DISCOVERY OF JURASSIC RADIOLARIA FROM ACMITE-RHODONITE-BEARING METACHERT OF THE GOSAISSYO METAMORPHIC ROCKS IN THE ABUKUMA TERRANE, NORTHEASTERN JAPAN

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The Abukuma plutono-metamorphic terrane is one of the main geologic provinces in Northeast Japan, and is well-known in the world as the typical terrain of the high-temperature/low-pressure type metamorphism since MIYASHIRO's (1958, 1961) classic studies. Three or more conflicting opinions have been postulated concerning the ages of metamorphic events of the terrane; one is that the age of the earlier regional metamorphism of the medium-pressure type is Early Paleozoic Era or earlier inferring that the terrane is the exposed polymetamorphic "Precambrian" basement of the Japanese Islands (*e.g.*, KANO, 1979, 1980); another is that the age of regional metamorphism is Late Paleozoic Era sup-

posing that it belongs to the Japanese Variscan-Abean Orogeny (MINATO *et al.*, 1979); and still another is that the ages of multiple metamorphic events are Middle to Late Mesozoic Era, inferring that the Jurassic orogeny is significant not only in Southwest Japan but also in Northeast Japan (UMEMURA & HARA, 1985; FAURE *et al.*, 1986).

Since 1984, we have been studying geology and petrology of the Abukuma metamorphic rocks, especially those in the central to southern part of the Abukuma Mountains, which are collectively called the Gosaisyo (Gosaisho, Gozaisyo)-Takanuki metamorphic complex. Recently published data (UMEMURA, 1979; UMEMURA *et al.*, 1983; SHIRAKI, 1982; UCHI-

Fig. 1. Generalized geologic map of southern Abukuma Mountains (after KANO *et al.*, 1973, partly modified and simplified).

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YAMA, 1984; FAURE *et al.*, 1986) as well as our unpublished data on the lithologic, deformational and metamorphic features of the complex suggest that the Gosaisyo-Takanuki metamorphic complex is divided into two distinct geologic units, the Gosaisyo series to the northeast and the Takanuki series to the southwest (Fig. 1). The Gosaisyo series is inferred to have been thrust over the Takanuki series.

The Gosaisyo series is composed mainly of basic and siliceous rocks with minor amounts of pelitic-psammitic and ultramafic rocks, whereas the Takanuki series consists largely of pelitic and psammitic rocks with small amounts of basic and calcareous rocks. The Gosaisyo series is characterized by buckle folding, while the Takanuki series shows a gentle dome structure with a migmatitic core, the Samegawa intrusive complex. The Gosaisyo series shows simple westward progressive metamorphism of the low-pressure facies series from the greenschist facies to the amphibolite facies (MIYASHIRO, 1958; KOJIROI, 1986). Although FAURE *et al.* (1986) assumed that the Gosaisyo series was once affected by the high-pressure/low-temperature type metamorphism (Sanbagawa metamorphism) together with the "Green Schist nappe" in Southwest Japan, there is no petrologic evidence which witnesses the assumption. On the other hand, the Taka-

nuki series has experienced superimposed metamorphic events under the different physical conditions from one another (especially pressure). Both the Gosaisyo and Takanuki series are intruded extensively by Jurassic (?) and Cretaceous plutonic rocks (UENO, 1977; MARUYAMA, 1978, 1979) (Fig. 1). MARUYAMA (1978, 1979) also reported Rb-Sr whole rock ages of about 400 Ma for the so-called older granites, some of which are intruded discordantly into the Gosaisyo series. K-Ar and Rb-Sr mineral ages of the metamorphic rocks range from 100 to 115 Ma, and are nearly equal to those for the adjacent plutonic rocks (UENO, 1977; SHIBATA & UCHIMI, 1983).

We have successfully discovered fossil radiolaria in acmite-rhodonite-bearing reddish metachert (Sp. YH86110201B) of the Gosaisyo series from an outcrop near Kiyodo (Fig. 2). Some of them are surprisingly well-preserved, and are *Tricolocapsa* ? sp., *Archaeodictyomitra* ? sp., *Hsuum* ? sp., *Praeconocaryomma* ? sp. and *Broctus* ? sp. (Fig. 3a-e). Such a radiolarian assemblage is similar to those reported in well-defined Jurassic strata (*e.g.*, YAO *et al.*, 1982). Therefore, the age of sedimentation of the metachert may be Jurassic.

The fossil locality is in the low-grade part of MIYASHIRO's (1958) zone B, that is, in the lower amphibolite-facies area. The metachert is a massive fine-grained reddish rock alternating with dark gray hematite layers up to a few cm thick. The constituent minerals of the rock are quartz, acmite, rhodonite, hematite, magnetite, and pyrite. Stilpnomelane, albite, and rhodochrosite are occasionally found. Quartz grains in the matrix are up to 50 μm in diameter, while those forming the inner part of fossil radiolaria and quartz veins are about 100 μm in diameter. Acmite, rhodonite, and hematite are usually very fine-grained (less than 5 μm in diameter) (Fig. 3f). Representative microprobe analyses of the constituent minerals except for quartz, albite, and pyrite in an exceptionally coarse-grained part along a quartz vein (Fig. 3g) are given in Table 1. Both the acmite and rhodonite are close to their endmember compositions. In particular, the Mn content of the acmite is very low, but it must be close

Fig. 2. Map showing fossil locality; a part of 1 : 50,000 map of "Takanuki" published from Geographical Survey Institute of Japan.

Fig. 3.

Scanning electron micrographs of representative fossil radiolaria (a-e) and photomicrographs of fossil-bearing reddish metachert (Sp. YH 86110201B) (f and g) of Gosaisyo metamorphic rocks.

a; *Tricolocapsa*? sp., b; *Archaeodictyomitra*? sp., c; *Hsuum*? sp., d; *Praeconocaryomma*? sp., e; *Broctus*? sp.

abt; albite, acm; acmite, hmt; hematite, qtz; quartz, rhn; rhodonite, stl; stilpnomelane.

to the maximum in such pyroxene formed under the lower amphibolite-facies conditions because of its coexistence with rhodonite. The acmite + magnetite + hematite + quartz assemblage is the dehydrated equivalent of riebeckite, as experimentally confirmed by ERNST (1962). According to ERNST (1962), riebeckite is stable up to 515°C at $P_{\text{total}} = P_{\text{fluid}} = 2\text{ kb}$, suggesting that the fossil-bearing rock was recrystallized at $T > 515^\circ\text{C}$. This is in good agreement with the calculated temperature of about 530°C by garnet-biotite thermometers (THOMPSON, 1976; FERRY & SPEAR, 1978) using a garnet rim-matrix biotite pair in an adjacent garnet-biotite-chlorite

schist (Sp. HZ-383).

The discovery of Jurassic radiolaria from the typical Gosaisyo metamorphic rocks would provide an important clue not only to the ages of metamorphic events of the Gosaisyo series but also to the ages of emplacement of plutonic rocks (especially the so-called older granites) in the Abukuma terrane.

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Table 1. Representative EDX analyses of minerals.

Specimen	YH86110201B						HZ-383	
	Acm	Rhn	Hmt	Mtt	Stl	Rhc	Gar*	Bio
SiO ₂	52.82	46.46	-	-	45.80	-	36.61	33.62
TiO ₂	-	-	0.16	-	-	-	-	1.86
Al ₂ O ₃	0.42	-	-	-	2.80	-	20.89	19.75
Fe ₂ O ₃ **	29.52	-	100.17	-	7.08	-	-	-
FeO***	-	5.23	-	88.59	-	1.70	26.06	22.16
MnO	1.85	45.34	0.46	2.94	13.60	49.76	13.34	0.23
MgO	0.91	0.86	-	-	13.81	1.49	1.42	7.37
NiO	-	-	-	2.31	-	-	-	-
CaO	2.08	2.48	-	-	1.40	6.39	1.67	-
Na ₂ O	12.45	-	-	-	-	-	-	-
K ₂ O	-	-	-	-	0.16	-	-	9.65
Total	100.05	100.37	100.79	93.84	84.65	59.34	99.99	94.64

YH86110201B: fossil-bearing metachert, HZ-383; garnet-biotite-chlorite schist.

Mtt; magnetite, Rhc; rhodochrosite, Gar; garnet, Bio; biotite. Others are as in Fig. 3.

* rim

** total Fe as Fe₂O₃

*** total Fe as FeO

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- * in Japanese with English abstract ** in Japanese

〈地名〉

Hitachi	日立
Mt. Gosaisyo	御齋所山
Taira	平
Kamiyama	神山
Ochiai	落合
Takanuki	竹貫
Kiyodo	清道
Saibachi	才鉢