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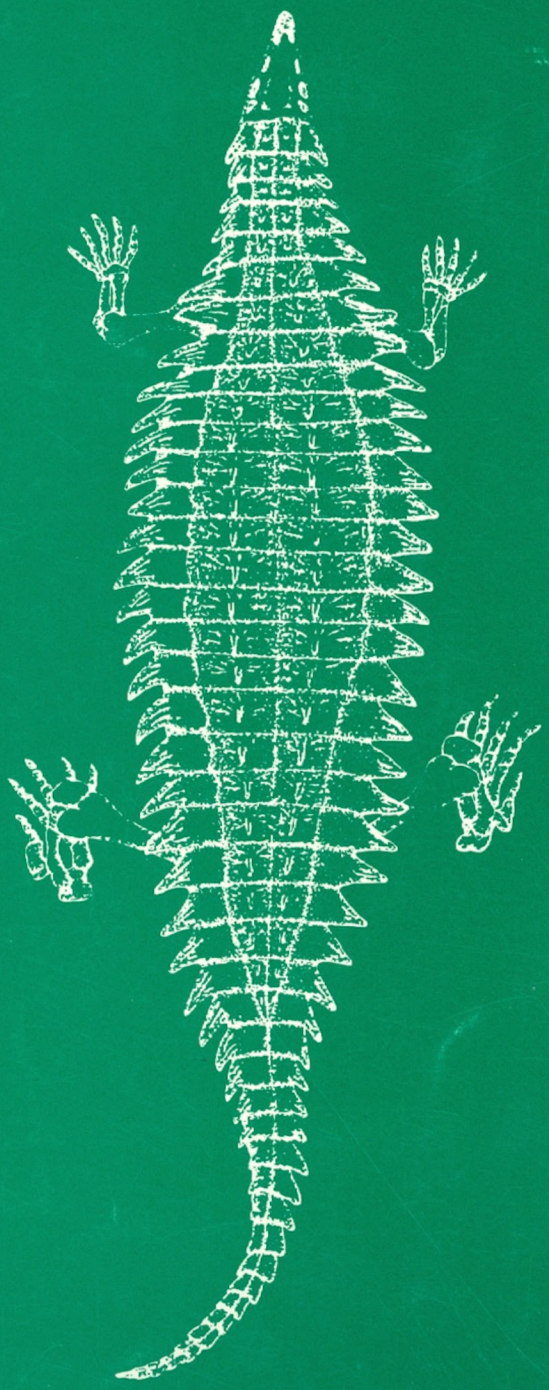

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Editor ALBERTIANA: Hans Kerp
WWU, Abt. Paläobotanik
Hindenburgplatz 57-59
W-48143 Münster, Germany
Fax: +49-251-834831
E-mail: kerp@uni-muenster.de

The primary aim of ALBERTIANA is to promote the interdisciplinary collaboration and understanding among the members of the I.U.G.S. Subcommission on Triassic Stratigraphy. Within this scope ALBERTIANA serves both as a newsletter for the announcement of general information and as a platform for discussion of developments in the field of Triassic stratigraphy. ALBERTIANA thus encourages the publication of announcements, literature reviews, progress reports, preliminary notes etc. - i.e. those contributions in which information is presented relevant to current interdisciplinary Triassic research.

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Cover: Longosuchus, *a typical Chinle group aetosaur. (from S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. & Sci., Bull. 3: G41)*

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PARASTRATOTYPE OF THE OLENEKIAN STAGE (LOWER TRIASSIC)

A. Dagys and E.S. Sobolev

Introduction

More than twenty stages and substages have been proposed for the Lower Triassic (Tozer, 1984) and, depending on different schemes, the Lower Triassic has been subdivided into one to four stages.

During the "Symposium on Triassic Stratigraphy", in Lausanne (October, 1991), this problem was discussed again, and at the official meeting of the "Subcommission on Triassic Stratigraphy" a twofold subdivision of the Lower Triassic into the Induan and the Olenekian as standard Stages, has been recommended.

The Olenekian Stage was introduced by Kiparisova and Popov (1956) with the stratotype near the mouth of the Olenek River (Mengilekh Creek) which contains the famous ammonoid faunas described by Keyserling (1845) and Mojsisovics (1886, 1888).

Later investigation have shown that in the stratotype of the Olenekian only two zones (*Spiniplicatus* Zone and *Grambergi* Zone) can be recognized (Lazurkin and Korchinskaya, 1963; Zakharov, 1978; Dagys et al., 1979).

The new zonal scheme of the Olenekian stage (Dagys and Ermakova, 1993) is based on investigations of several additional sections (parastratotypes or auxiliary stratotypes) located at the lower reaches of the Lena and Olenek Rivers, as well as in Eastern Taimyr.

The best parastratotype for the Upper Olenekian (Spathian) exists in Eastern Taimyr (Chernokhrebetnaya River Basin) at Divny Creek (text-fig. 1), situated close to the famous Triassic sections at Cape Tsvetkov. The sections at Divny Creek was briefly described by Dagys et al., (1989), and later reinvestigated by one of the authors (Sobolev, 1992). It contains in sequence almost all biostratigraphical units of the Upper Olenekian (except the oldest subzone). The sections at Ostantsovaya Creek, nearby the former one, are also very important, especially for the zonation of the terminal Olenekian and the definition of the Lower/Middle Triassic boundary of the Boreal Realm.

1. East Taimyr, Divny Creek, left tributary of the Chernokhrebetnaya River (10.5 km from mouth)

Total thickness of the section about 680 m.

1st unit: Dark-red sandstone alternating with greenish-grey siltstone.
Fauna:
Clypeoceratoides gantmanni (Popov), *Arctoceras blomstrandi* (Lindstr.).
30 m covered

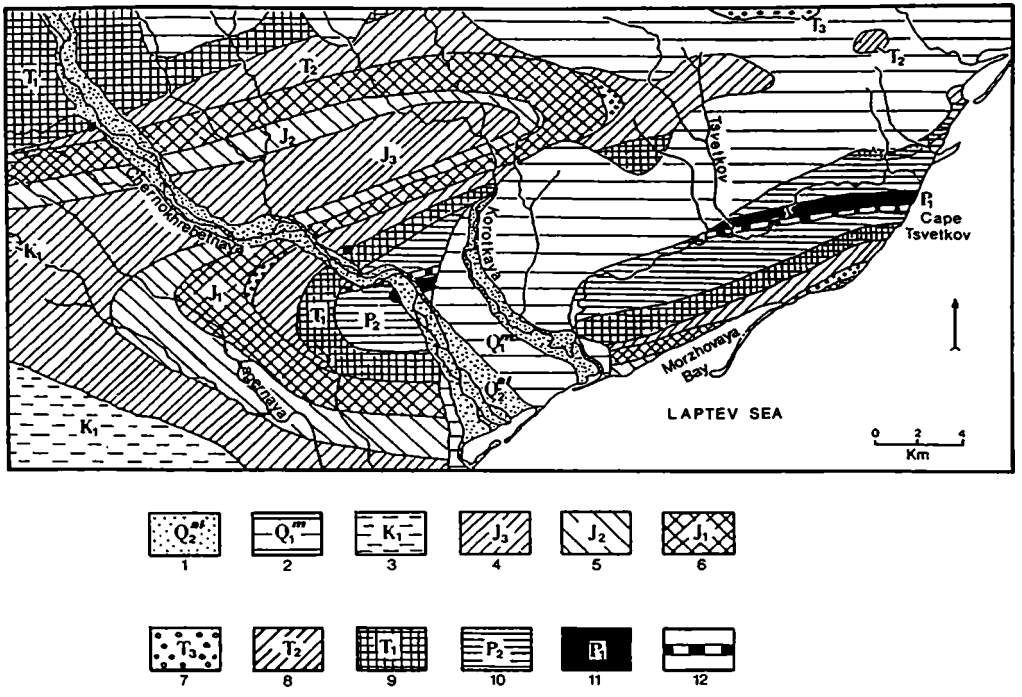

Fig. 1: 1 - Quarternary, alluvial deposits; 2 - Quarternary, morain; 3 - 11 Lower Cretaceous - Lower Permian deposits; 12 - Zones of tectonic crushing; 13 - Main Upper Olenekian sections.

Main sections

2nd unit, 20 m (fragmentary exposed): Mudstone, greenish-grey or dark-grey, with rare, small, clayish limestone concretions.

Fauna:

1 m from base of unit: *Boreoceras planorbis* Dagys & Ermakova.

20 m from base of unit: *Bajarunia* sp., *Boreoceras* cf. *planorbis*.

35 m covered

3rd unit, 20 m: Sandstone, fine-grained, light-grey, alternating with greenish-grey siltstone.

4th unit, 41 m (fragmentary exposed): Mudstone, dark-grey, with small calcareous nodules.

Fauna:

40 m from base of unit: *Bajarunia euomphala* (Keys.), *Boreoceras* cf. *demokidovi* (Popov)

35 m covered

5th unit, 23.6 m: Mudstone, dark-grey, with medium sized, clayish calcareous concretions (diameter 5-10 cm).

Fauna:

13 m-23 m from base of unit: *Bajarunia euomphala*, *Boreoceras demokidovi*, *Koninckitoides posterius* (Popov).

6th unit, 20 m (fragmentary exposed): Mudstone, dark-grey, with large calcareous concretions.
Fauna:
10 m-15 m from base of unit: *Pseudosageceras* sp., *Nordophiceras* ex. gr. *contrarium* (Popov), *Boreoceras* sp. juv. (cf. *lenaenses* Dagys & Konst.)

7th unit, 23.6 m: Mudstone, dark-grey, with frequent interlayers of small calcareous nodules.
Fauna:
0.1 m from base of unit *Praesibirites tuberculatus* (Dagys & Konst.), *Anoploceras taimyrense* Schastl., *Nordophiceras* n. sp., *Pseudosageceras* sp.
2.6 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* sp., *Anoploceras taimyrense*.
4.1 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp., *Phaedrysmocheilus evolutus* Sobolev, *Anoploceras taimyrense*.
5.0 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp.
7.5 m from base of unit: *Praesibirites tuberculatus, Anoploceras taimyrense*.
8 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* sp.
9 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp., *Pseudosageceras* sp.
9.5 m from base of unit: *Nordophiceras* n. sp., *Anoploceras taimyrense*.
10 m from base of unit: *Praesibirites tuberculatus, Anoploceras taimyrense*.
13.5 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp.,
18 m from base of unit: *Nordophiceras* sp.
21 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp., *Anoploceras taimyrense*.

8th unit, 8 m: Mudstone, reddish-brown, with frequent small calcareous nodules.
Fauna:
1.4 m from base of unit: *Praesibirites tuberculatus* (transitional to *Praesibirites egorovi* Dagys & Erm.), *Nordophiceras* n.sp.
2.6 m from base of unit: *Praesibirites egorovi*.
3.9 m from base of unit: *Praesibirites egorovi*.
4.1 m from base of unit: *Praesibirites* ex gr. *egorovi, Nordophiceras* n. sp., *Phaedrysmocheilus evolutus*.
5.7 m from base of unit: *Praesibirites egorovi* (transitional to *Parasibirites kolymensis* Bychk.)
6.0 m from base of unit: *Parasibirites kolymensis, Sibirites* aff. *elegans* Dagys & Erm.
6.2 m from base of unit: *Parasibirites kolymensis, Para.* sp.
6.4 m from base of unit: *Parasibirites kolymensis*.
7.4 m from base of unit: *Parasibirites kolymensis, P.* ex gr. *grambergi* (Popov), *P.* aff. *kolymensis*.

9th unit, 31.5 m: Mudstone, dark-grey, with frequent horizons of small calcareous nodules.
Fauna:
3.5 m from base of unit: *Parasibirites grambergi*.
6.0 m from base of unit: *Parasibirites grambergi, Para. mixtus* Popov, *Sibirites elegans*.
7.5 m from base of unit: *Parasibirites grambergi, Sibirites elegans*.
11.5 m from base of unit: *Parasibirites grambergi, Pseudosageceras* sp., *Arctomeekoceras* sp.
18.5 m from base of unit: *Parasibirites grambergi, P. mixtus, Nordophiceras kazakovi* Dagys & Erm., *Anoploceras* cf. *taimyrense*.
25.5 m from base of unit: *Parasibirites subpretiosus* Popov, *P.* aff. *grambergi, Subolenekites* aff. *pilaticus* (Tozer).
27.5 m from base of unit: *Parasibirites grambergi, P. subpretiosus, Sibirites elegans,*

Subolenekites aff. *pilaticus*, *Phaedrysmocheilus* ex gr. *evolutus* Sobolev.

29.5 m from base of unit: *Parasibirites grambergi*, *P. mixtus*, *Sibirites elegans*, *Pseudosageceras* sp., *Phaedrysmocheilus* ex gr. *evolutus* Sobolev.

10th unit, 4.4 m: Siltstone, sandy, dark-greenish-grey, with large flattened calcareous concretions.

Fauna:

3.5 m from base of unit: *Parasibirites grambergi*.

11th unit, 17.5 m: Siltstone, clayish, greenish-grey, with numerous small calcareous nodules.

Fauna:

6.5 m from base of unit: *Parasibirites grambergi*, *Sibirites elegans*, *Nordophiceras kazakovi*.

11.5 m from base of unit: *Parasibirites grambergi*, *Subolenekites* aff. *pilaticus*.

16.5 m from base of unit: *Parasibirites grambergi*, *Subolenekites* sp.

12th unit, 3.9 m: Siltstone, clayish, greenish-grey, with large, flattened calcareous concretions.

Fauna:

3.3 m from base of unit: *Phaedrysmocheilus* ex gr. *evolutus* Sobolev.

3.8 m from base of unit: *Parasibirites grambergi*.

13th unit, 17.2 m: Siltstone, greenish-grey, with small (diameter 1-3 cm) and medium-sized (diameter 10-15 cm) calcareous concretions.

Fauna:

9.2 from base of unit: *Parasibirites grambergi*, *Subolenekites* cf. *altus* (Mojs.).

14th unit, 5 m: Siltstone, greenish-grey, with rare small calcareous nodules and large flattened concretions.

Fauna:

2.5 m from base of unit: *Boreomeekoceras keyserlingi* (Mojs.), *Phaedrysmocheilus* ex. gr. *nestori* Schim.

15th unit, 22.4 m: Siltstone, sandy, greenish-grey, with rare small calcareous nodules.

16th unit, 50 m: Siltstone, sandy, greenish-grey, with layers of large flattened calcareous concretions.

Fauna:

7.5 m from base of unit: *Phaedrysmocheilus* ex gr. *nestori* Schim.

9.6 m from base of unit: *Phaedrysmocheilus nestori*.

49 m from base of unit: *Parasibirites efimovae* Bychk.

17th unit, 13 m: Siltstone, sandy, greenish-grey, with flattened calcareous concretions,

Fauna:

1.0 m from base of unit: *Sibirites pretiosus* (Mojs.), *Olenekoceras laevigatum* Dagys & Erm., *Boreomeekoceras keyserlingi*.

18th unit, 28 m: Siltstone, dark grey, with rare small calcareous nodules and layers of large flattened calcareous concretions.

Fauna:

10.3 m from base of unit: *Olenekoceras laevigatum*.

12.8 m from base of unit: *Olenekoceras* cf. *laevigatum*.

14.8 m from base of unit: *Parasibirites efimovae*, *Sibirites pretiosus*, *Boreomeekoceras keyserlingi*.

18.5 m from base of unit: *Sibirites pretiosus*, *Subolenekites altus*, *Boreomeekoceras keyserlingi*.

19.0 m from base of unit: *Parasibirites efimovae*, *Sibirites pretiosus*, *Subolenekites altus*, *Boreomeekoceras keyserlingi*.

19.3 m from base of unit: *Sibirites eichwaldi* (Keys.), *Subolenekites altus*, *Boreomeekoceras keyserlingi*.
19.8 m from base of unit: *Nordophiceras karpinskii* (Mojs.).

19th unit, 28 m: Sandstone, fine-grained, dark-red, alternating with dark-greenish-grey, siltstone, with rare flattened calcareous concretions.

Fauna:
0.1 m from base of unit: *Olenekites altus*, *Boreomeekoceras keyserlingi*.
1.0 m from base of unit: *Olenekoceras middendorffi* (Mojs.), *O. nikitini*, *Arctomeekoceras rotundatum* (Mojs.).
2.0 m from base of unit: *Sibirites eichwaldi*, *Olenekoceras middendorffi*, *Subolenekites altus*, *Boreomeekoceras keyserlingi*, *Arctomeekoceras* sp.
3.0 m from base of unit: *Subolenekites altus*, *Boreomeekoceras keyserlingi*.
8.4 m from base of unit: *Olenekoceras middendorffi*, *Boreomeekoceras keyserlingi*, *Phaedrysmocheilus subaratus* (Keys.).
18.8 m from base of unit: *Olenekoceras middendorffi*.

20th unit, 240 m: Sandstone, fine-grained, dark-red or reddish-green, interbedded with thin layers of greenish-grey siltstone. About in the middle of the unit 25 m medium- to coarse-grained, dark-grey sandstones.

21st unit, 50 m: Mudstone, dark-grey, with rare small calcareous nodules.

Fauna:
upper 10 m: *Svalbardiceras spitzbergense* (Freb)., *Svalbardiceras* sp., *Prosphingites czekanowskii*, *Prosphingites tenuis*, *Nordophiceras* sp., *Keyerlingites* (?) sp.

22nd unit 10 m: Siltstone, dark-greenish-grey, with large calcareous concretions and thin interbeds of phosphatic nodules.

Fauna:
5.0 m from base of unit: *Costispiriferina lenaensis* Dagys.
8.0 m from base of unit: *Karangatites* sp.

2. East Taimyr, mouth of Ostantsovaya Creek, right tributary of Chernokhrebetnaya River
(23 km from mouth)

Total thickness of section: about 178 m

1st unit, 27 m: Siltstone, dark-grey, alternating with fine-grained sandstone.

Fauna:
10 m from base of unit: *Olenekoceras middendorffi*, *Boreomeekoceras keyserlingi*, *Subolenekites* sp., *Sibirites eichwaldi*.

2nd unit, 8 m: Siltstone, greenish-grey.

Fauna:
5 m from base of unit: *Boreomeekoceras keyserlingi*, *Subolenekites* sp.

3rd unit, 20 m: Sandstone, fine-grained, grey, interbedded with greenish-grey siltstone.

4th unit, 5 m: Siltstone, greenish-grey.

5th unit, 10 m: Sandstone, fine- and medium-grained, gray.

Fauna:
8 m from base of unit: *Olenikites spiniplicatus* (Mojs.), *Olenekoceras middendorffi*, *Boreomeekoceras keyserlingi*.

6th unit, 18 m: Sandstone, medium-grained, dark-gray or dark-green, interbedded with greenish-gray siltstone.

7th unit, 36 m: Siltstone, dark-greenish-gray, with calcareous concretion, with interbeds of fine-grained, greenish-gray sandstone (at about the middle of the unit).

Fauna:

3-8 m from base of unit: *Olenikites spiniplicatus, Olenekoceras middendorffi, Pseudosvalbardiceras sibiricum* (Mojs.), *Prosphingites czekanowskii.*

20-30 m from base of unit: *Olenikites spiniplicatus, Olenekoceras nikitini* (Mojs.), *Keyserlingites subrobustus* (Mojs.), *Subolenekites altus, Pseudosvalbardiceras sibiricum, Prosphingites czekanowskii, Propsphingites tenuis, Phaedrysmocheilus* n.sp.

8th unit, 10 m: Siltstone, dark-greenish-gray.

Fauna:

8.5 m from base of unit: *Svalbardiceras* cf. *spitzbergense, Keyserlingites* sp., *Prosphingites* sp.

9th unit, 8.5 m: Sandstone, dark-greenish-gray, with scattered small pebbles (diameter 1-3 cm).

Fauna:

8.0 m from base of unit: *Karangatites arkhipovi* Dagys & Erm., *Stenopopanoceras karangatiense* (Popov), *Arctonautilus ljubovae* (Schastl.), *Costispiriferina lenaense*.

10th unit, 15 m: Mudstone, greenish-gray, with interlayers of phosphatic lenses (0,1-0,3 m) and nodules.

Fauna:

11.7 m from base of unit: *Karangatites* sp.

12.0 m from base of unit: *Karangatites* aff. *arkhipovi, K.* sp.

Zonation

Section I (Divny Creek) contains almost all Upper Olenekian zones and subzones described by Dagys and Ermakova (1993). The underlying beds belong to the *Kolymensis* Zone of the Lower Olenekian (Unit 1).

Analogues to the *Tardus* Zone (uppermost Lower Olenekian) and the lower part (*Eiekitensis* Subzone) of the *Euomphala* Zone (lowermost Upper Olenekian) are unknown so far in the Chernokhrebetnaya River region, perhaps due to the partly coverage of the sections.

The ammonoid assemblage from Unit 2 - 5 is characteristic for the *Euomphala* Zone.

Unit 2 contains the index fossil for the *Planorbis* Subzone; Unit 3 - 5, with *Bajarunia euomphala* and *Boreoceras* ex. gr. *demokidovi* indicate the *Apostolicum* Subzone.

The small fauna of the badly exposed Unit 6 (*Nordophiceras* cf. *contrarium, Boreoceras* ex gr. *lenaense*) indicates most probably the *Lenaense* Subzone (lowest subdivision of the *Contrarium* Zone); its base coincides with the first appearance of the genus *Nordophiceras*.

The twelve succeeding calcareous nodule-layers from Unit 7 contains a uniform ammonoid fauna (*Nordophiceras taimyrensis, Praesibirites tuberculatus*), characteristic for the

Tuberculatus Subzone (*Contrarium* Zone). The base of this subzone is characterized by the first appearance of the genus *Praesibirites*.

Unit 8 embraces two distinct successive ammonoid assemblages. While the fauna of the lower part (*Nordophiceras* sp., *Praesibirites egorovi*) is indicating the *Egorovi* Subzone of the *Contra-*

rium Zone, the upper one clearly belongs to the *Grambergi* Zone (*Kolymensis* Subzone) as shown by the first appearance of the genus *Parasibirites* (*P. kolymensis*) and *Sibirites* (*S. elegans*).

The ammonoid fauna from Unit 9 - 13 is characterized by a quite uniform assemblage dominated by *Parasibirites* ex gr. *grambergi* (*P. grambergi, P. mixtus, P. subpretiosus*), indicating the *Mixtus* Subzone of the *Grambergi* Zone.

Unit 14 - 18 (lower 19 m) with *Parasibirites efimovae, Sibirites pretiosus* and *Olenekoceras laevigatum* can be attributed to the *Efimovae* Subzone (*Grambergi* Zone).

The ammonoid fauna of the upper part of Unit 18 and Unit 19 (*Olenekoceras middendorffi, Subolenekites altus, Boreomeekoceras keyserlingi, Sibirites eichwaldi*) is characteristic for the lower part of the *Spiniplicatus* Zone.

While Unit 20 is without any fossils, the terminal Unit 21 of this section contains an ammonoid assemblage unknown until now from Siberia, in which species of the genera *Svalbardiceras* and *Prosphingites* are dominating.

In section II (mouth of Ostantsovaya Creek) the upper part of the Olenekian is more fossiliferous. In this section the ammonoid faunas of the uppermost biostratigraphical Olenekian unit of Siberia - the *Spiniplicatus* Zone - allows a threefold subdivision. For this reason a new subzonal scheme is proposed here for the terminal Olenekian.

Olenikites spiniplicatus Zone

Index species: *Dinarites spiniplicatus* Mojsisovics, 1886 (p.10, pl.1, fig.1; Arctic Siberia, Olenek River).

Fauna: The ammonoid assemblage of this zone is the most diverse and richest of the Olenekian Stage. It contains the following genera: *Nordophiceras, Pseudosvalbardiceras, Arctomeekoceras, Boreomeekoceras, Svalbardiceras, Timoceras, Olenikites, Subolenekites, Olenekoceras, Keyserlingites, Prosphingites* and *Pseudosageceras*.

Lower boundary: First appearance of the genera *Olenekites, Timoceras, Pseudosvalbardiceras, Arctomeekoceras*, and some very characteristic species such as *Olenekoceras middendoffi, Sibirites eichwaldi, Nordophiceras karpinskii* etc.

Subdivision: Three subzones: *Sibirites eichwaldi - Prosphingites czekanowskii - Svalbardiceras spitzbergense*.

Sibirites eichwaldi Subzone

Index species: *Ceratites eichwaldi* Keyserling, 1845 (p.249, p.3, fig. 11-14); Olenek River, Arctic Siberia.

Stratum typicum: Unit 1 - 6, Ostantsovaya Creek, East Taimyr.

Fauna: Most characteristic ammonoids are species of the genera *Olenekoceras* (*O. middendorffi, O. nikitini*), *Nordophiceras* (*N. karpinskii, N. schmidti*), *Sibirites* (*S. eichwaldi*), *Pseudosvalbardiceras* (*P. sibiricum*), and moreover some species which first appeared in the *Efimovae* Subzone of the *Grambergi* Zone: *Boreomeekoceras keyserlingi, Subolenekites altus*.

Lower boundary: Coincides with the lower boundary of the *Spiniplicatus* Zone.

Prosphingites czekanowskii Subzone

Index species: *Prosphingites czekanowskii* Mojsisovics, 1886 (p.64, pl.15, figs. 10 -12), Olenek River, Arctic Siberia.
Stratum typicum: Unit 7, Ostantsovaya Creek, East Taimyr.
Fauna: The ammonoid assemblage is similar to that of the *Eichwaldi* Subzone. It differs from it by the appearance of *Prosphingites czekanowskii*, *Prosphingites tenuis*, and *Keyserlingites subrobustus*.
Lower boundary: First appearance of the genera *Prosphingites* and *Keyserlingites*.

Svalbardiceras spitzbergense Subzone

Index species: *Lecanites ? spitzbergensis* Freboild, 1929 (pl.VI, fig.1), Svalbard.
Stratum typicum: Unit 8, Ostantsovaya Creek, East Taimyr.
Fauna: Characteristic for this subzone are species of the genera *Svalbardiceras* and *Prosphingites*; in addition the genera *Nordophiceras* and *Keyserlingites* are recorded. The ammonoid assemblage of this subzone needs further investigations.
Lower boundary: First appearance of the genus *Svalbardiceras*.

NE Asia (Siberia)		Arctic Canada	British Columbia	Svalbard
Olenikites spiniplicatus	*Svalbardiceras spitzbergense*	*Keyserlingites subrobustus*	*Keyserlingites subrobustus*	*Keyserlingites subrobustus*
	Prosphingites czekanowskii			
	Sibirites eichwaldi			
Parasibirites grambergi	*Parasibirites efimovae*			
	Parasibirites mixtus			
	Parasibirites kolymensis	*Subolenekites pilaticus*		
Nordophiceras contrarium	*Parasibirites egorovi*			
	Parasibirites tuberculatus			
	Boreoceras leneense			
Bajarunia eumorphala	*Boreoceras apostolicum*			
	Boreoceras planorbis			
	Bajarunia siekitensis			

Table 1: Biostratigraphic correlation chart of Boreal Upper Olenekian zonal scheme.
The *Subrobustus* Zone of the Canadian Arctic and Svalbard containing the genera *Svalbardiceras*, *Keyserlingites* etc. are correlative only with the upper part of the *Spiniplicatus* Zone (*Czekanowskii* and *Spitsbergense* Subzones).

The two lower subzones of the *Spiniplicatus* Zone are widely distributed in North-East Asia, from Eastern Taimyr up to the Okhotsk Sea (Dagys et al., 1979), but usually they have not been subdivided. Analogues of the upper subzone has been recorded, apart from Eastern Taimyr, only from the Lena River delta. In this regions ammonoid assemblages characteristic for the *Eichwaldi* and *Czekanowskii* Subzones are known from the upper part of the Ystannakh Formation (Dagys and Kazakov, 1984). From the overlaying Pastakh Formation some rare specimens of *Svalbardiceras* sp. have been collected, most probably indicating the *Spitsbergense* Subzone.

Correlation

The detailed correlation of the boreal Upper Olenekian has been discussed in some previous publications (Dagys and Ermakova, 1993; Dagys and Weitschat (1993).

The *Euomphala* and *Contrarium* Zones are known until now only from the eastern parts of the Boreal basin, and the absence of reliable analogues in the western areas is one of the most discussed biostratigraphical problems of the Boreal Triassic.

First Late Olenekian ammonoids have appeared in western boreal regions only in the *Grambergi* Zone. The Arctic Canadian *Pilaticus* Zone (Tozer, 1967) may be correlated with the Siberian *Kolymensis* Subzone of the *Grambergi* Zone, because in Siberia the distribution of *Subolenekites pilaticus* is restricted to this subzone only (Table 1).

Analogues of the *Mixtus* and *Efimovae* Subzones (*Grambergi* Zone) and of the *Eichwaldi* Subzone (*Spiniplicatus* Zone) are unknown until now in western parts of the boreal Triassic basin.

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Comments, reactions or contributions to ALBERTIANA?
Send it to the editor!
Hans Kerp, WWU - Abt. Palãobotanik
Hindenburgplatz 57-59, W-48143 Münster, Germany
Tel: +49-251-833966; Fax: +49-251-834831
E-mail: kerp@uni-muenster.de