests.

Outline of geology of the Hinode mine

The Hinode mine is located near a junction of the Ponoromushi River and the Oromushi River, about 10 Km southwest of Kitami City. Result of geological investigation of the Hinode mine was reported by Doi et al. (1965). And Tajika and Iwata (1987) have recently reported the results of geological study of the Nikoro Group around the Kunneppu limestone deposit which lies near the Hinode mine. The Nikoro Group has a strike of N 20°-60° E and a dip of 20°-50° SE, and



Text-Fig. 3 Simplified geological map around the Hinode mine (modified from Doi et al., 1965).



Text-Fig. 4 Sampling locality of chert in the Hinode mine (modified from Doi et al., 1965).

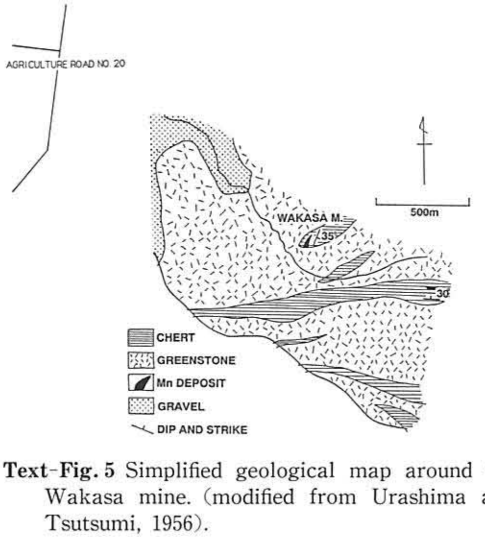
shows roughly a homoclinal structure. However, small folds and faults are developed in places and the geological structure of the Nikoro Group of this area is considered to be complicated.

A simplified map of manganese deposit of the Hinode mine is shown in Text-Fig. 4. Manganese ores were exploited from three pits (A, B, C) during 1948(?)-1955 (Hasegawa et al., 1983). Manganese deposit of this mine was known to be 20—80 cm thick and had an extension of several meters (Doi et al., 1965). This deposit exists in bedded red cherts. Manganese ore of the Hinode mine consists mainly of braunite and a small amount of hollandite and Mn-pumpellyite is accompanied.

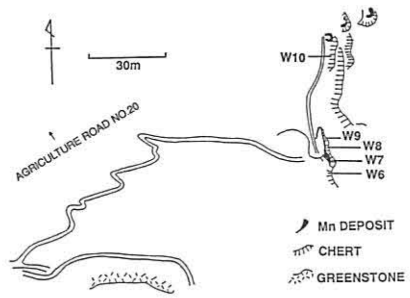
Outline of geology of other manganese and manganiferous iron deposits

Wakasa Mine

The Wakasa mine is situated at the tributary of the Bushi River (Text-Fig.



Text-Fig. 5 Simplified geological map around the Wakasa mine. (modified from Urashima and Tsutsumi, 1956).



Text-Fig. 6 Samplig locality of chert in the Wakasa mine (modified from Doi et al., 1956).

2). As shown in Text-Fig. 5, chert and greenstone are extensively distributed. Chert is usually red to reddish brown in color and composed principally of radiolarian tests. Manganese deposits typically occur in the bedded red chert (Text-Fig. 5 and 6). The ore bodies have a strike of NE-N 30°E and dip 20°-40°NW. The ore bed varies 0.5-2.5 meters in thickness and shows an irregularly lenticular shape. The ore is characteristically rich in sillica, but poor in iron (Urashima and Tsutsumi, 1956). The ore is composed mainly of braunite, pyrolusite and a small amount of neotocite.

Hokkaido Mine

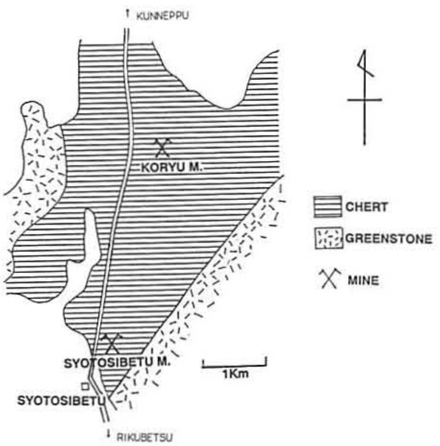
The location of the Hokkaido mine is shown in Text-Fig. 2. Manganese ore is concentrated within lenticular bedded chert (Text-Fig. 9), and up to 0.5-3 meters in thickness and 3-10 meters in length (Kishimoto and Watanabe, 1958). The dominant minerals which constitute ore bodies are braunite, rhodonite, hematite, and quartz. This mine produced 500 metric tons of ore with 40% Mn in average (Bamba, 1984).

Syotosibetu Mine and Koryu Mine

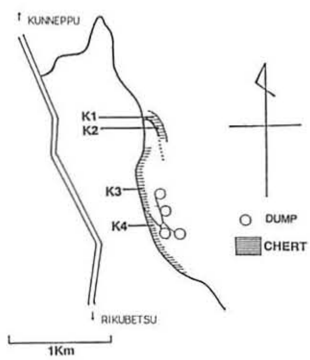
The Syotosibetu and the Koryu mines occur near the Hinode mine (Text-Fig. 2). Chert samples were collected from road cutting (Text-Fig. 8). Strata-bound manganese oxide deposits usually occur in bedded red chert (Text-Fig. 7). In the Syotosibetu mine, the manganese beds intercalated in chert exhibit similar attitudes. The ore bodies occur in close association with chert. The strike of manganese deposit of the Syotosibetu mine is NE 5°-38°, and it has a dip of 46°-72°SE. This means that manganese and silica were originally precipitated together. Well-fractionated manganese ores were formed later by diagenesis (Fujiwara et al., 1962). In manganese ores of these mine, the following minerals have been identified; braunite, hollandite, todorokite, and birnessite.

Kokuriki Mine and Nikura Mine (manganiferous iron deposits)

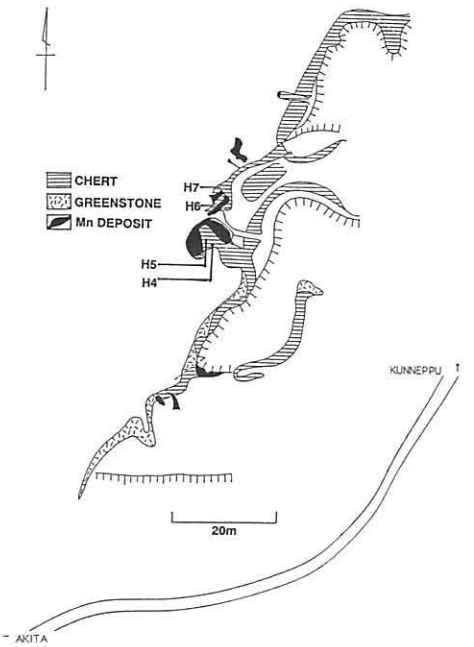
The ore bodies lie between the chert and basaltic pillow lava. The hanging wall seems to be chert, and foot wall is basaltic pillow lava. The extension of lenticular ore bodies vary its length from 50 meters long with 1 meter thick to 700 meters long with 10 meters thick (Bamba, 1984). The ores, dark brown in color,



Text-Fig. 7 Simplified geological map around the Syotosibetu and the Koryu mines.



Text-Fig. 8 Sampling locality of chert in the Koryu mine.



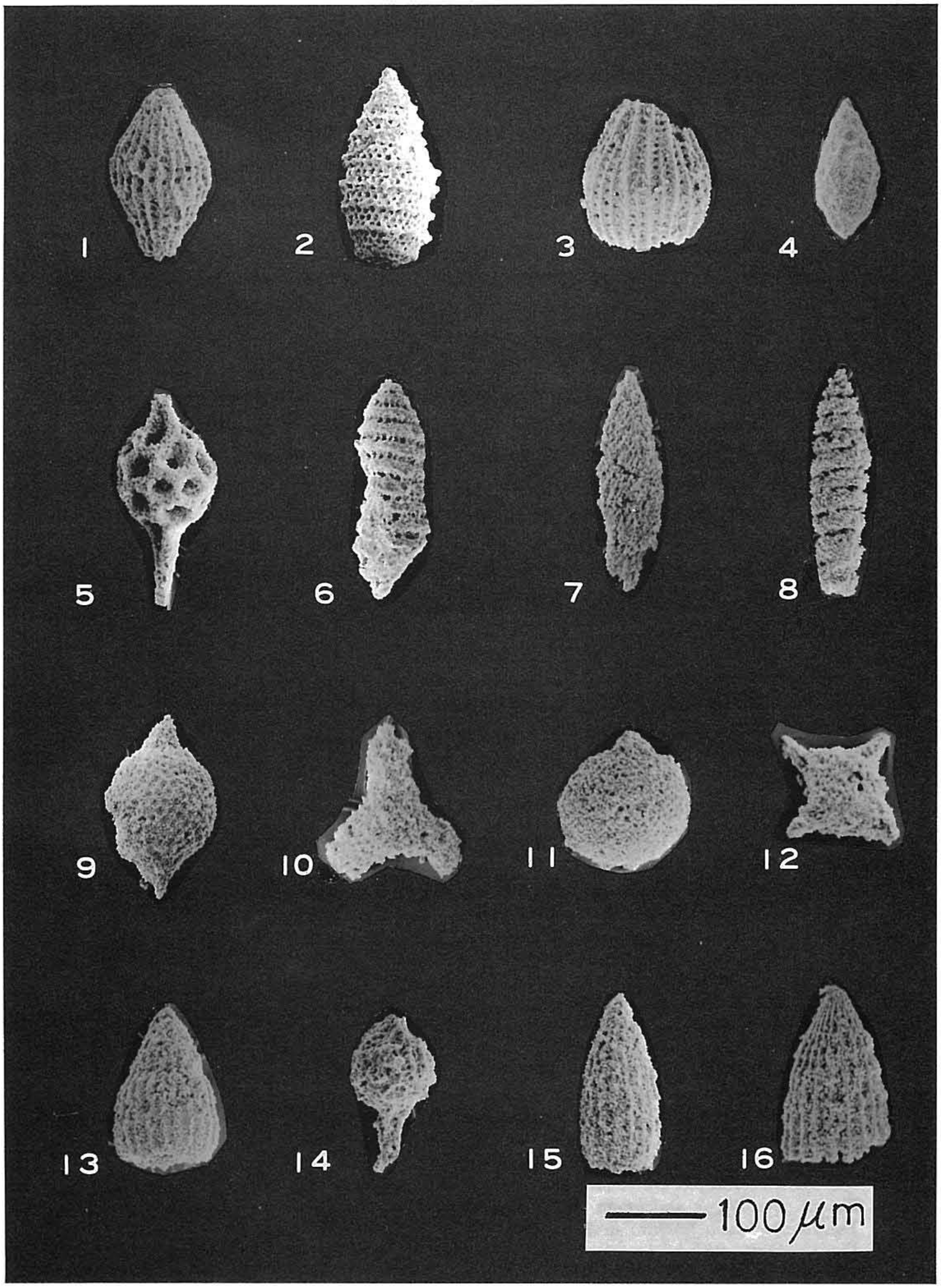
Text-Fig. 9 Sampling locality of chert in the Hokkaido mine.

are generally compact and massive and consist of very fine grained hematite and quartz, associated with braunite, Mn-pumpellyite. Radiolarian tests replaced by quartz are distributed in the matrix of chalcedony and dusty hematite in the chert (Togari et al., 1988).

Explanation of Plate 1

Radiolarians form the chert of the Hinode mine (Loc. H88011a). Scale bar 100 μm.

Fig. 1. *Emiluvia* sp.
Fig. 2. *Archaeodictyomitra* aff. *lacrimula* (Foreman)
Fig. 3. *Paronaella* sp.
Fig. 4. *Thanarla conica* Aliev
Fig. 5. *Eucyrtis micropora* Squinabol
Fig. 6. *Archaeodictyomitra lacrimula* (Foreman)
Fig. 7. *Sphaerostylus lanceola* (Parona)
Fig. 8. *Stichocapsa* sp.
Fig. 9. *Eucyrtis* sp.
Fig. 10. *Acaeniotyle umbilicata* (Rüst)
Fig. 11. *Parvicingula* sp.
Fig. 12. *Napora* sp.
Fig. 13. *Diborachlas tytthopora* Foreman
Fig. 14. *Eusyringium* (?) sp.
Fig. 15. *Acaeniotyle umbilicata* (Rüst)
Fig. 16. *Xitus* cf. *spicularis* (Aliev)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Radiolarians of the Hinode Mine

Extraction procedure of radiolarian fossils

Chert samples were immersed in 5-10% HF solution for several hours, and extracted radiolarians were then boiled in H_2O_2 for 20 minutes to avoid clay particles and organic materials. Identification of radiolarian fossils was made under SEM (Scanning Electron Microscope).

Radiolarians were obtained from bedded chert of A-pit of the Hinode mine. Fossil localities are shown in Text-Fig. 4. H88001 is the footwall of the deposit and H88002 and H88003 are from the hanging wall of the deposit. H88011a is recovered from the country rock debris of A-pit. A list of radiolarians from the above-cited localities is shown in Table 1 (See Plate 1 and Figs. 1-2 of Plate 2). Among these radiolarians *Thanarla conica* is known to range from late Valanginian to Albian (Pessagno, 1977; Taketani, 1982; Schaaf, 1981). *Eucyrtis micropora* is known to range from Berriasian to Aptian (Sanfilippo and Riedel, 1985). *Diborachlas tytthopora* and *Podobursa tricola* are known to range from late Valanginian to early Aptian (Sanfilippo and Riedel, 1985), and *Archaeodictyomitra lacrimula* from middle Barremian to early Aptian (Schaaf, 1981; Nakaseko and Nishimura, 1981). Consequently, the bedded chert consisting the country rock of the Hinode mine is considered to be accumulated during the early Cretaceous (middle Barremian-early Aptian; ca. 110-120Ma).

Radiolarians from other manganese and manganiferous iron mines

Wakasa Mine

Bedded red cherts from Locs. W-7,8,9,10 yielded abundant radiolarians as the

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Explanation of Plate 2

Radiolarians from various manganese mines in the Tokoro Belt. Scale bar 100 μm.

Fig. 1. *Archaeodictyomitra lacrimula* (Foreman) Loc. Hinode mine.
Fig. 2. *Ristola boesii* Parona Loc. Hinode mine.
Fig. 3. *Thanarla broweri* (Tan Sin Hok) Loc. Kokuriki mine.
Fig. 4. *Archaeodictyomitra* aff. *lacrimula* Loc. Syotosibetu mine.
Fig. 5. *Sphaerostylus lanceola* (Parona) Loc. K-3, Koryu mine.
Fig. 6. *Parvicingula* sp. Loc. W-7, Wakasa mine.
Fig. 7. *Eucyrtis micropora* (Squinabol) Loc. W-7, Wakasa mine.
Fig. 8. *Eucyrtis* sp. Loc. Wakasa mine.
Fig. 9. *Diacanthocapsa* sp. Loc. W-7, Wakasa mine.
Fig. 10. *Paronaella* sp. Loc. W-7, Wakasa mine.
Fig. 11. *Sethocapsa* sp. Loc. K-3, Koryu mine.
Fig. 12. *Crucella* sp. Loc. W-7, WAkasa mine.
Fig. 13. *Thanarla pulchra* (Squinabol) Loc. K-4, Koryu mine.
Fig. 14. *Acaeniotyle umbillicata* (Rüst) Loc. W-7, Wakasa mine.
Fig. 15. *Archaeodictyomitra* sp. Loc. W-8, Wakasa mine.
Fig. 16. *Dictyomitra* sp. Loc. W-8, Wakasa mine.

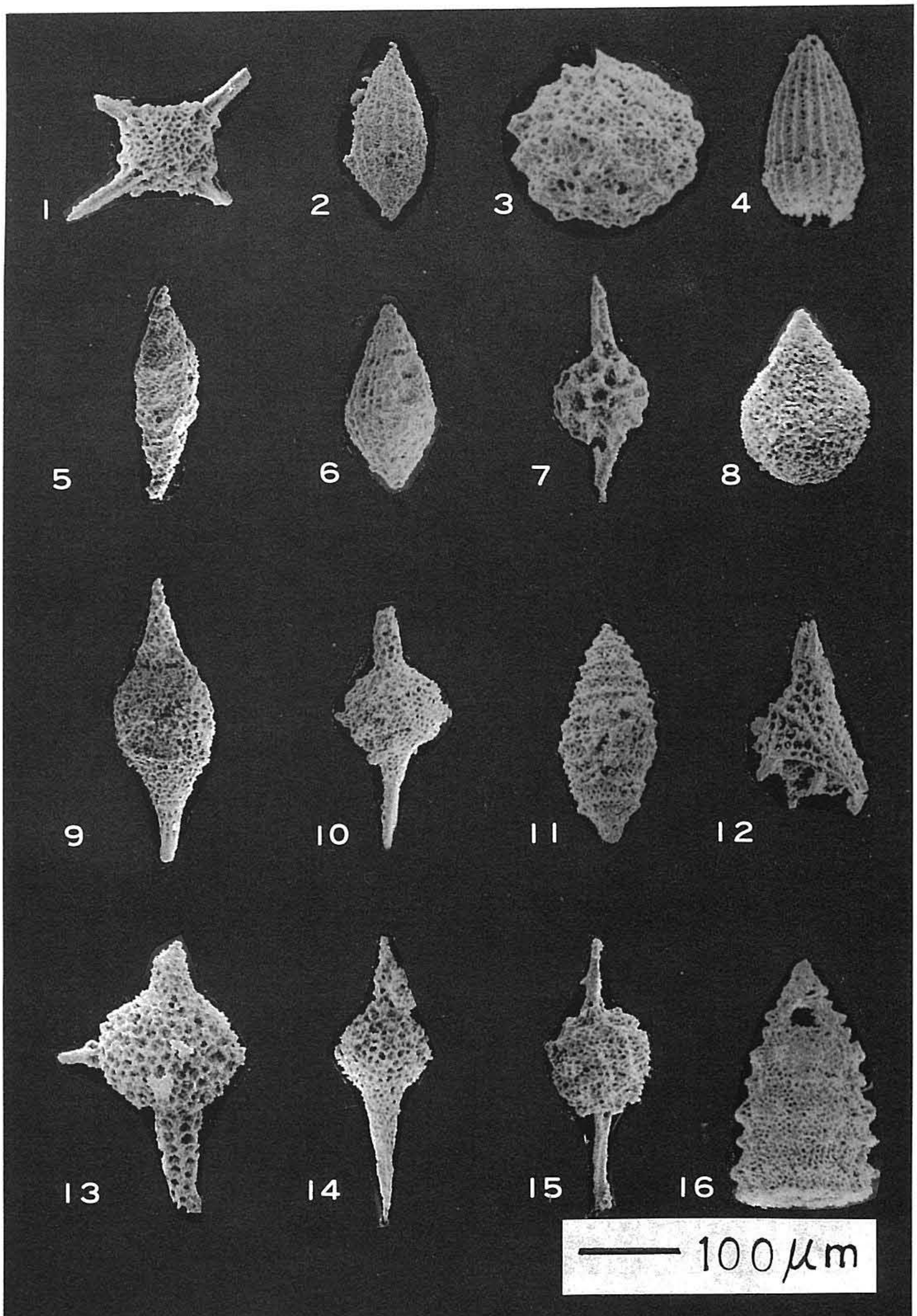
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Table 1 Radiolarian fossils from chert matrices of manganese deposits in the Tokoro Belt.

Localities / Radiolarian Species	Hinode Mine				Wakasa Mine			Koryu Mine		Syotosibetu Mine	Hokkaido Mine	Kokuriki Mine	Nikura Mine
	H 8801	H 8801 la	H 8802	H8803	7	8	9	3	4				
Acaeniotyle umbilicata (Rüst)	●	●	●	●								●	
Archaeodictyomitra lacrimula (Foreman)		●											
A. aff. *lacrimula* (Foreman)	●	●	●	●								●	
A. sp.	●	●	●	●							●	●	●
Archaeospongoprunum sp.	●	●	●	●	●	●	●	●	●	●	●		
Crucella sp.					●	●							
Diacanthocapsa sp.		●			●	●							
Diborachlas tytthopora Foreman		●			●								
Dictyomitra sp.	●	●	●	●	●	●	●			●			
Emiluvia sp.		●											
Eucyrtis micropora Squinabol	●	●	●	●	●	●	●	●	●	●	●		
E. sp.	●	●	●	●				●	●				
Napora sp.					●	●							
Paronaella sp.		●			●	●	●	●	●				
Parvicingula sp.		●			●	●							
Podobursa tricola Foreman		●											
Praeconocaryomma sp.		●			●	●							
Ristola boesii (Parona)		●											
Sphaerostylus lanceola (Parona)	●	●	●	●		●		●	●	●			
Sethocapsa sp.		●			●	●		●					
Stichocapsa sp.		●			●								
Thanarla broweri (Tan Sin Hok)												●	
T. pulchra (Squinabol)		●											
T. conica (Aliev)		●											
Xitus sp.		●											

following; *Acaeniotyle umbilicata, Archaeodictyomitra* sp., *Archaeospongoprunum* sp., *Diborachlas tytthopora, Dictyomitra* sp., *Diacanthocapsa* sp., *Eucyrtis micropora, E.* sp., *Crucella* sp. (Plate 2), *Napora* sp., *Parvicingula* sp., *Paronaella* sp., *Thanarla conica.* Among these radiolarians *Diborachlas tytthopora* is known to range from late Valanginian to Aptian (Sanfilippo and Riedel, 1985). *Thanarla conica* ranges from Berriasian to Albian (Pessagno, 1977). Therefore, the red chert of the Wakasa mine is considered to have been accumulated during early Cretaceous. The age of chert of this mine is estimated to be approximately the same with that of the Hinode mine.

Hokkaido Mine

Loc. 4 and 5 yielded a small amount of radiolarians. Radiolarians are almost totally recrystallized. *Archaeospongoprunum* spp., *Eucyrtis micropora, Sphaerostylus lanceola, Parvicingula* sp. were obtained. The chert of this mine is also considered to have been accumulated during early Cretaceous (probably approximately the same with the Hinode mine).

Koryu Mine

Red chert from locs. of K-3, 4 yielded poor recrystalldzed radiolarians. The following species are included; *Eucyrtis* cf. *micropora, Archaeodictyomitra* sp., *Parvicingula* sp., *Sphaerostylus lanceola, Thanarla pulchra. Thanarla pulchra* is known to range from early Cretaceous (Berriasian to Barremian). We estimate that the age of this chert may not be so much older that than of the Hinode mine.

Syotosibetu Mine

Red chert of hanging wall of this mine yielded a small amount of the following radiolarians; *Acaeniotyle umbilicata, Archaeodictyomitra* aff. *lacrimula, Sphaerostylus lanceola. Acaeniotyle umbilicata* is known to range from Berriasian to Albian (Sanfilippo and Riedel, 1985). This chert may also be early Cretaceous in age.

Kokuriki manganiferous iron deposit

Red chert of the hanging wall of this deposit yielded a small amount of the following radiolarians; *Archaeodictyomitra* aff. *lacrimula, Eucyrtis* cf. *micropora,* and *Thanarla broweri* (Plate 2). *Thanarla broweri* is known to range from Beriasian to Aptian (Sanfilippo and Riedel, 1985). On account of few species the precise geological age of the red chert of this deposit was not determined, but we estimate that this chert has been accumulated during early Cretaceous (probably after Valanginian). Red chert of the Nikura mine yielded a very small amout of radiolarians, but we could not identify them on account of ill-presevation.

Discussion

This study has revealed that manganese deposit of the Hinode mine was formed during a short period of the early Cretaceous (middle Barremian to early Aptian). Other manganese deposits in the Tokoro Belt including the Wakasa, Hokkaido, Koryu, and Syotosibetu mines are also considered to be formed at approximately the same period (early Cretaceous). These results revise a former idea that manganese deposits were formed during the late Jurassic. In this study we also tried to determine the geological age of formation of manganiferous iron ore deposits, but the time gap of formation between manganese deposits and manganiferous iron deposits seems to be not great as considered before. Further studies will be necessary to reveal the genesis and environment of formation of manganese and manganiferous iron deposits in the Tokoro Belt.

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References

Bamba, T., 1984. The Tokoro Belt, a tectonic unit of the Central Axial Zone of Hokkaido. *Jour. Fac. Sci., Hokkaido Univ.* Ser. IV., 21: 21-75.

Doi, S., Futamase, A., and Yokoyama, E., 1965. Manganese deposit around Otani, Kunneppu Town. *Hokkaido Chikashigen Chosashiryo.*, 101: 1-19 (in Japanese)

Fujiwara, T., Suzuki, M., and Doi, S., 1962. Geology and Ore deposits of the Rikubetsu Area. *Hokkaido Chikashigen Chosashiryo.*, 78: 14-17 (in Japanese).

Hasegawa, K., Terashima, K., and Kurosawa, K., 1983. *Metallic Mineral Resources of Hokkaido. Geology and Resources of Hokkaido, Japan III*. Geol. Surv. Hokkaido., 1-62.

Kishimoto, F., and Watanabe, Y., 1956. Research report on manganese deposits of the Hokkaido mine. *Hokkaido Chikashigen Chosashiryo.*, 28: 38-42 (in Japanese).

Nakaseko, K., and Nishimura, A., 1981. Upper Jurassic and Cretaceous Radiolaria from the Shimanto Group in southwest Japan. *Sci. Rep. Coll. Gen. Osaka Univ.*, 30(2): 33-203.

Pessagno, E. A., Jr., 1977. Lower Cretaceous radiolarian biostratigraphy of the Great Valley Sequence and Fransiscan Complex, California Coast Ranges. *Cushman Foundation of Foraminiferal Research,* Spec. Vol., 152: 1-87.

Sakakibara, M., Niida, K., Toda, H., Kito, N., Kimura, G., Tajika, J., Kato, T., Yoshida, A., and Research Group of the Tokoro Belt, 1986. Nature and tectonic history of the Tokoro Belt. *Assoc. Geol. Collab. Japan, Mon.*, 31: 173-187 (in Japanese with English abstract)

Sanfilippo, A., and Riedel, W. R. 1985. Cretaceous Radiolaria. In Bolli, H. M., Saunders, J. B., and Perch-Nielsen, K. (eds.), *Plankton Stratigraphy.*, Cambridge Universioy Press: 573-630.

Schaaf, A., 1981. Late early Cretaceous Radiolaria from DSDP Leg 62. In Thiede, J., Vallier, T. L., et al., (eds.), *Init, Rep. DSDP, 62, Washington, (U. S. Govt. Printing Office).*, 419-470.

Tajika, J., and Iwata, K. 1987. Olistostrome? The Nikoro Group around Otani, Kunneppu, (preliminary report). *HSG Newsletter.*, 2: 1-5.

Taketani, Y., 1982. Cretaceous radiolarian biostratigraphy of the Urakawa and Obira areas, Hokkaido. *Tohoku Univ., Sci. Rep., Second Ser. (Geol.).*, 52: 1-76.

Togari, K., Akasaka, M., Sakakibara, M., and Watanabe, T., 1988. Mineralogy of Manganiferous Iron Deposits and Chert from the Tokoro Belt, Hokkaido. *Mining Geol. Special Issue.*, No., 12: 115-126.

Urashima, Y., and Tsutsumi, S., 1956. Research report on manganese deposits of the Wakasa mine. *Hokkaido Chikashigen Chosashiryo.*, 28: 6-12 (in Japanese).

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