Совместим схематичное изображение опыта (рис.7) и совмещенный график роста соляного диапира (рис.8-Б) для того, чтобы наглядно получить изображение того, как произошел рост соли в опыте (рис.9).

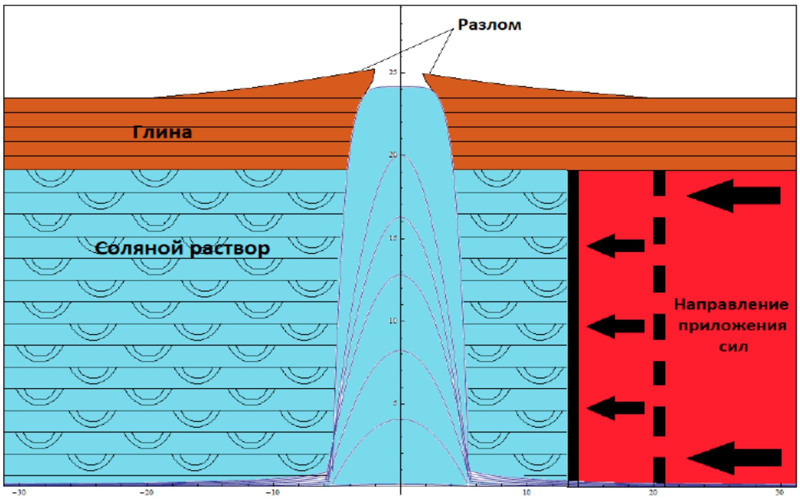

Рис. 9. Совмещенный график лабораторного опыта с результатами математического моделирования, иллюстрирующий рост диапира.

Таким образом, сделаем следующие выводы:

1) подтверждается возможность образования соляных диапиров в Арктике условиях рифтогенеза и неотектоники;

2) под влиянием тектонического напряжения происходит рост и формирование соляного диапира, а его конфигурация зависит от различных геологических факторов;

3) комплексный анализ различных геофизических методов аргументирует наличие соляных диапиров в районе исследования и повышает степень вероятности наличия нефти на глубине;

4) при бурении следует учитывать особенности соленосных толщ и возникающие дополнительные риски.

5) лабораторный опыт, иллюстрирующий свойство солей «всплывать» к поверхности, говорит о том, что буровой раствор, содержащий в своем составе соли, ни в коей мере нельзя подвергать захоронению без предварительной очистки, так как это может привести к засолонению почв и значительному ущербу народному хозяйству.

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***Dorjnamjaa, D., **Voinkov, D.M., *Altanshagai, G., *Enkhbaatar, B**

**Institute of Paleontology and Geology, Mongolian Academy of Sciences,Ulaanbaatar,*

***VNIIGeosystem, Moscow*

ON THE LOWER CAMBRIAN KHASAGTIAN GROUP OF THE ICHNOFOSSILS AND SOFT-BODIED FAUNA OF THE ZAVKHAN PHOSPHATE BASIN IN WEST MONGOLIA

Abstract. This presentation considers deals with biostratigraphic peculiarities of the Zavkhan phosphate basin by example of the Tsagaanolom shelfy trough. The Tsagaanolom trough was formed a large shelfy basin that is located in the western part of the Khangai intraplate orocline geostructure and existed during Late Neoproterozoic to Early Cambrian times.This phosphate shelfy trough is important to Late Precambrian - Cambrian geology and paleontology because the stratigraphic sections of the Maikhanuul (diamictite), Tsagaanolom (carbonate), Bayangol (terrigenous) and Salanygol (carbonate-terrigenous) formations are thick, relatively complete, well exposed and particularly correlatable with classical sections of the Siberian platform. Also important is the fact that the sections contain a combination of stratigraphic features seldom found elsewhere over this interval in a single region: diamictites, bacterial fossils, trace fossils, small shelly fossils, soft-bodied fossils, sponge spicules, archaeocyaths and calcimicrobes, abundant carbonates for carbon and strontium isotope stratigraphy, and good potential for sequence stratigraphy

Keywords: Bayangol section, Ediacarian-Lower Cambrian boundary, Bacterial fossils, Trace fossils, Soft-bodied fossils, Small shelly fossils

INTRODUCTION

We present new results from the first detailed paleontological study of the Ediacaran-Early Cambrian siliciclastic and carbonate dominated deposit in the Zavkhan phosphate basin in 1990-1996 and 2006-2017. Here we focus on the succession of ichnofossils and soft-bodied fossils in order to highlight the factors affecting geobiofacies and fossil distribution across the boundary itself. Khasagtian group of an inskeletal fauna is all the ichnofossils and soft-bodied fauna from the Ediacaran-lower Cambrian concordant limitotype strata of Mongolia. Field work was undertaken along the North Khasagt Khairkhan range, Bayan Gol, Tsagaan Gol gorges, including Tayshir refer section (Fig.1).

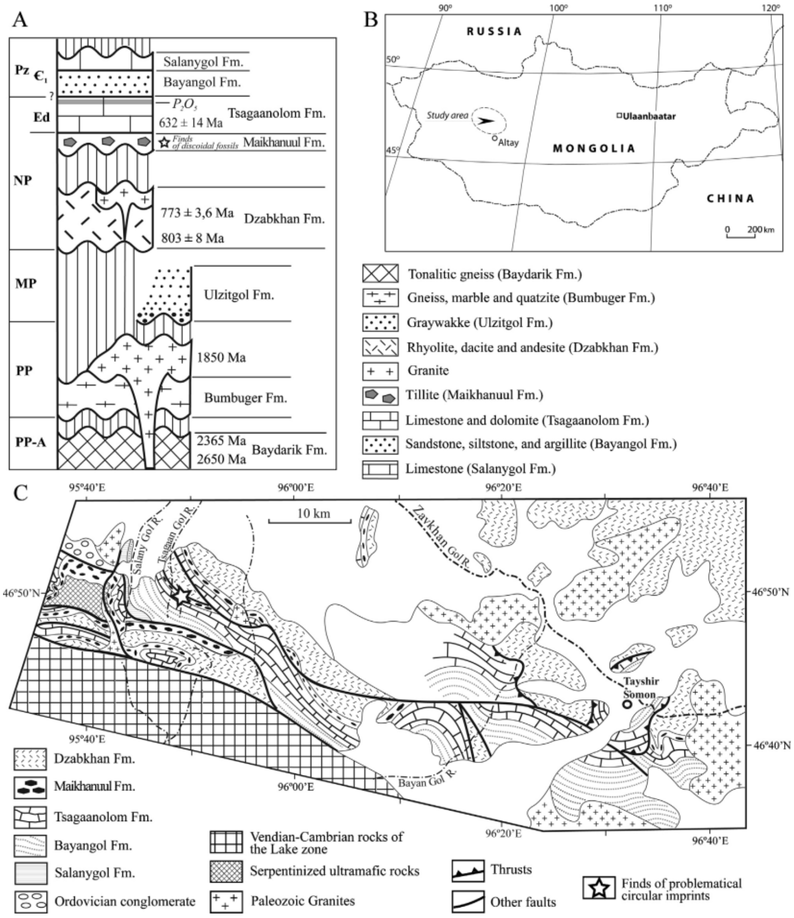


Fig. 1. (A) Schematic stratigraphic column of the Zavkhan basin. (B) Sketch map showing the location of the study area (Zavkhan basin) in west Mongolia. (C) Schematic geological map of the Salany Gol R., Tsagaan Gol R., Bayan Gol R., and Tayshir gorge (Khevtee Tsakhirnuruu) areas within the Khasagt Bogd mountain (Levashova et al., 2010).

In southern part of the Khasagt Khairkhan range an Orolgai section of the Tsagaanolom, Bayangol, Salaanygol and Khairkhan formations was being examined by us together with paleontologists from Sweden (C. B. Skovsted), England (T. P. Topper), Australia (M. J. Betts) and China (G. X. Li) in 2018. Majority material was found as float at each section. Specimens were phorographed in the field, and some cast with dental alignate, using neat shampoo as a releasing agent. The holotypes of the collections of paleontologically and stratigraphically significant material have been deposited at the Institute of Paleontology and Geology, Ulaanbaatar, at the Paleontological Museum of the Paleontological Institute of the RAS and other standard materials at the University Museum, Oxford (OUM), Department of Earth Sciences (Sedgwick Museum), University of Cambridge, Department of Paleobiology Swedish Museum of Natural History Stockholm, Sweden and Natural History Museum of Denmark Copenhagen, Denmark. .

RESULTS

The Zavkhan phosphate basin of western Mongolia was carbonate platform in the Neoproterozoic-Cambrian period (Dorjnamjaa et al., 2016, 2018, 2019). In this area Ediacaran-Early Cambrian seccession rests nonconformably on Early Neoproterozoic Zavkhan (3000 m) and Maikhanuul

(220 m) formations and are represented by Tsagaanolom (1600-1900 m) and Bayangol formations (Dorjnamjaa et al., 2016). Ediacaran problematic biota (presumably, Beltanelloides, Beltanelliformis or Nemiana); numerous fragments of cyanobacterial mats (with dominant taxon Siphonophycus); colonies of coccoid microfossils; mineralized multi-layered algae, which probably regarded to Thalophycoides and rich assemblage of trace fossils were discovered in the Bayangol formation. Algae of genus Thalophycoides demonstrate cellular construction and thallus structure of pseudo-parenchymatous type comparable to that of red algae. The complex of trace fossils let us make the reconstruction of the first Cambrian bioturbators and some conclusion on the ichnostratigraphy in the Precambrian-Cambrian boundary interval. The Bayangol formation (up to 940 m) is represented by alternating packages of carbonates and siliciclastics. The local stratotype section of the Bayangol formation have been established at the Bayan Gol gorge. The analogous sections are known within the Orolgai, Salany Gol, Tsagaan Gol, North Duulga Gol gorges and Tayshir or Durulj gorge. The way in which the Ediacaran- Lower Cambrian boundary International Global Stratotype was positioned coincides with the appearance of Phycodes pedum ichnozone at Fortune Head section, Newfoundland and Tommotian regional stage, Siberia. The Khasagtian fauna was collected from sections along Bayan Gol and Tayshir gorges. Close to the base of bed 18 of "particoloured stone" member numerous Spatangopsis (Figs. 1; 2; 6:7) and Medusoid were found (Fig.10A).These are regarded as soft bodied fossils by Goldring & Jensen (1996). -

Fig.2. Lowermost eighteenth bed of the Bayangol formation with Spatangopsis mongolica Dorjnamjaa and Phycodes pedum Seilacher in the Bayan Gol gorge (GPS: 46^0 41' 48, 9''; 96^0 17' 54, 0''). Photograph D. Dorjnamjaa, 29.08.2017

Fig.3. New location of Spatangopsis mongolica Dorjnamjaa, phosphatic silty sandstone in the base of 18th bed of the Bayangol formation indicative the limitotype boundary between Ediacaran and Lower Cambrian. Bayan Gol gorge. Photograph D.Dorjnamjaa, 29. 08. 2017

Ichnofossil assemblage (Figs.4; 5; 6). Bayan Gol gorge. Distribution of the ichnofossils in the sections of Bayangol formation, "Particoloured stone" member bed 18. An ichnotaxon is Phycodes pedum Seilacher, Didymaulichnus miettensis Young, Helminthoida cf. miocenica Sacco, bed 20: above ichnotaxa, together with Cochlichnus isp., Rusophycus cf. avalonensis Crimes and Anderson,

a, b, c, d, e, f *g*

Fig.4. (Field photographs except c, f) (a) Helminthoida isp.(SM X 25957). (b) Didymaulichnus miettensis Young. Endichnial reliefs in fine-grained sandstone with lateral belevs partly exposed. (c) Zoophycos (? Spirophyton) isp. (OUM AY 15), Tayshir I. (d) Treptichnus bifurcus?. (e) Rusophycus cf.avalonensis Crimes & Anderson,positive hyporelief. (f)? Plagiogmus isp. (OUMAY13). (g) Palaeophycus tubularis Hall Hypichnion. x 1.0. All specimens x10.Specimens figured (b, e) are from unit 20, Bayangol formation; those figured (a, c, f) are from Tayshir gorge. Specimen (g) figured is from Lower Bayangol formation (unit 18). Photographs D. Dorjnamjaa, 1993 and 2017 (g).

Monomorphichnus isp., Tsagaan Gol gorge: Bayangol formation. Phycodes pedum Sealacher, Didymaulichnus miettensis Young, Hormosiroidea isp.. Treptichnus cf. triplex. Tayshir gorge: Bayangol formation. Didymaulichnus miettensis Young, Cochlichnus isp., Helminthoida isp., Monomorphichnus isp., Oldhamia radiata Forbes, Zoophycos isp. It should be particularly emphasized that Pycodes pedum is common in beds 18 and 20 at Bayangol formation in several toponomic expressions but mostly as positive hyporeliefs by R. Goldring et al. (1996) and D. Dorjnamjaa et al. (2004, 2005).

Palaeophycus tubularis Hall, 1847. Figure 3g. Several float slabs from unit 20 (Bayan Gol) and unit 35 (Tsagaan Gol) show a thinly mud-lined and sand-filled burrow of variable diameter (8.0 mm max.) as ephichnial full reliefs.

Helminthoida cf. miocenica Sacco,1886. Figure 3a. Directed meandering burrows are commom in units 18 and 20 at Bayan Gol. The burrows are 3-4 mm wide and with rather short meanders, with loops almost closing, and frequent overlaps and crossings. In unit 20 the meanders are relatively parallel, burrows are 3-6 mm wide with height: width ratio 3-5:1.Slabbing of material from unit 20 shows that the trace is preserved as a hypichnial burrow and as full, positive or negative reliefs, and that it is post-depositional.

Chochlichnus isp. several specimens found as float from unit 20, Bayan Gol, show sinuous positive relief, respresenting burrows. The unevenly sinuous structure is suggestive of the trace of the “funnel” associated with “Psammichnites-plagiogmus”.

Didymaulichnus miettensis (Meandering bilobed trail) Young, 1972. Figure 3b. This ichnotaxon is present in all sections as endichnial reliefs, which are from unit 20, Bayangol formation, Bayan Gol. This ichnotaxon is widespread in the Upper Precambrian to Lower Cambrian (Bromley, 1990).

Monomorphichnus isp. A single line of obliquely-arranged, parallel, straight scratches shows as positive hyporeliefs. The scratches range from thinner an fainter (c.4.0 mm) to stronger and longer scratches (c.10 mm).

Rusophycus cf.avalonnensis Crimes & Anderson, 1985. Figure 3e. Several specimens found as float from the top of unit 20 in Bayan Gol show a paired group of hypichnial transverse, almost parallel, structures without angular convergence, representing shallow impingement onto a casting substrate below a sand bed. While some show typical coffee-bean form, others are no more than surface scratches.

Zoophycos isp. Figure 3c. One specimen (Tayshir section) preserves what appears to be part of a circular Zoophycos-type spreit. The diameter of forms appears to have been less than 10 cm, which is smaller than typical for Zoophycos. We consider that the Tayshir specimens represent one of the earliest locations of Zoophycos.

Phycodes pedum Seilacher, 1955. Phycodes pedum is common in the lower part of unit 18 and upper part of unit 20 at the Bayan Gol and North Duulga Gol gorges in several toponomic expressions but mostly as positive hyporeliefs (Figs. 4;5). Besides Phycodes pedum was known from Bayangol formation of the Dzun Arts (Esakova et al., 1996), Tayshir and Orolgain areas. Its earliest appearance, around 635 Ma, which was contemporaneous with the last of the Ediacaran biota, is used to help define the dividing line, considered geologically at 541 Ma, between the Ediacaran and Cambrian Periods. Exactly age range is 635.0 to 478.6 Ma. As known distribution: Cambrian of Canada (1- Newfoundland collection) and Mongolia (1-Bayangol gorge), Ordovician of Poland (2), Ediacaran of Namibia (1), Norway (1), Spain (1). Total:

7 collections each includ a single occurrence. Environments: marine (1 collection), deltaic (1), submarine fan (1), open shallow subtidal (3), shoreface (1). Sister taxa: Phycodes circinatus, Phycodes palmatum, Phycodes palmatus, Phycodes ungulatus, Phycodes wabanensis. Thus, Phycodes pedum is being important for defining the Precambrian-Cambrian boundary or marking the Cambrian-Ediacaran GSSP and ICSS (2012). It occurs in high relief on the soles of thin-bedded sands, silts, and is the preserved burrow of an animal rather than a fossil of that animal. Cross sections reveal that the bundles of smoothly curved burrows seen in bottom view are actually the bases of closely packed vertical spreite bodies consisting of retrusive backfill lamellae. This species has a fairly complicated and distinctive burrow pattern: along a central, sometimes sinuous or looping burrow it made successive probes upward through the sediment in search of nutrients, generating a trace pattern reminiscent of a fan or twisted rope. Since only its burrows have been found, it is presumed that the Phycodes zoobenthos lacked any hard anatomical features, such as shells or bones. Its morphology and relationship to modern animals is therefore unknown, and some dispute even its inclusion within the animal kingdom. Synonyms are Treptichnus pedum (Seilacher, 1955) and Treptichnis bifurcus (Miller, 1889), Manykodes pedum, Trichophycus pedum. The name Treptichnus pedum means "turned-trail (Greek) of feet (Latin)" and formerly named Phycodes pedum, Manykodes pedum by Srivastava et al. (2016). All the ichnofossils are typical of shallow marine microfossils.

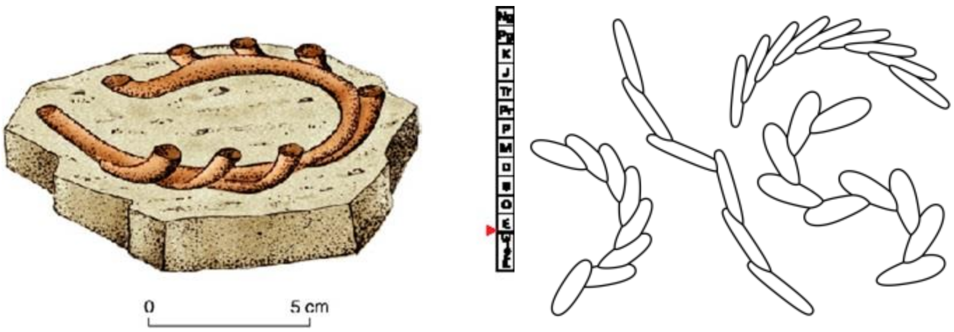


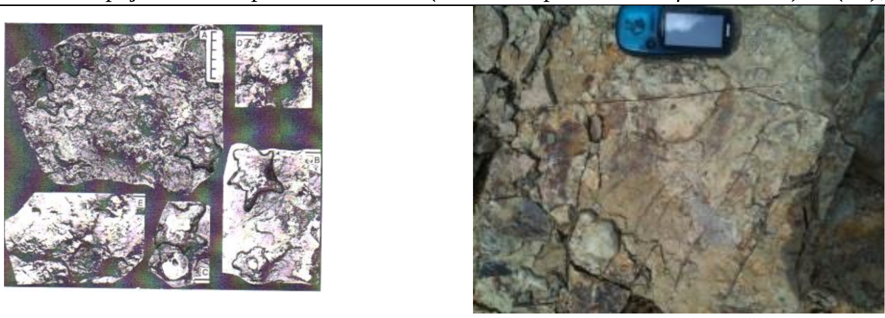
Fig.5. Phycodes pedum.Curvilinear burrows with successive tooths viewed from an external side schematic drawins)

A B

Fig.6.A-Phycodes pedum remains of the Bayangol formation. B-Sister taxa: Treptichnus bifurcus. silty sandstone slab (Miller,1889); This ichnogenus is interpret as a trace fossils, such as footprints, nests, Bayan Gol gorge, field polychaete worms and photograph, D. Dorjnamjaa, 1993, and an amphipoda (Bromley,1990).

SOFT-BODIED FOSSILS. The new words about Spatangopsis mongolica Dorjnamjaa (Fig.6), Paracharnia gen, nov., Oldhamia radiata Forbers and Medusoid (Fig. 7). These soft-bodied fauna discovered for the first time, from Bayangol formation in 1991 and 1993, also 2017.

Psammocoral Spatangopsis Torell as a genus is known from Cambrian sediments in Swede, Estonia, Scotland and Mongolia. Where as, Spatangopsis mongolica Dorjnamjaa (as a new species) was found and described at the level with Phycodes pedum from unit 18 of Bayangol formation, it is the only occurrence in the world at present (Dorjnamjaa et al., 2016,2019). This species (zoophyte) is only known from hyporelief casts, rather than complete sand buttons. It had a large ventral dimple and a number of rays variable from three-five to seven.



A *B*

Fig.7. A-Ventral surface of Spatangopsis mongolica Dorjnamjaa.Three-five to seven rayed specimens. Note the variable development of the ventral dimple. Scale bars represent 10 mm.Remains from Lower Cambrian Bayangol formation, Bayan Gol gorge (Dorjnamjaa et al., 2012). B- S.mongolica remains on the green phosphatic silty sandstones slab, 200 m above from the base of Bayangol formation.GPS: 46^{0}41'55,2'';96 ^{0}18'03,5''. Photograph D.Dorjnamjaa.29.08.2017.

Fig.8.Geological profile of "Tayshir-1" section, Ediacaran (Tsagaanolom)-Lower Cambrian (Bayangol) boundary of the organogenous sediments along the Tayshir gorge(Dorjnamjaa et al., 2018).

1. Maikhanuul formation (NP mu)- diamictite (ungraded, uncarbonate terrigenous sedimentary rock with derived angular soled granitic, sandstone and volcanic pebbles), 2-Tsagaanolom formation (EdCo)- dolomites, dolomitic plaglike limestones, locally compact brecciated with microphytolites (Radiosus limpidus Z.Zhur., Asterosphaeroides tayshir D.Dorjnamjaa forma nova) and algae (Renalcis pectunculus Korde., Epiphyton scapulum Korde.), calcareous siltstones; 3-7- Byangol formation (E$_1$bn). 3- arkosic, calcareous, clayey, glauconitic sandstones, marly, 4- siltstones, silty sandstones, argillite, 5- claystones, aleurolite; fossilised calyptra, 6-schistose grit, biohermal, biostromal limestones,7-shale, clay, calcareous grit, 8- acid volcanic vein dike; 9-A- oncolites (Figs.14-15**),** Б-calcareous algae (Renalcis), algal calyptra; 10-A-SSFs (molluscs, tubular fossils), Б- zooproblematica (Hyoliths, Cambrotubulus); 11-A- Medusoid (jellyfish), Б-Paracharnia; 12- A-Oldhamia radiata, Б-Trace fossils- Helmintoida isp, Planolites; 13-Elements of bed occurrence.

Within Tayshir section the Maikhanuul diamictites (about 4-m thick) are overlain by platy bedded carbonates of the Ediacaran Tsagaanolom formation consisting of conglomerates contains a variety of clasts ranging in size from pebbles to 30 cm (Fig. 8). The clasts are ungraded soled granitic, sandstone and volcanic pebbles and embedded in a matrix composed of sandy-argillaceous. These diamictites are very similar to that of the lower Duulga member diamictites in the Tsagaangol section. Bayangol formation (360 m) is represented mainly terrigenous sediments and conformable with the Tsagaanolom formation. This formation is subdivided into two parts, each of which is represented by two members. The uppermost part of the tsagaanolom formation consists of plaglike calcareous dolomite and dolomitic limestones (80 m) with oncolites (Radiosus limpidus Z. Zhur., Asterosphaeroides tayshir D.Dorjnamjaa forma nova, also Vesicularites bothrydioformis (Krasnop.)., V. compositus Z.Zhur. etc.) and algae (Renalcis pectunculus Korde., Epiphyton scapulum Korde.). Thus, the Bayangol formation can be divided into four units or members (Dorjnamjaa et al., 1991, 1993). For the first time we have called these members as "Durulj" according to Tayshir local name.

The Durulj member I, up to 140 m thick, exhibiting gradual transition to the carbonate member, is represented by greenish-bluish-grey and grey-green sandy siltstones, clayey sandstones, glauconitic silty sandstones, and slightly- micaceous siltstones with interbeds of hieroglyphic and cavernous limestones. Azimuth of dip: NE 25^0; dip angle: up to 30^0. At the level 70-80 m above a sole of this formation we have been able to discovery in 1988 Paracharnia Sun. and Oldhamia radiata (determination of S. Vodanuyk), Chochlichnus sp., Helminthopsis sp., Planolites sp ., Phycodes sp (?) and Rangea sp. (Ivantsov, 2009). At the same time molluscs (Latouchella korobkovi (Vost.), L. minuta Zheg., Barskovia mongolica Zheg., Nomgoliella sinistrivolubilis Miss., Ilsanella compressa Zheg.), zooproblematica (Cambrotubulus decurvatus Miss., Siphogonuchites sp., Lopochites latazonalis Qian., Halkieria sp., Archaeooides granulatus Qian.), Phycodes sp., hyoliths (Ovalitheca mongolica Sys.), algae from calyptra (Renalcis pectunculus Korde., Tarthinia rotunda Drosd., Epiphyton fruticosum Vol.) were revealed in this member (Esakova et al., 1980).

The Durulj member II (up to 60 m thick) mainly represented by primarily, greenish to light grey coloured, inequigranular feldspathic-quartzitic sandstones, alternating, frequently with grey-greenish coloured claystones, limestones with Renalcis, siltstones and fine argillaceous sandstones. The argillaceous rocks may contain the individual tubular small shelly fossils: Cambrotubulus decurvatus Miss., Rhabdochites exaspertus He. Biostromal limestones contain microphytolte: Radiosus derosus Yaksch., R. aculeatus Z.Zhur. (determination of A. Terleev).

The Durulj member III (up to 70 m thick) is in conformity with the underlying member and consists of carbonate siltstones and shales with individual interbeds of algal limestones. The clastic rocks are mainly represented by silty claystones, ochreous-yellowish, greyish, and claystones grey, greenish-grey, with ribbon lamination in dark and light varieties. Some intermediate layers contain molluscs: Nomgoliella rotunda E. Zhegallo, Latouchella parva E.Zhegallo, Barskovia sp., Ilsanella sp. (determination of E. Zhegallo)

The Durulj member IV is represented by terrigenous-caronate sediments (up to 90 m thick), which consist of biohermal limestones, carbonate sandstones and siltstones. Azimut of dip: NE 20^0; dip angle: up to 25^0. The terrigenous rocks are represented by an alternation of silty claystones, brown, more rarely green, and siltstones with ribbon lamination. In silty claystones along the bedding planes numerous spots and remains of organic material and imprints of algae are observed. The calc-claystones contain molluscs and the small shelly fossils: Latouchella korobkovi (Vost.), Barskovia sp., and Hyolithellus sp. In the upper part of this member greenish-grey siltstones contain medusoid (jellyfish).

Numerous new findings of the zooplankton (SSFs, Jellyfish) and zoobenthos (Trace fossils, Paracharnia, Oldhamia radiata, bacterial fossils) in this Tayshir reference section quite may indicate that the stratigraphic interval between the lowermost carbonate unite of the Tsagaanolom formation and the Durulj member I could be suggested as a new limitotype level of the Ediacaran-Lower Cambrian stage boundary (Fig.9).

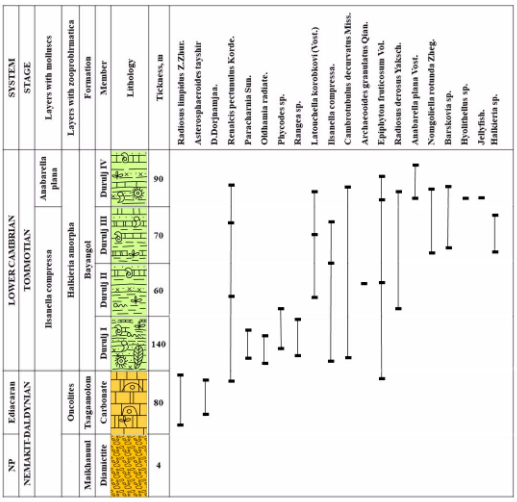


Fig. 9. Stratigraphic chart of the Precambrian-Lower Cambrian strata of the "Tayshir-1" Section (Tayshir gorge, Zavkhan river area) and occurrence of molluscs, algae, zooproblematica and Ediacaran-type fossils (developed and modified after N.V.Esakova and E.A.Zhegallo, 1980, from D.Dorjnamjaa et al., 1993).

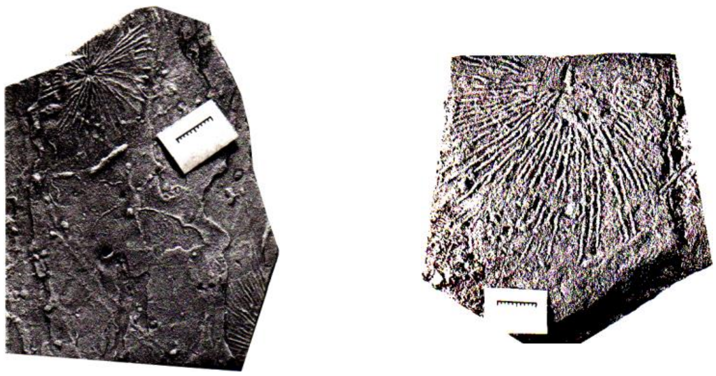
<u>MEDUSOID (jellyfish)</u>. More better occurrences were by discovered by us at the Durulj member IV of the Bayangol formation allong the Tayshir gorge (Fig.10A) and a Bogd River near Aldarkhaan settlement (sum). Jellyfish are one of the two forms that coelenterates take: it is the free-swimming sexual phase in the life cycle of a coelenterate, in this phase it has a gelatinous umbrella-shaped body and tentales.Tayshir jelly-fish has a strong resemblance to a cyclomedusa. Jellyfish range from about one millimeter in bell height and diameter to nearly 2 metres (6.6 ft) in bell height and diameter; the tentacles and mouth parts usually extend beyond this bell dimension. They are found in every ocean, from the surface to the deep sea. Scyphozoans (the "true jellyfish") are exclusively marine, and some hydrozoans with a similar

appearance live in freshwater. Large, often colorful, jellyfish are common in coastal zones worldwide. Jellyfish have roamed the seas for at least 500 million years, and possibly 700 million years or more, making them the oldest multi-organ animal (Fig.10 B).

A *B*

Fig.10. A-New occurrence of jellyfish from Durulj, B-The major surfaces and member IV of the Bayangol formation within axes of a scyphozoan (Jellyfish). Tayshir gorge, size of the exodermpart (aboral surface) depending is 15- 30cm in diameter., on the body that species contains water between 95-98%. GPS:46^{0}42'15,3''96^{0} 32' 34, 5''.Photo: D. Dorjnamjaa, 30.08.2017

Oldhamia radiata Forbes. 1848. This ichnofauna is interpreted as Early Cambrian to early Middle Cambrian, based on comparison with Oldhamia-bearing ichnofaunas of similar age in North America, Argentina, and western Europe, and on archaeocyathids and olenellids in overlying units. Oldhamia is an ichnogenus describing burrows produced by worm-like organisms mining underneath microbial mats and regarded as a feeding structure typically radiating from a common central organ (Figs.11;12). *Oldhamia radiata* was discovered in the mid-19th century on Bray Head. Oldhamia trace fossil assemblages from green and maroon argillites at 34 localities in the British Mountains and Barn Mountains of northernmost Yukon, and 3 localities in the Grant Land Formation of northern Ellesmere Island contain abundant Planolites spp., Oldhamia curvata, Oldhamia flabellata, and Oldhamia radiata, and rare Oldhamia antiqua, Bergaueria hemispherica, Cochlichnus sp., Didymaulichnus? sp., Helminthoidichnites sp., Monomorphichnus sp., Protopaleodictyon sp., and Tuberculichnus? sp. Additionally, 11 new sites in the Selwyn Mountains of north-central Yukon have yielded an ichnofauna including Helminthorhaphe sp., O. curvata, O. flabellata, O. radiata, Plagiogmus? sp., Planolites sp., and unidentified small hemispherical traces. The Tayshir Oldhamia specimens are very close in morphology to specimens illustrated in Hofmann et al. (1994) and Seilacher et al. (2005) and termed by us as Oldhamia radiata Forbes originally (Dorjnamjaa et al., 2001, 2009). We believe paradigms are still quite plentiful and can be found off the Bayan Gol and Tsagaan Gol, also Salaany Gol sections within the North Khasagt Khairkhan area.



A *B*

Fig.11. The Oldhamia radiata from unit or Durulj member I of the Lower Cambrian occurrence Bayangol formation within the Tayshir gorge.
Narrow radiated morphostructure with characteristic emanation. B-Silky radiated morphostructure with characteristic hole in centre of
horizontal axis (Dorjnamjaa et al., 2012)

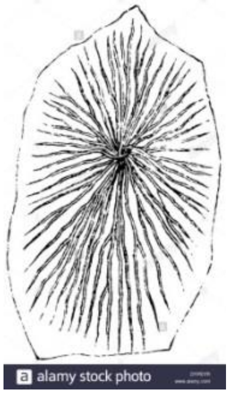
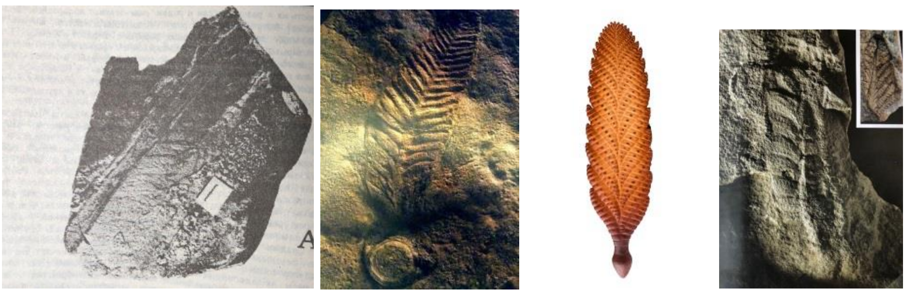


Fig.12.Cambrian Oldhamia radiata Forbes, 1848. Wsicklow, Ireland

Paracharnia Sun. It was found by D.Dorjnamjaa and J.Yondontsamts from Lower Cambrian Bayangol formation within Tayshir gorge in 1988 (Fig.13A). This genus (zoophyta?) first described by A. Vodanyuk from Novosibirsk Institute of Geology and Geophysics, RAN (Dorjnamjaa et al., 1991). It was originally interpreted as an algae (Ford), it was recast as a sea pen, a sister group to the modern soft corals, from 1966 onwards (Glaessner). The sea pen interpretation has recently been discredited. Similar fossils found in the 1930s (Namibia) and the 1940s (Australia) but were thought to be of Cambrian age. This genus of frond-like Cambrian-Ediacaran lifeforms with segmented, leaf-like ridges branching alternately to the right and left from a zig-zag medial suture (thus exhibiting glide reflection, or opposite isometry). It is a highly significant fossil. Its close association with abundant Jellyfish, Oldhamia radiata, microphytolites, Phycodes sp. (?), Rangea sp. (Fig.12), blue-green Renalcis algae (Fig.14), macroscopic algal remains of *Vendotaenia* sp. and its proximity to the overlying basal Cambrian small shelly fossil assemblages (molluscs, tubular fossils) in the same succession of the Bayangol formation emphasise its palaeontological and biostratigraphic significance**.**



A B C

Fig. 13. Rangea sp. Durulj member I. Photo: Ivantsov, 2009
A- The fossilised genus Paracharnia specimen was found from Durulj member I of the Lower Bayangol formation along the Tayshir gorge (Dorjnamjaa et al., 1991); B,C. Reconstruction of Paracharnia at MUSE - Science Museum in Trento

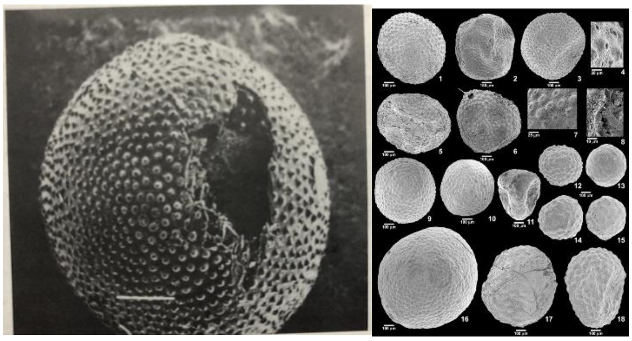
A B

Fig. 14.A- Blue-green Renalcis and Gordonophyton calcareous colonial algae (septate) remains on the imestones slab, Bayangol formation, Dudulj member II . GPS: 46 ^{0}42’15’’; 96 ^{0}32’34’’. Field photograph, D.Dorjnamjaa, 30.VIII.2017. B- An analogical marine blue-green septate algae of the Azov Sea

ZOOPROBLEMATICA (ARCHAEOOIDES QIAN). Archaeooides granulatus Qian, 1977 was described originally from the lower part of the Bayangol formation in the Salaanygol Gorge (Tommotian Stage) (Voronin et al., 1982) and Kheseen formation from Khubsugul basin (Bacterial…,2002). This soft-bodied fossils looks like a flattened, deflated hollow sphere ball with protuberant papillae on the surface (Fig. 14), which were discovered by us from Bed 12 of the Tsagaanolom formation during the field research at the Bayangol Gorge in 2018(Fig.15). Archaeooides specimens were known from Cambrian of China (19 collections), Germany (1 col.), Kazakhstan (1 col.), Russian Federation (1 col.), and Mongolia (1 col.). We have showed the original pictures of the Archaeooides which were published in Journal of Paleontology, 80(5): 811-825. 2006. htts: /doi.org/ 10.1666/0022-2360(2006) 80[811:ECM EEA]2.0.CO; 2 (Fig.16).

A B C

Fig. 15. A. Zooproblematica-planktonic organism (Archaeooides granulatus Qian, 1977). Characteristic of concentration of the Archaeooides specimens in the phosphatized argillo-calcareous rocks: “Bed 12” of the Tsagaanolom formation, Bayangol Gorge. B, C-Zooproblematica (Archaeooides granulatus Qian, 1977). Ditto. The isolated or individual specimens (0.5-2.0 cm in diameter). Photo: D. Dorjnamjaa, 21-22. VIII. 2018



A B

Fig.16A.Archaeooides sp. planktonic organism from Lower Cambrian phosphorites in the Khubsugul basin (Bacterial…, 2002).

Fig.16B.(Figure 4—SEM photomicrographs of spheres referred to Archaeooides sp.). 1, Spherical form, Sample 99139, GSC 123989; 2, deflated sphere, Sample 99127, GSC 123990; 3, 4, sphere with deflated surface and detail of protuberances, Sample 1680-2, GSC 123991; 5, highly deflated sphere showing preservation of protuberances in deflated surfaces, Sample 99127, GSC 123992; 6–8, deflated hollow sphere with detail of protuberances (7) and detail of thin wall (at arrow in 6) and internal filament with spherulitic texture (at arrow in 8), Sample 16999139, GSC 123993; 9, 10, regularly ornamented spheres, Sample 1680-2, GSC 123994, 123995; 11, deeply deflated, ornamented sphere, Sample 99127, GSC 123996; 12–15, small spheres, Samples 1680-3, 1680-2, 1680-2, 1680-1/3; GSC 123997, 123998, 123999, 124000; 16, large sphere, Sample 1680-2, GSC 124001; 17, ornamented sphere with polar “X,” Sample 1680-3, GSC 124002; 18, coarsely ornamented sphere, Sample 1680-2, GSC 124003.

ONCOLITE (Radiosus limpidus Z.ZHUR.). Nodular structure of round and oval form, central part of node is fulfilled with small and large grained columnar carbonate with black round synthetic differences, in periphery is observed a thin light layer (Fig. 17). A layer is come through with wide radial rays. Some nodes have in periphery dim or diffuse sharp-tongued edges. In thin section there are more 5 nodes.Tayshir section, carbonate member of the Tsagaanolom formation.

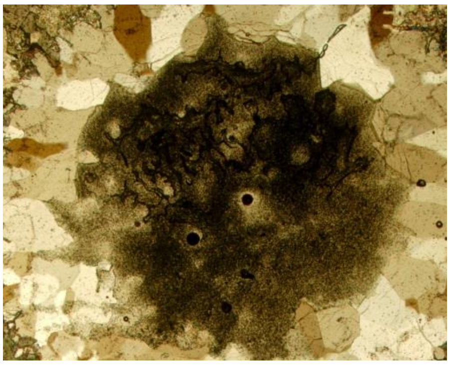


Fig.17. Thin section, sample 21/07. Radiosus limpidus Z. Zhur. NIKON ESLIPSE E400 POL. Photo S. Purevsuren

ONCOLITE (Asterosphaeroides tayshir D. DORJNANJAA forma nova). Radiolith structure of round and oval form, central part fulfilled with fine grained carbonate, in periphery is observed one light wide layer (Fig.18). A layer is come through with numerous light radial rayes going to periphery from center of node consisting of covered grained carbonate. An insaide of structure there are more fine dark synthetic nodes. In thin section there are more 10 nodes. Tayshir section, carbonate member of the Tsagaanolom formation.

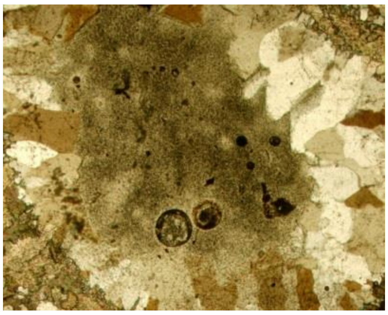


Fig.18. Thin section, sample 21/07.Asterosphaeroides tayshir D. Dorjnamjaa forma nova NIKON ESLIPSE E400 POL. Photo S. Purevsuren

STROMATOLITE (thrombolites). Stromatolite layered deposit, mainly of limestone, formed by the growth of blue-green algae (primitive one-celled organisms).This is a laminated usually mounded sedimentary fossil formed from layers of cyanobacteria, calcium carbonate, and trapped sediment. Stromatolites were common in Precambrian time (i.e., more than 541 million years ago). We are able to have discovery the thromblite-like stromatolite (Figs.19; 20) at the unit 18 of the Lower Cambrian Bayangol formation (Brasier et al., 1996, Dorjnamjaa et al., 2016,2018).

Fig.19.The stromatolitic domes are typically 30 cm in diameter. Cambrian trombolite-like microbial structure. At 10-15 m above from a base of unit 18 with Spatangopsis mongolica Dorjnamjaa, Bayangol formation, Bayan Gol gorge. Photograph D. Dorjnamjaa, 27.08.2017

Thrombolites are ancient types of microbial communities that photosynthesize. They are similar to stromatolites, but they are formed differently. Stromatolites are clearly layered, but thrombolites are not. They are "clotted accretionary structures". They formed in shallow water by the trapping, holding, and cementing sedimentary grains by microorganisms, especially cyanobacteria. They were common in the Cambrian and early Ordovician, and few examples still exist today. Here we have shown some good known fossils of stromatolite from Western Australia and South Africa in order to compare to Lower Cambrian thrombolite-like stromatolite from Bayangol formation (Fig. 19). So, all the ichnofossils and soft-bodied fauna from the Ediacaran- Lower Cambrian concordant strata of Mongolia are called by us as Khasagtian group of an inskeletal fauna.

A *B*

Fig.20. A. Living stromatolites in Hamelin Pool of Shark Bay, Western Australia. B. *Old fossils of stromatolite (South Africa).*

Conclusions

1. The base of the Bayangol formation is taken at the reappearance of siliciclastic sediments which forms an alternating sequence of thick units of limestones and siliciclastics.

2. Khasagtian fauna enter close to the base of the siliciclastic units on the soles of thin silty sandstones only becoming common in association with sandstones towards the top of the lower beds of unit 18, where the beds are amalgamated or composite and include casts of psammocorallids (Spatangopsis), Jellyfish and Oldhamia radiata. This new group of fossils present over the Ediacaran-Cambrian boundary interval in Zavkhan phosphate basin are almost entirely from the siliciclastic intevals.

3. Khasagtian fauna or fossil assemblages, including Phycodes pedum (Treptichnus pedum), Spatangopsis mongolica, were found at levels with Nemakit-Daldynian-type skeletal fossils and isotopes and an assemblage with Rusophycus cf. avalenensic plus other early arthropod traces was found above.

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