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Lower Silurian Cephalopod Limestones from the Mojero River Section (Eastern Siberia, Russia) and their Paleogeographic Relationships

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5 Text-Figures

Russia
Eastern Siberia
Lower Silurian
Cephalopod Limestones
Paleogeography

Contents

Cephalopodenkalke aus dem Untersilur des Mojero-Fluß-Profils (Ostsibirien, Rußland) und ihre paläogeographischen Beziehungen

Zusammenfassung

In dieser Arbeit werden Cephalopodenkalke aus dem Silur des Mojero-Fluß-Profils von Ostsibirien behandelt.

Die artliche Zusammensetzung der reichen Fauna wird erwähnt und eine Beschreibung der Lithologie gegeben. Die Bildung dieser Kalke fand in einem flachen Meeresbecken unter verminderter Wasserzirkulation und upwelling-Bedingungen statt. Nach Conodonten hat die reiche Fundstelle ein Alter in der *D. kentuckyensis*-Conodontenzone bzw. entspricht der Zeit vor dem Auftreten der Graptolithenart *M. modestus sibiricus* (= *vesiculosus*), d.h. älteres Llandovery.

Paläogeographische Beziehungen bestehen auf der einen Seite nach China, auf der anderen Seite aber auch nach Mittel- und Südeuropa.

Abstract

Silurian cephalopod limestones are known from the East Siberian Mojero river section. Lithology and fauna composition are described.

These sediments are considered to be due to the deterioration of water circulation in the nearbottom conditions of a relatively shallow basin and high efficiency of pelagic assemblages associated with upwelling. Their age is defined by conodonts of the *D. Kentuckiensis* Biozone and by pre-*M. modestus sibiricus* (= *M. vesiculosus*) Biozone graptolites.

Paleogeographic relations to China and Middle and Southern Europe exist.

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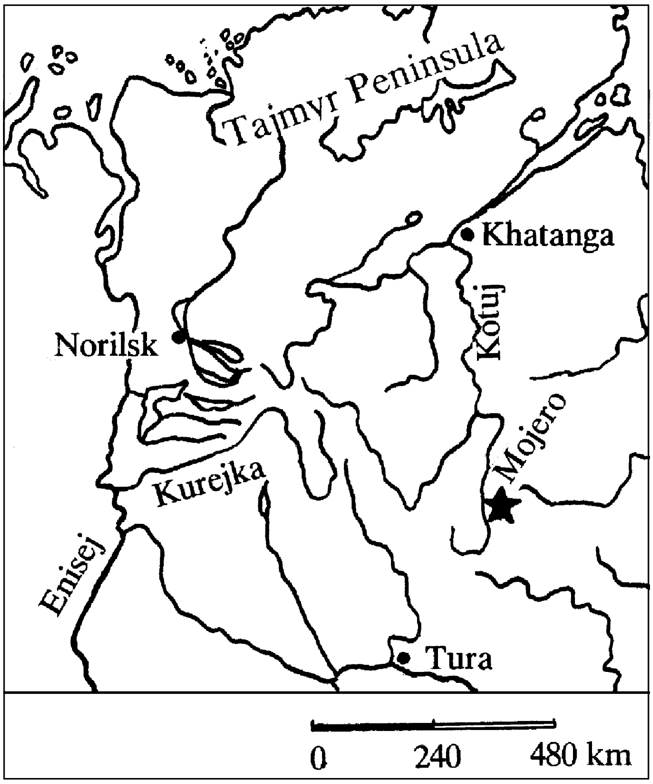
1. Introduction

Cephalopod limestones are known from Llandoverian sequences of China (CHEN et al., 1981) and Turkey (DEAN & MONOD, 1990), in the Wenlock and Ludlow of Bohemia, Yugoslavia, Spain and Germany (KŘIŽ, 1979, 1992), France (BABIN, 1966), Austria (SCHÖNLAUB, 1980, 1985, 1992; SCHÖNLAUB & BOGOLEPOVA, 1994), Algeria and Turkey (POJETA et al., 1976), Morocco (TERMIER, 1950), Sardinia (SERPAGLI & GNOLI, 1977; GNOLI et al., 1979; FERRETTI, 1989; GNOLI & SERPAGLI, 1991), Caucasus (YANISHEVSKIJ, 1918), South Urals (IVANOV & PUCHKOV, 1984), Tyan-Shan (VOLKOVA & CHERNOVA, 1961), Novaya Zemlya (NEKHOROSHEVA, 1981), Arctic Canada (POJETA & NORFORD, 1987) and Tajmyr (BOGOLEPOVA, 1994; 1995a – in press).

In this article I present the results of a cephalopod limestone biofacies study from the Mojero river section in Eastern Siberia, which was carried out during the field work in 1978.

2. Local Geology

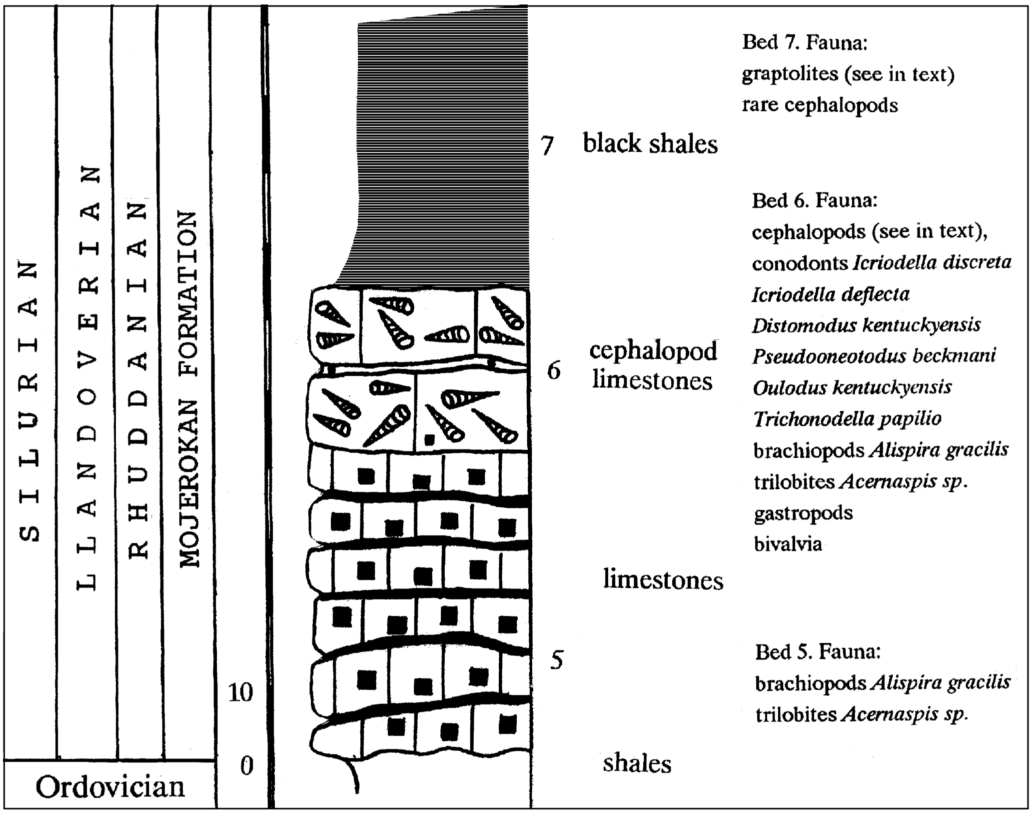
The Mojero river area (Text-Fig. 1) is on the south-western limb of the Anabar shield and is characterized by a monoclinal attitude of beds plunging south-westward. The river valley, some 100 m deep, entrenches the old Paleozoic sequence near-across the strike of the beds. Therefore downstream all older deposits are exposed in the valley. The general attitude of the beds is only affected by local dislocations caused by the Late and post-Paleozoic trappean intrusions. The Silurian sequences are exposed in the basin of the river middle course. The sequence is followed through a distance of 90 km at a mediterranean section of the river, from the mouth of the Bugarikta creek in the north, where Silurian rocks rest disconformably on Upper Ordovician ones to the mouth of the Kholyukhan creek in the south, where they are overlapped by Lower Devonian deposits (SOKOLOV, 1985).



Text-Fig. 1.
Locality map. Mojero river section marked by star.

The investigated section is located in the mouth of a small creek of Mojerokan, that is a right tributary of the Mojero river (67N, 104W).

3. Mojero River Section – Cephalopod Limestones



Text-Fig. 2.
Lower part of the Mojero river section (O. BOGOLEPOVA, section OB782), showing cephalopod limestones.

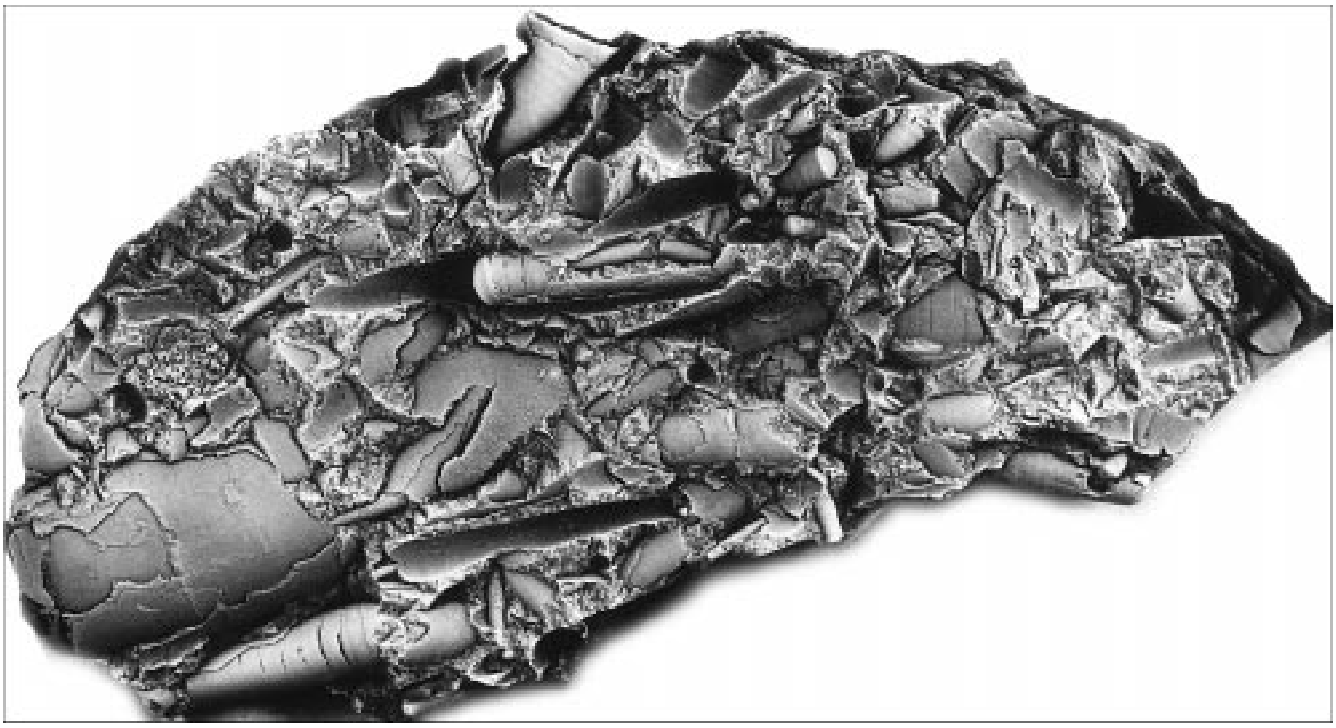
3.1. Lithology

A general outline of the section to which the author contributed is published (SOKOLOV, 1985). Included here is the description of the lower part which is of interest to us (Text-Fig. 2).

Bed 5 comprises six beds of dark grey, bituminous limestones with large (1–2 × 2–5 cm) pyrite concretions, each 9 to 15 cm thick, with tubercle bedding surface. The upper three beds alternate

Text-Fig. 3.
Lower Silurian Cephalopod limestone of the Mojero river section.
Photograph by E.I. MIAGKOVA (1960).

with thin (1–1.5 cm^3) interlayers of black shales. The thin-section shows fine-grained, cloddy dolomitic limestones (5–6%) with segregation of secondary calcite and dark-brown organic matter (essentially in the fractures), richly pyritized (15–35%). Detritus occurs sporadically in the lower part of the bed. Angular unsorted fragments of ostracode shells, trilobite carapaces and algal pellets are ubiquitous here. Limestones occur on the eroded surface of marls or lightgrey limestones of the underlying bed with unsignificant angular unconformity. Fossil remains are numerous through the bed. They are small and well preserved. Brachiopods represented principally by complete



Text-Fig. 4.
Lower Silurian Cephalopod limestone of the Mojero river section.
Photograph by O.K. BOGOLEPOVA. Natural size.

Text-Fig. 5.
Lower Silurian Cephalopod limestone of the Mojero river section.
A part of a slab from the author's collection (natural size).
Photograph by O.K. BOGOLEPOVA.

shells predominate. Trilobite fragments occur in the upper part of the bed. The thickness is 0.55 m.

Bed 6 consists of black bituminous limestone which smells of kerosene, in places it is divided into two layers by cavernous limestones of 2–3 cm thick enclosing calcite geodes and pyrite concretions. The limestone contains numerous oriented cephalopods which are rock-making (Text-Figs. 3, 4, 5). The remains of another group of fauna (brachiopods, bivalves, trilobites, gastropods and ostracodes) are of small size, poor diversity, rare and even solitary, scattered throughout the bed. The bed is 0.3 m thick.

Bed 7 consists of black thin-laminated flat-bedded, foliated shales. In the upper part the rocks are more calcareous, solid, passing into clayey flat-bedded limestones in the roof of the bed. Some 1.2 m above the base of the bed occurs a thin (1 cm) interlayer of light-grey fine-grained dolomitic dense limestone. Large sized concretions of pyrite and hematite are found throughout the bed (6–7 per m^2). The limestone yields cephalopods, brachiopods, ostracodes. All fossils are of small size and scattered burial. Shales contain graptolites, hyolites, brachiopods. The bed is 1.6 m thick.

3.2. Fossil Content

Biota of cephalopod limestones of the Mojero river section consist of numerous nautiloids, diverse in systematic composition, from embryonic forms to mature ones, of good preservation and different size, conodonts, occasional bivalves, brachiopods, trilobites and gastropods of poor systematic composition and small size. The systematic composition of conodonts, brachiopods and trilobites is shown in Text-Fig. 2. Nautiloids from cephalopod limestones were first described by E.I. MIAGKOVA in 1967. The assemblage consists of representatives of Orthocerida, Discosorida, Oncocerida, attributed to 12 families, 19 genera, 25 species (MIAGKOVA, 1967). In the vast world literature published by that time there was not any reliable data about cephalopod assemblages of the Llandovery or analogous age. This complex even now is the richest of the known ones in the Lower Silurian (BOGOLEPOVA, 1989, 1990). After studying the collection made on the Mojero river section in 1978 and the material from E.I. MIAGKOVA (1967) (Central Siberian Geological Museum, Novosibirsk) the systematic content of this assemblage is recognized as follows:

– Order Orthoceratida [*Dolorthoceras* MILLER, 1931 (= *Mongoceras* MIAGKOVA, 1967 = *Malgaoceras* MIAGKOVA, 1967); *Geisonoceras* F. ZHURAVLEVA, 1959; ?*Kentronites* F. ZHURAVLEVA 1964 (= *Tambegiroceras* MIAGKOVA, 1967; = *Joldagiroceras* MIAGKOVA, 1967); *Kionoceras* HYATT, 1885]
– Order Discosorida [*Phragmoceras* BRODERIP, 1839]
– Order Oncocerida [*Jovellania* BAYLE, 1879 (= *Hiregiroceras* MIAGKOVA, 1967; = *Moyerocanoceras* MIAGKOVA, 1967; = *Pachyceras* MIAGKOVA, 1967; = *Rhytidoceras* MIAGKOVA, 1967; = *Xyloceras* MIAGKOVA, 1967); *Oncoceras* HALL, 1847 (= *Tallatoceras* MIAGKOVA, 1967); *Oonoceras* HYATT, 1884 (= *Neoceras* MIAGKOVA, 1967); *Osbornoceras* FOERSTE, 1936 (= *Edenoceras* MIAGKOVA, 1967); *Rizosceras* HYATT, 1884; *Oyogiroceras* MIAGKOVA, 1967; *Tripteroceras* HYATT, 1884 (= *Mucteoceras* MIAGKOVA, 1967)]

3.3. Depositional Environment

The accumulation of black bituminous limestone thickness and black sometimes bituminous and grey shales is connected with a transgression begun in the East-Siberian basin in the early Silurian. A lot of examples of bituminous shales formation on the beginning of the transgressive series or near their base are well known (HALLAM & BRADSHAW, 1979). In some cases the horizons of bituminous shales are very traceable. The facies connected with them are shallow, that is why it is impossible to explain their deposition only by the conditions of a deep isolated basin (as Black Seal) (type 1b according to J. WILSON, 1975). The model where conditions leading to these deposits appear as a result of the combination of very weak sea bottom inclination, when nearbottom water circulation is limited, and high organic productivity of pelagic fauna, connected probably with upwelling. More free water circulation occurred during further transgression, when with better water circulation nonbituminous clay shales with different infauna were forming. Cephalopod limestone facies were spread in the north-eastern (the basin of Mojero. Olenek-Morkoka rivers and north-western (along Enisej river – the basin of Letnayay, Fat'yanikha, Kurejka rivers) parts of the basin.

The dominant lithologic rock types, their color, bedding, biota – all these confirm the right use of the shortly described above model of cephalopod limestones formation in the Lower Silurian of Eastern Siberia (BOGOLEPOVA, GUBANOV, in prep.).

3.4. Age

Most of the cephalopod species from the Mojero river section are described as endemic and to date the rocks enclosing them would be premature. We know the earliest cephalopod assemblage from the middle part of Llandoverian of China (CHEN et al., 1981), but the author does not consider it to be possible to make conclusions about their being of the same age (with the only similar genus, but nevertheless common morphological closeness of the whole assemblage) without direct study of the paleontological material. The age of cephalopod limestones is dated on the base of conodonts found in the same layer (Text-Fig. 2) as the *D. kentuckyensis* Biozone (MOSKALENKO, 1986). The graptolites collected from the shales above: *Metabolograptus moyeroensis, Glyptograptus* ex gr. *tamariscus, Paraclimacograptus innotatus innotatus* and others (OBUT & SENNIKOV, 1985) suggest a more precise date, i.e. the *P. acuminatus* Biozone (BOGOLEPOVA, 1995b, in press).

4. Discussion

In connection with the published paper of C. HOLLAND, M. GNOLI & K. HISTON (1994), where these authors present data about accumulations of nautiloid cephalopods in the Ordovician–Devonian, naming them “concentrations”, I would like to draw the attention to one rather terminological question. It is worth dividing these data into:

1) concentration – accumulations of cephalopods that we observe on one or several bedding planes (the author was studying a similar concentration of actinoceratid siphones around bioherms in the Lower Silurian of Siberia). Here we deal with one population and the event that occurred in an immediate (in respect to geological history) time interval. Reasons for these concentrations are mostly of a local character and
2) cephalopod limestones or cephalopod limestone biofacies – facies the formation of which occurred in a certain physical-geographical environment with certain type of biota. Their distribution can be observed in space as well as in time. These deposits are a good stratigraphic marker, for example at the level of the *S. fritchi linearis* Biozone in Bohemia, Sardinia, the Carnic Alps and Montagne Noire (KŘIŽ & SERPAGLI, 1994). Tajmyr (Eastern Siberia) (BOGOLEPOVA, 1995a, in press) and the reasons causing their deposition are undoubtedly of regional and global character.

5. Paleogeographic Remarks

The cephalopod limestones, described in this paper represent the oldest Silurian locality of the cephalopod limestone biofacies ever discovered. These deposits developed on the outer margins of the Siberian platform during episodes of upwelling (BOGOLEPOVA & GUBANOV, in prep.).

The closeness of the cephalopod associations of Eastern Siberia and China in the early Llandovery, the occurrence in the cephalopod limestones of Eastern Siberia, the ancestral forms of Bohemian type Bivalvia, representatives of Lunulacardiidae and Antipleuridae (BOGOLEPOVA & KŘIŽ, 1995, in press), genera of which have occurred later (Wenlock–Ludlow) in the northern part of Gondwana: Prague Basin, Bohemia (KŘIŽ, 1991, 1992); Carnic Alps, Austria (KŘIŽ, 1974, 1979; SCHÖNLAUB, 1992); Sardinia (KŘIŽ & SERPAGLI, 1994), Massif Armoricain, Montagne Noire and Massif Mouthoumet, France (KŘIŽ & PARIS, 1982; KŘIŽ, 1994). The similarities in graptolites, conodonts, chitinozoans, trilobites were a result of surface currents which provided the transportation and exchange of faunas between these different regions and were responsible for the distribution of the cephalopod limestone biofacies. These data are in agreement with the reconstructions of the Silurian surface circulation made by P. WILDE, W. BERRY & M.S. QUINBY-HUNT (1991).

6. Conclusions

1) Cephalopod limestone facies are known in the Lower Silurian of Eastern Siberia. In the section of the Mojero river they are represented by black bituminous limestones 30 cm thick with numerous cephalopods, conodonts and rare small brachiopods, gastropods, trilobites and bivalvia.
2) These deposits were formed under conditions of a shallow basin along its outer margins and near the bottom with decreased water circulation. Concentrations of cephalopods, coinciding with certain narrow belts of the basin, are a result of upwelling of nutritiously rich waters.
3) The age of cephalopod limestones from the Silurian section of the Mojero river is dated according to conodonts as the *D. kentuckyensis* Biozone.

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