RADIOLARIAN AGE OF THE LOWER YEZO GROUP AND THE UPPER PART OF THE SORACHI GROUP IN HOKKAIDO

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ABSTRACT—The Lower Yezo Group and the Sorachi Group are distributed in the Sorachi-Yezo belt which trends N-S in Hokkaido, and the Kamuiyotan Metamorphic Rocks also occur in this belt. The Lower Yezo Group consists of terrigenous rocks, and the Sorachi Group is composed mainly of green rocks and siliceous shale. The Lower Yezo Group overlies conformably the Sorachi Group. Radiolarian fossils occur in many localities of the Lower Yezo and Sorachi Groups. The age of these groups based on radiolarian assemblages is as follows: The Lower Yezo Group is of late Hauterivian to early Albian age; the uppermost part of the Sorachi Group is equated with the late Hauterivian; and the lower upper part of the group is of Berriasian to early Hauterivian age.

Key words: Radiolaria, Hokkaido, Lower Yezo Group, Sorachi Group.

INTRODUCTION

In the Sorachi-Yezo belt (Kiminami et al., 1985) trending N-S in Hokkaido, the Sorachi Group, the Yezo Supergroup (Okada, 1983) and the Kamuiyotan Metamorphic Rocks are distributed (Fig. 1).

The Sorachi Group consists of green rocks and siliceous rocks. Kito et al. (1986) divided the group into the upper and lower parts. The lower part is composed mainly of green rocks such as pillow lava and hyaloclastite. The upper part consists of pillow lava, siliceous rocks, acidic tuff and shale. The Sorachi Group has been considered to be Late Jurassic to Early Cretaceous in age on the basis of radiolarian fossils (Nakaseko et al., 1979; Kanie et al., 1981; Kito et al., 1986; Kito, 1987; Minoura et al., 1982; Ishizuka et al., 1983, 1984; Kiminami et al., 1985, 1987).

The Yezo Supergroup overlies conformably the Sorachi Group and is composed mainly of terrigenous sedimentary rocks. The supergroup consists of the Lower Yezo, Middle Yezo, Upper Yezo and Hakobuchi Groups. In the last three groups, biostratigraphic sequences based on megafossils and microfossils have been clarified and the age of the groups is precisely determined. On the other hand, the age of the Lower Yezo Group is not precisely known because megafossils occur only sporadically and radiolarian fossils are relatively poorly known though they are present.

The Lower Yezo Group is composed mainly of sandstone, mudstone and a turbidite facies of alternating beds of sandstone and mudstone. The lower part of the group consists mainly of sandstone and the upper part of mudstone. An Orbitolina limestone is intercalated in the upper horizon of the group. The group is assigned to a late Valanginian/early Barremian to middle Albian age on the basis of such molluscs as ammonoid (Hashimoto et al., 1967; Matsumoto, 1984; Obata et al., 1973) and radiolarian fossils (Kito et al., 1986).

The purpose of this paper is to clarify the geological age of the Lower Yezo Group based on radiolarian fossils. In addition, radiolarian ages of the Sorachi Group have also been investigated.

SAMPLING LOCALITIES

In the Lower Yezo Group, radiolarian samples were collected mainly from where molluscan fossils occurred. About one hundred samples were collected from four districts. Sampling sites in each district are shown in Figs. 2-1, 2, 3, 4.

1. The lower stream of the Pankenai River of Shimonakagawa in Nakagawa town (Fig. 2-1)

The stratum exposed there belongs to Kj2 unit of the Kamijii Formation (Hashimoto et al., 1967) of the Lower Yezo Group. The facies in this district comprises sandstone, mudstone and alternating beds of sandstone and mudstone and contains calcareous nodules and thin tuff layers. The ammonoid Parahoplites collossus, discovered from a calcareous nodule in the alternating beds, indicates a middle late Aptian age (Matsumoto, 1984).

Three samples, Sn1, Sn2 and Sn12 from this district, yielded radiolarian fossils. Sn1 and Sn2 were sampled from the alternating beds and Sn12 from mudstone.

2. The Sagkonon forestry road of Nakagawa in Nakagawa town (Fig. 2-2)

Along the road, the Panakushigawa Formation of the Sorachi Group and the Onodera and Kamijii Formations of the Lower Yezo Group are exposed (Nagao, 1962). The Panakushigawa Formation is composed of siliceous shale, acidic tuff and chert. The Onodera Formation consists mainly of conglomerate and sandstone, and the overlying Kamijii Formation consists of mudstone and alternating beds of sandstone and mudstone. From the Panakushigawa Formation, Kawaguchi (1985) reported radiolarians indicative of a late Hauterivian to Barremian age.

Along this road, radiolarians are present only in the Panakushigawa Formation. Samples Sk1, Sk3 and Sk4, from lower to upper, yielded abundant radiolarian fossils. Sk1 is green chert, Sk3 is siliceous tuff and Sk4 is acidic tuff.
3. The dam-site of Lake Onnebetsu in Shibetsu City (Fig. 2-3)
In this area, the Sorachi Group containing the Horokanai Ophiolite is distributed (Ishizuka, 1980). A chert bed within the Horokanai Ophiolite, the lower part of the Sorachi Group, is assigned to the Tithonian (Ishizuka et al., 1983) and late Kimmeridgian/early Tithonian (Kiminami et al., 1987) based on radiolarian fossils. The upper part of the Sorachi Group is assigned to the latest Tithonian to Hauterivian/Barremian in age. Kawabata (1988) reported Kimmeridgian to early Berriasian radiolarians from a chert and siliceous mudstone of the Sorachi Group in this district.
Radiolarian-bearing samples, On3 (siliceous green shale) and On6 (brown chert) are from the uppermost part of the Sorachi Group exposed at the Onnebetsu dam-site.

4. Along the Sorachi River in the Furano district (Fig. 2-4)
In this district, the Sorachi Group is divided by Kito (1987) into three formations: S1, S2 and S3 in ascending order; and the Lower Yezo Group, which overlies conformably the Sorachi Group, is divided into two formations: the Tomitoi Sandstone and the Shimanoshita Shale in ascending order. The S1 unit is composed mainly of basaltic lava and hyaloclastite, S2 almost all of bedded green chert and S3 of basaltic pillow lava, siliceous shale, shale, chert, sandstone and acidic tuff. The Tomitoi Sandstone is composed of alternating beds of sandstone and mudstone, and the Shimanoshita Shale of thin bedded alternating beds of mudstone and sandstone. Both the Tomitoi Sandstone and the Shimanoshita Shale are a turbidite facies.

In the Sorachi and Lower Yezo Groups of this area, Kito (1987) established three radiolarian zones: the Emiluvia chica, “Cecrops” septemporatus and Archaeodictyonitria lacrimula Zones in ascending order. The Emiluvia chica Zone lies in the upper part of the S2 of Kito (1987) to the lower part of the S3, assigned to a Tithonian to late Valanginian age. The “Cecrops” septemporatus Zone is present in the upper part of the S3, assigned to the late Valanginian to early Barremian. The Archaeodictyonitria lacrimula Zone is situated in the lower part of the Shimanoshita Shale, assigned to the late Barremian or later.

In the present study, three routes were selected for sampling in this district as follows:

(1) The lower stream of the Nae River, a branch of the Sorachi River, in Ashibetsu City and Nakafurano town
Samples N2A and N2E were collected from the upper part of S3, and sample N4 from the upper part of S2. N2A is green siliceous shale, N2E shale and N4 green bedded chert.

(2) Tomitoi stone quarry, in Nakafurano town
The Tomitoi Sandstone and the lowermost part of the Shimanoshita Shale are exposed in this quarry. Sample Sm6 belongs to the Tomitoi Sandstone, and Sm1A to the lowermost part of the Shimanoshita Shale.

(3) The Toputoeushunai Right-River, a branch of the...
Sorachi River, in Asahibetsu City

Along the river, the Shimano-Shita Shale is distributed. Sample Sm102 belongs to the upper part of this formation. The *Orbitolina* limestone is exposed near the sample locality.

RADIOLARIAN AGE

Samples were treated with a 5% HF solution for about 24 hours and those samples, which contain organic and/or calcareous materials, were cleaned by H₂O₂ and/or HCl. Radiolarian fossils were picked from residues, and were observed and identified by a scanning electron microscope.

The occurrence of important, age-diagnostic radiolarian fossils is shown in Table 1. The age of each sample was assigned, referring mainly to the zonation of Schaaf (1985) and additionally to those of Foreman (1975) and Pessagno (1977).

1. THE LOWER YEZO GROUP

   (1) Upper part

   The radiolarian assemblage of sample Sn12 from the Kamiy Formation of Shimonakagawa is similar to that of the *Stichocapsa euganea* Zone to *Archaeospongoprunum cortinaenensis* Zone interval of Schaaf (1985), to which an Aptian age is assigned. Sn12 is also correlated with the lowermost part of the *Acaeniotyle umbilicata* Zone (Barremian or Early Aptian) of Foreman (1975).

   Samples Sn1 and Sn2, near sample Sn12, yielded the same radiolarian assemblage as Sn12.

   The ammonoid *Parahoplites colossus* was obtained near locality Sn2 (Matsumoto, 1984). The ammonite is indicative of a middle late Apatian age, which discords with the age determined by the radiolarian assemblage.

   Sample Sm102 from the upper part of the
<table>
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<tr>
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Fig. 3. Radiolarians from the studied area (1). All figures are scanning electron micrographs, scale bar = 0.1 mm. Scale a for 5 and 12. Scale b for 1-4, 6-11 and 13-16. 3-1. Acarinioya diaphorogona Foreman—sample Sm1A, 3-2. Acarinioya umbilicata (Rüst) sample Sm1A, 3-3. Acarinioyxia trizonala (Rüst)—sample Sm12, 3-4. Allevium helene Schaaf—sample Sm1A, 3-5. Euthyasia chica Foreman—sample N4, 3-6. Pantamellia lanceola (Parona)—6; sample N4; 7; sample Sk4, 3-8. Triactina hybum Foreman—sample Sm1A, 3-9. Archaeodictyonitra apiara (Rüst)—sample N2A, 3-10. Archaeodictyonitra lacrimala (Foreman)—sample Sm1A, 3-11. Archaeodictyonitra vulgaris Pessaggio—sample Sm1A, 3-12. Eucyrtis micropora (Squinabol)—sample On3, 3-13. Eucyrtis tenus (Rüst)—sample Sm1A, 3-14. Eusyringium (?) foremanae Taketani—sample Sm102, 3-15. Hemicryptocapsa tuberosa Dumitrica—sample Sk3, 3-16. Holocryptocanium barbui Dumitrica—sample Sm12.
Fig. 4. Radiolarians from the studied area (2). All figures are scanning electron micrographs. Scale bar = 0.1 mm. Scale a for 1-7. Scale b for 8-15. 1, 2. *Mirifusus chenodes* (Renz)—sample Sm1A, 4-3. *Mirifusus mediolatatus* (Rust) s.l.—3. sample Sm6; 4: sample N4, 4-5. *Obesacapsula morroensis* Pessagno—sample Sk1, 4-6. *Obesacapsula rotunda* (Hinde)—6. sample Sm6; 7: On3, 4-8. *Parvicingula boesii* (Parona)—8. sample Sk3; 9: Sk4, 4-10. *Parvicingula cosmicoma* (Foreman)—sample N4, 4-11. *Podobursa triangularis* (Fischli)—sample Sm1A, 4-12. *Pseudodictyomitra carpathica* (Lozynják)—sample On3, 4-13. *Pseudodictyomitra depressa* Baumgartner—sample N4, 4-14. *Pseudodictyomitra leptocoma* (Foreman)—sample N2A, 4-15. *Pseudodictyomitra blyae* (Tan Sin Hok)—sample N2A.
Fig. 5. Radiolarians from the studied area (3). All figures are scanning electron micrographs. Scale bar = 0.1 mm. Scale a for 7, 14 and 15. Scale b for 1-6 and 8-13. 5-1. Pseudodictyomitra lodogaensis Pessagno—sample Sm102, 5-2. Pseudodictyomitra cf. pentacolaensis Pessagno—sample Sn2, 5-3. Pseudodictyomitra puga (Schaaf)—sample Sk3, 5-4. Seichovacca uterculus (Parona)—sample N2A, 5-5. Seichovacca cf. uterculus (Parona)—sample Sm1A, 5-6. Quinabollum fossilis Dumitraca—sample Sn12, 5-7, 8. Stichocapsa euganea (Quinaboll)—sample Sm102, 5-9. Thanarla cf. elegantissima (Cita)—sample Sm6, 5-10. Thanarla praevetla Pessagno—sample Sm102, 5-11, 12. Thanarla pulchra (Quinaboll)—11: sample N2A; 12: sample Sm1A, 5-13. Willtriedellum peterschmittae Schaaf—sample Sk3, 5-14. Xitus spiculites (Aliev)—sample Sk4, 5-15. Xitus alevei (Foreman)—sample Sk4.
Shimanoshita Shale in the Furano district (near the outcrop of the Orbitolina limestone) also belongs to the upper part of the Lower Yezo Group.

The age of this sample is Aptian based on the zonation of Schaal (1985). This sample is also assigned to the lower part of the Acaenitiole umbilicata Zone (Barremian or early Aptian to late Aptian or early Albanian of Foreman (1975) and to the Petasiforma foremanae Zone (late Albanian) of Pessagno (1977).

(2) Lower part
Sample Sm1A from the lowermost part of the Shimanoshita Shale of the Lower Yezo Group in the Furano district yielded abundant radiolarian species.

This radiolarian assemblage is the same as that of the Crolanium pythiae Zone established by Schaal (1985), to which a Barremian age is assigned, and as that of the Eucyrtis tenuis Zone (Valanginian or Hauterivian to Barremian) of Foreman (1975).

(3) Lowermost part
Sample Sm6 from the Tomitoi Sandstone, the bottom formation of the Lower Yezo Group, of the Furano district, yielded radiolarian fossils.

The radiolarian assemblage is assigned to the Dibolachris typhopora Zone by Schaal (1985) and the zone is correlated to the upper Hauterivian.

2. The Sorachi Group
(1) Uppermost part
Samples Sk3, Sk4, On3, N2A and N2E, collected from the uppermost part of the Sorachi Group, yielded abundant radiolarian fossils.

This radiolarian assemblage is the same as that of the Nitarchi Formation in the Uraokawa district reported by Kanie et al. (1981), the “Cécrops” septemtoratus assemblage of S3, which Kito et al. (1986) established in the Furano district, and the assemblage reported in the same district by Okada et al. (1982).

The age of this assemblage is late Hauterivian (the Dibolachris typhopora Zone of Schaal, 1985). It is also assigned to the Sethocapsa trachyrostraca Zone of Foreman (1975), correlative in age with the Valanginian or Hauterivian to Barremian.

(2) Upper part
Sample N4 was collected from a chert facies belonging to S2 unit (Kito, 1987) in the upper part of the Sorachi Group in the Furano district.

The radiolarian assemblage is the same as that occurring in the Emiluvia chica Assemblage established in this district by Kito (1987). A Berriasian to early Hauterivian age is assigned to it on the basis of the zonation by Schaal (1985).

Sample Sk1 from the upper part of the Sorachi Group in the Sakkokan forestry road in Nakagawa is the same age as that of sample N4.

CONCLUSION

The geological ages of the Lower Yezo and Sorachi Groups were determined on the basis of radiolarian assemblages as follows (Table 2):

The base of the Lower Yezo Group, the Tomitoi Sandstone, is of late Hauterivian age. The lower part of the Lower Yezo Group, represented by the lowermost part of the Shimanoshita Shale, is equated with the Barremian. The upper part of the group, represented by the upper part of the Kami Formation, is assigned to the Aptian Stage. This correlation is concordant with that indicated by the ammonoid data. The top of the Lower Yezo Group is equated with the early Albanian.

<table>
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Table 2. Geologic ages of the strata in the studied districts.

- Os
- Tv
- Pp
- Au
- Ac
- Se
- Cp
- Dt
- Mc
- - Pc
because the upper part of the Shimanoshita Shale contains Aptian or Albian radiolarian assemblage and the base of the Middle Yezo Group, overlying the Lower Yezo Group, is of a late Albian to Cenomanian age based on the radiolarian assemblage (Taketani, 1981). Moreover, the nautiloid Cymatoceras cf. sakalavanum, assigned to the early to middle Albian, occurs from the base of the Middle Yezo Group in the Urakawa district (Matsumoto et al., 1984).

The uppermost part of the Sorachi Group, typically represented by the Nitarachi Formation in the Urakawa district, S3 in the Furano district, and the uppermost part of the Sorachi Group in the Nakagawa district, is composed commonly of siliceous shale, acidic tuff, shale and sandstone. This part is assigned to the upper Hauterivian. The lower upper part of the Sorachi Group, represented by chert of S2 in the Furano district, is correlated with part of the Berriasian to lower Hauterivian interval.

The stratigraphic sequence of radiolarians in the Lower Yezo Group and the precise age of the lower part of the Sorachi Group are as yet to be clarified.

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