Upper Precambrian microphytolites and stromatolites from Svalbard

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Abstract

Result of the areal and vertical distribution of Riphean and Vendian communities of microphytolites of Spitsbergen and Bjørnøya have been dealt with in the paper, and data on distribution of upper Riphean stromatolites of Nordaustlandet are presented. Stromatolites from other regions of the archipelago have been described in detail by Raaben (1975).

Microphytolites and stromatolites or phytolites were formed by carbonate secreting blue-green algae and possibly bacteria by processes of homogenic and mechanic sedimentation. Stromatolites are undulate-layered structures attached to a substrate; microphytolites are nodular or pelletoidal carbonate structures not attached to a substrate.

A. Microphytolites of Spitsbergen and Bjørnøya

Study of Upper Precambrian microphytolites collected by Krasil'ščikov from Spitsbergen and Bjørnøya began in the early 1960's and was later continued by Milstein. A main contributor to the study of the formations in the regions discussed was Zabrodin.

Microphytolites and stromatolites are widespread in the Upper Precambrian deposits of Spitsbergen and Bjørnøya. They have been found in sections of Nordaustlandet (western part), north-eastern Spitsbergen (Ny Friesland, Olav V Land), southern Spitsbergen (Hornsund area), and Bjørnøya. A number of microphytolite assemblages were recognized through analyses of geographical and stratigraphical distribution of microphytolites, based on data obtained by Raaben, Zabrodin, and Golovanov. The assemblages were named after the formation in which they occur and index fossils.

Assemblage "Höferpynten"

Osagia tenuilamellata — Vesicularites raabenae

Distribution: Regional. The sequence at Höferpynten including the Sofiebogen Formation, Höferpynten Formation and the base of the Gåshamna Formation, also presumably the lower member of the Flora[1] Formation, Nordaustlandet.

Composition: After MILSTEIN and ZABRODIN: *Osagia* of the Middle Riphean with *Osagia tenuilamellata* REIT., *O.* cf. *tenuilamellata* REIT., *O. minuscula* MILST. (in collection), *Vesicularites* aff. *igaricus* MILST., *V. raabenae* ZABR.

Age: Middle — Upper Riphean after MILSTEIN and ZABRODIN (?).

Assemblage "Bogen"

Osagia kingbreensis — Radiosus sculeatus — Radiosus deciniens

Distribution: Local. The Bogen Member of the Kingbreen Formation.

Composition: After ZABRODIN: *Osagia kingbreensis* ZABR., *Radiosus decipiens* ZABR., *R. aculeatus* ZHUR., *R. elongatus* ZHUR., *R. pachyradiatus* ZABR.

Age: Upper Riphean Bir'yan division after RAABEN and ZABRODIN.

Assemblage "Norvik"

Asterosphaeroides — Radiosus

Distribution: Local. The Norvik Formation.

Composition: After MILSTEIN: *Asterosphaerides* REITL., *Radiosus* ZHUR.

Age: Riphean after MILSTEIN.

Assemblage "Enpiggen"

Asterosphaeroides tubulosus — Radiosus limpidus — Radiosus fasciculatis

Distribution: Local. The Enpiggen Member of the Oxfordbreen Formation.

Composition: After ZABRODIN: *Radiosus aculeatus* ZHUR., *R. limpidus* ZHUR., *R. manjaricus* ZABR., *R. Fasciculatus* ZABR., *Asterosphaeroides tubulosus* ZABR., *Volvatella Svalbardica* ZABR.

Age: Upper Riphean, Bir'yan division after RAABEN and ZABRODIN.

Assemblage "Grusdievbreen–Hunnberg"

Osagia pullata — Vesicularites elongatus — Vesicularites raabenae

Distribution: Regional. The upper member of the Grusdievbreen Formation, Lower Hunnberg Formation.

Composition: After MILSTEIN: *Vesicularites* REITL., *Vesicularites flexuosus* REITL., after ZABRODIN: *Vesicularities vapolensis* ZABR., *V. raabenae* ZABR., *V. elongatis* ZABR., *V. enigmatus* ZABR., *V. parvus* ZABR., *Osagia maculata* ZABR., *O. pullata* ZABR., *O. milsteinae* ZABR., *Astrosphaeroides* (?) *ruminatus* ZABR.

Age: Middle-Upper Riphean after MILSTEIN and GOLOVANOV. Upper Riphean, Min'yar division, B'yank subdivision after RAABEN and ZABRODIN.

[1] The terms "regional distribution" and "local distribution" refer to the distribution of microphytolites within Spitsbergen and Bjørnøya only.

Assemblage "Svanbergfjellet–Hunnberg"

Osagia milsteinae — Vesicularites enigmatus — Vesicularites vapolensis

Distribution: Regional. The Svanbergfjellet Formation, Upper Hunnberg Formation.

Composition: After MILSTEIN: *Osagia columna* REITL., *Asterosphaeroides* REITL. (was found in an isolated outcrop of limestone). After ZABRODIN: *Vesicularites vapolensis* ZABR., *V. raabenae* ZABR., *V. enigmatus* ZABR., *Osagia maculata* ZABR., *O. milsteinae* ZABR., *Radiosus licudus* ZABR., *R. aculeatus* ZHUR., *Asterosphaeroides* (?) *ruminatus* ZABR.

Age: Middle — Upper Riphean after MILSTEIN and GOLOVANOV. Upper Riphean Min'yar division, B'yank subdivision after RAABEN and ZABRODIN.

Assemblage "Draken"

Vesicularites bothrydioformis — Vesicularites concretus — Nuberularites abustus

Distribution: Local. The Draken Formation.

Composition: After ZABRODIN: *Vesicularites concretus* ZHUR. ZHUR., *V. bothrydioformis* (KRASNOP.), *V. lobatus* REITL., *Radiosus polaris* ZABR., *Nubecularites abustus* ZHUR.

Age: The top of the Upper Riphean, Vendian Yuomian division after RAABEN and ZABRODIN.

Assemblage "Russehamna"

Distribution: Local. The Russehamna Formation.

Composition: After ZABRODIN at the base of the section: *Osagia crispa* ZHUR., *Radiosus* cf. *aculeatus* ZHUR., somewhat higher: *Vesicularites vapolensis* ZABR., *V. elongatus* ZABR., *V. enigmatus* ZABR., *V. parvus* ZABR. *Osagia* aff. *maculata* ZABR., after MILSTEIN in ascending order four local assemblages are recognized:

Assemblage I:	*Vesicularites lobatus* REITL., *Nubecularites* MASL.
Assemblage II:	*Osagia crispa* ZHUR., *O. medwezhiella* n.sp., *Vesicularites alexandrovi* n.sp., *Radiosus aculeatus* ZHUR.
Assemblage III"A":	*Osagia maculata* ZABR., *O. pullata* ZABR., *O. milsteinae* ZABR. (samples from separate blocks), *Vesicularites elongatus* ZABR., *V. raabenae* ZABR.
Assemblage III"B":	*Vesicularites compositus* ZHUR., *V. enigmatus* ZABR., *V. vapolensis* ZABR., *V. lobatus* REITL., *V.* aff. *bothrydioformis* (KRASNOP), *V. elongatus* ZABR., *V.* cf. *elongatus* ZABR., *V. parvus* ZABR., *Asterophaeroides* (?) *ruminatus* ZABR.
Assemblage IV:	microphytolites, oncolites, *Vesicularites* REITL.

Age: After RAABEN and ZABRODIN: Upper Riphean Min'yar division, B'yank subdivision. After MILSTEIN: assemblage II Upper Riphean, assemblage III "B" Upper Riphean, Vendian (Yudomian) complex.

Local assemblages together with the assemblages "Russehamna" are correlated with "Grusdievbreen–Hunnberg", "Svanbergfjellet–Hunnberg" and "Draken" assemblages.

Assemblage "Backlundtoppen–Ryssø"

Osagia maculata — Osagia porrecta — Osagia milsteinae

Distribution: Regional. The lower and upper members of the Backlundtoppen Formation, the Ryssø Formation.

Composition: After MILSTEIN in the lower part of the section (in alluvial disintegrated rocks): *Osagia frislandica* MILST., *O.* aff. *torta* MILST., *Asterophaeroides* REITL., *Catagraphia* MASL., *Vesicularites eniseicus* MILST. In the upper part of the section *Catagraptus* MASL. After ZABRODIN in the lower part of the section *Osagia musculata* ZABR., *O. pullata* ZABR., *O. milsteinae* ZABR., *O. porrecta* ZABR., in the upper part of the section: *Radiosus polaris* ZABR., *Nubecularites abustus* ZHUR., *Vesicularites lobatus* REITL., *V. concretus* ZHUR.

Age: After MILSTEIN and GOLOVANOV: Riphean, Upper Riphean. After RAABEN and ZABRODIN: the top of the Upper Riphean, Vendian (Yudomian) division.

Assemblage "Elbobreen–Backaberg"

Osagia svalbardica — orbiculatus — Vermiculites irregularis

Distribution: Regional. The Elbobreen Formation, the upper unit of the Backaberg Formation.

Composition: After MILSTEIN: *Osagia svalbardica* MILST. *Vermiculites irregularis* (REITL.). After ZABRODIN: *Vesicularites lobatus* REITL., *V. bothrydiformis* (KRASNOP.), *V. concretus* ZHUR., *V. orbiculatus* ZABR., *Radiosus polaris* ZABR., *Nubecularites abustus* ZHUR., *Volvatella* sp.

Age: After MILSTEIN: Vendian (Yudomian) complex. After RAABEN and ZABRODIN: the top of the Upper Riphean, Vendian (Yudomian) division.

Assemblage "Drakoisen"

Vesicularites lobatus — Nubecularites abustus

Distribution: Local. Drakoisen Formation.

Composition: After ZABRODIN: *Vesicularites lobatus* REITL., *Nubecularites abustus* ZHUR.

Age: The top of the Upper Riphean, Vendian (Yudomian) division.

The composition of species and genera change up the section. Each assemblage is named after a group of index fossils, in order to mark its appearance.

The oldest "Höferpynten" assemblage (*Osagia*) is similar in composition to the second assemblage by ZHURAVLEVA but it cannot be assigned to the Middle Riphean because it contains *Vesicularites raabenae.*

The assemblages "Bogen", "Norvik", "Enpiggen" include the genus *Radiosus.* this and the presence of forms from the third assemblage of ZHURAVLEVA confirms RAABEN and ZABRODIN's date of Upper Riphean in age.

The "Grusdievbreen–Hunnberg" and "Svanbergfjellet–Hunnberg" assemblages include *Osagia–Vesicularites.* These assemblages have nothing in common with the third assemblage of ZHURAVLEVA and hence with the Upper Riphean deposits. The above assemblages contain the Middle Riphean *Osagia columnata*

(from an isolated outcrop) and a number of forms known to the author from the Kolosov Formation of Taimyr which were previously assigned to the Middle Riphean. So, at present we cannot postulate with certainty an Upper Riphean age for the "Bogen", "Svanbergfjellet–Hunnberg", "Enpiggen", "Grusdievbreen–Hunnberg" assemblages.

These assemblages and the divisions established by RAABEN within the Upper Riphean are dated as Middle–Upper Riphean. The "Draken" assemblage (*Vesicularites*) is equivalent to the fourth, Vendian (Yudomian) assemblage of ZHURAVLEVA. The "Backlundtoppen–Ryssø" (*Vesicularites–Osagia*) assemblage and the fourth (*Vesicularites*) assemblage of ZHURAVLEVA contains *Osagia maculata*, *O. pullata*, *O. milsteinae* which belong to the older *Osagia–Vesicularites* assemblages such as "Grusdievbreen–Hunnberg" and "Svanbergfjellet–Hunnberg". The Middle-Upper Riphean *Vesicularites eniseicus* was also found there (unfortunately, in disintergrated alluvial blocks). Therefore the authors regard the "Backlundtoppen–Ryssø" and the "Draken" assemblages as transitional between the Upper Riphean and Vendian, and not as pure Vendian (Yudomian).

The "Elbobreen–Backaberg" and "Drakoisen" assemblages may be correlated with confidence with the fourth Vendian (Yudomian) assemblage of ZHURAVLEVA.

On the basis of the microphytolite study it is possible to come to the following general conclusions about the formation ages. The formations of the Lomfjorden Supergroup of Ny Friesland, the Murchisonfjorden Supergroup of Nordaustlandet and probably the Höferpynten Formation of the western coast of Spitsbergen belong to the Middle-Upper Riphean. The sequence of "old dolomites" of Bjørnøya (the Russehamna Formation) is Upper Riphean in age. The Polarisbreen Group of Ny Friesland belongs to the Vendian.

Many forms of the microphytolites of Spitsbergen and Bjørnøya were reported by ZHURAVLEVA and ZABRODIN from the Upper Riphean rocks of the Urals and Timan. Microphytolite assemblages recognized from these regions correlate with those from Spitsbergen and Bjørnøya. In the present author's opinion it is impossible to draw a boundary between Upper Riphean and Vendian (Yudomian) assemblages. The older assemblages are considered to be Middle-Upper Riphean. In this connection earlier views of RAZNITSYN concerning the Middle Riphean age of the Bystra Formation must be considered.

B. Riphean stromatolites of Nordaustlandet

The first information about stromatolites from Nordaustlandet was recorded by KULLING (1934). Later they were studied by GOLOVANOV and RAABEN (1967).

The Riphean deposits of Nordaustlandet are represented mainly by the Murchisonfjorden Supergroup, subdivided on the basis of recent data into the following formations (above the Franklinsundet Group): Flora, Norvik, Raudstup–Sälodd, Hunnberg, and Ryssø (FLOOD et al. 1969, KRASIL'SČIKOV 1973).

The stromatolites were collected by KRASIL'ŠČIKOV in 1963 and 1964. They were found only in the Ryssø and Hunnberg formations, where they consist of columnar forms (GOLOVANOV 1967). Both branching and non-branching columnar stromatolites occur in the Hunnberg Formation. The lower part of the formation contains actively branching forms of *Gymnosolen murchisonicus* GOLOVANOV. The upper horizons yield actively, passively, branching, and non-branching columnar stromatolites. *Inseria blingica* GOLOVANOV, *I. chunnbergica* GOLOVANOV, *Yungulsia* sp. are among the actively branching forms. Passively branching stromatolites include *Kussiella* (?) sp., and non-branching columniar forms consist of *Jacutophyton spitsbergensis* GOLOVANOV and *Conophyton* sp.

Strongly recrystallized columnar stromatolites occur in dolomites of the lower part of the Ryssø Formation. The upper parts yield columnar actively branching stromatolites *Gymnosolen* cf. *ramsayi*.

The stromatolites studied from the Hunnberg and Ryssø Formations are very similar to those of the Upper Riphean assemblage of the Karataus Series of the south Urals and its equivalent from the Polyudov Range, Timan, Kanin Peninsula, and Kildin Island (GOLOVANOV and RAABEN 1967). Thus, on the basis of stromatolites studies, the Hunnberg and Ryssø Formations are assigned to the Upper Riphean. The overlying deposits of the Goria Series, on the basis of microphytolites are dated as Vendian (MILSTEIN 1967), while the underlying deposits of the Franklinsundet Group, the Flora, Norvik, Raudstup–Sälodd Formations on the basis of macrophytolites and their position in the section are assigned to the Middle- Upper Riphean.

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