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ON THE CORRELATION OF THE TREMADOCIAN AND ARENIGIAN BOUNDARY BEDS IN THE EAST BALTIC

In the East Baltic as over the vast area of the East-European Platform the Tremadocian/Arenigian boundary is connected with the rocks rich in glauconite. There have been different suggestions to define the boundary — the base or top or somewhere inside glauconitic beds. The present paper deals with the outcrop sections of the boundary beds in the North-Estonia—Ladoga clint area, for comparison we have used the Serebryaniki core from the Moscow district and the Stora Backor section from Sweden (according to Lindström, 1954, 1971*a* and Tjernvik, 1956) (Figs 1, 2).

Fig. 2 shows a general lithology of the boundary beds in these sections — the Scandinavian and Moscow district ones are represented by deeper water facies, the East Baltic ones by shallower shelf deposits which are less clayey in composition and there occur less frequently graptolites and partly trilobites most often used earlier for correlation. Our study is based mainly on conodonts.

The sequence of the main stratigraphic units made use in the paper is as follows (from top):

Regional stages	Formations	Members
Volkhov	Toila	Saka
		Päite
Latorp	Leetse	Mäeküla
		Joa
		Klooga
Varangu	Varangu	
	Türisalu (part)	

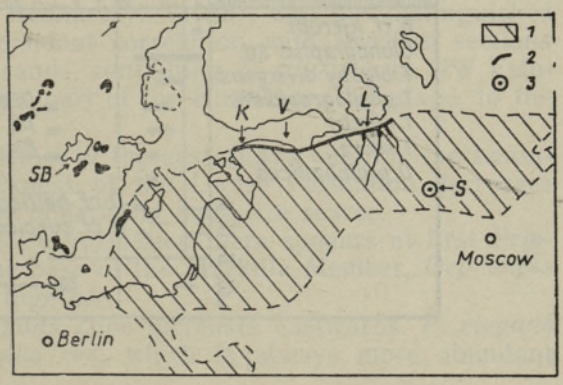

Fig. 1. Map showing location of the sections, given in Fig. 2. (SB — Stora Backor, K — Keila-Joa, V — Varangu, L — Lava, S — Serebryaniki). 1 — area of the Tremadocian and Arenigian epicontinental deposits; 2 — outcrop areas; 3 — boring.

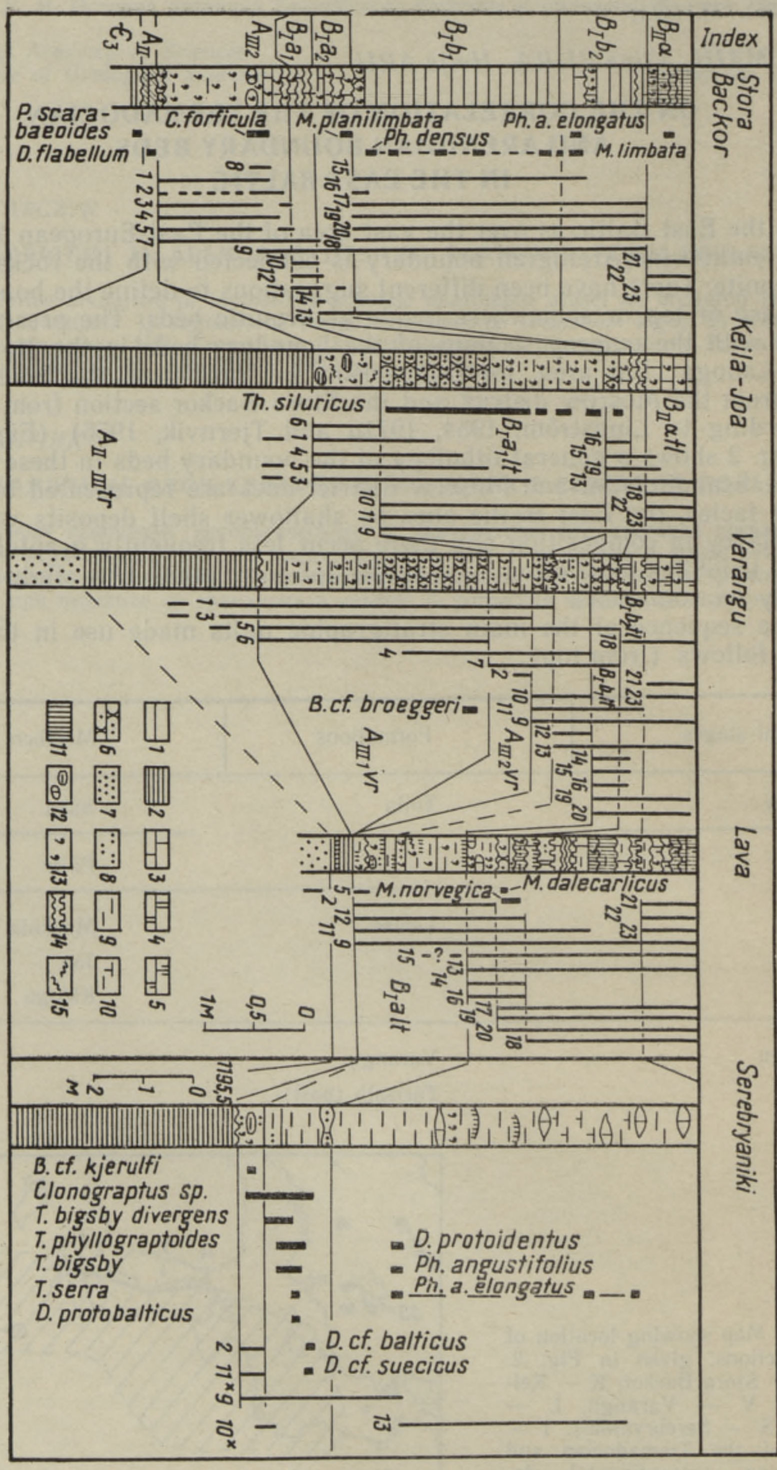
Index
Stora Backor
Keila-Joa
Varangu
Lava
Serebryaniki
P. scarabaeoides
D. flabellum
C. forficula
M. planilimbata
Ph. densus
Ph. a. elongatus
M. limbata
Th. siluricus
B. cf. broeggeri
M. norvegica
M. dalecarlicus
B. cf. kjerulfi
Clonograptus sp.
T. bigsby divergens
T. phyllograptoides
T. bigsby
T. serra
D. protobalticus
D. protoidentus
Ph. angustifolius
Ph. a. elongatus
D. cf. balticus
D. cf. suecicus

Fig. 2. Investigated sections and correlation of the Tremadocian/Arenigian boundary deposits.

Lithological legend: *1* — greenish grey argillites (shales); *2* — dark brown kerogenic argillites ("Dictyonema Shales"); *3* — limestones; *4* — dolomites; *5* — dolomitic limestones; *6* — aleurolites (above) and sandstones (below); *7* — sands; *8* — aleurites; *9* — clays; *10* — marls; *11* — red coloured beds; *12* — pebbles; *13* — glauconite; *14* — discontinuity surfaces; *15* — burrows.

Conodonts: 1 — *Cordylodus prion* Lindstr.; 2 — *Paroistodus numarcuatus* (Lindstr.); 3 — *Cordylodus rotundatus* Pand., 4 — *Drepanoistodus acuminatus* (Pand.); 5 — *Cordylodus angulatus* Pand; 6 — *Drepanoistodus deltifer pristinus* (Viira); 7 — *D. d. deltifer* (Lindstr.); 8 — *Pravognathus aengensis* Lindstr.; 9 — *Drepanodus arcuatus* Pand.; 10 — *Paroistodus proteus* (Lindstr.); 10* — *P.* aff. *proteus*; 11 — *Acodus deltatus* Lindstr.; 11* — *A.* aff. *deltatus* (older form); 12 — *Drepanoistodus inconstans* (Lindstr.); 13 — *Drepanoistodus forceps* (Lindstr.); 14 — *Prioniodus elegans* Pand.; 15 — *Oistodus lanceolatus* Pand.; 16 — *Oepikodus evae* (Lindstr.); 17 — *Stolodus stola* (Lindstr.); 18 — *Protopanderodus rectus* (Lindstr.); 19 — *Scolopodus rex* Lindstr.; 20 — *Periodon flabellum* (Lindstr.); 21 — *Baltonidus triangularis* (Lindstr.); 22 — *Baltoniodus navis* (Lindstr.); 23 — *Microzarkodina flabellum* (Lindstr.).

Indexes of the regional units: Э $_3$ — Upper Cambrian; A_{II} — Pakerort Regional Stage; A_{III1} — lower part of Varangu Stage with *Drepanoistodus deltifer pristinus* Zone; A_{III2} — upper part of Varangu Stage with *D. d. deltatus* Zone; B_Ia_1 — lower part of Hunneberg Substage with *Paroistodus proteus* Zone; B_Ia_2 — upper part of Hunneberg Substage with *Prioniodus elegans* Zone; B_Ib_1 — lower part of Billingen Substage with *Oepikodus evae* Zone; B_Ib_2 — upper part of Billingen Substage with *Periodon flabellum* and *Oistodus lanceolatus;* $B_{II}\alpha$ — lower Substage of the Volkhov Stage. A_{II-III}tr — Türisalu Formation; A_{III}vr — Varangu Formation; B_Ia lt — Leetse Formation; B_Ib_1 lt — upper part of the Leetse Formation (Mäeküla Member); $B_Ib_2$tl — lower part of the Toila Formation (Päite Member); $B_{II}\alpha$ tl — lower part of the Toila Formation in Volkhov Stage (Saka Member).

The lowermost part of the terrigenous glauconite beds studied belongs to the Varangu Formation. This is represented by grey clays with glauconitic interbeds and late Tremadocian graptolites *Bryograptus* and *Clonograptus* (Кальо, Кивимяги, 1974). According to conodonts there was established the *Drepanoistodus deltifer* Zone which may be subdivided into two subzones as follows (from bottom): *D. deltifer pristinus* and *D. deltifer deltifer* (Вийра et al., 1970; Szaniawski, 1980).

Higher in the East Baltic sections there follows a more sandy and silty glauconitic Leetse Formation, the major part of which corresponds to the *Paroistodus proteus* Zone. There occur also *Paltodus inconstans* and *Acodus deltatus* (Fig. 2), treated as belonging to the Arenigian. The lower part of the Formation (Klooga Member), especially in NW Estonia, contains some conodonts (*Cordylodus angulatus*, *D. d. deltifer*, etc.) ranging from the underlying beds.

There occur also *Thysanotos siluricus* (Eichwald) considered as a classical Upper Tremadocian species. It seems, however, that Polish and Czechoslovakian specimens of the species differ from the Estonian ones. This was noted already by W. Bednarczyk (1988), who has distinguished *T. siluricus* sensu lato. The conodont correlation with Swedish sections shows that glauconitic clayey sands, containing *T. siluricus* in NW Estonia, correspond to the lowermost part of the Hunneberg Substage, to the *Megistaspis armata* Zone.

P. proteus Zone is more distinct in the east (Lava outcrop, the Leningrad District), where the thickness of the Leetse Formation decreases and the forms, coming from the underlying beds, are scarce.

In the upper part of the Leetse Formation there appears at first *Prioniodus elegans* and then, at the base of the Mäeküla Member, *Oepikodus evae* and *Oistodus lanceolatus* together.

The thickness of the *P. elegans* Zone increases eastwards. *P. elegans* occurs together with *Scolopodus rex*, which is always more abundant than the zonal form.

Generally, the *P. elegans* Zone corresponds to the *D. balticus* graptolite Zone which represents the boundary interval between the Hunneberg and Billingen Substages (Bergström, 1968; Lindström, 1971*b*; Jaanusson, 1982). We consider it most convenient to define the base of the Billingen Substage at the base of the *O. evae* Zone proceeding from the changes in fauna and a gap at this level.

At the base and the upper boundary of the beds with *P. elegans* we can find pebbles (Mäekalda section in Tallinn). In the outcrop area, at the level of the appearance of *P. elegans* and especially at the level of *O. evae*, the section becomes noticeably more carbonate.

In the Mäekalda Member the *O. evae* Zone (thickness predominantly less than 0.5 m) is widely distributed. At this level articulate brachiopods, crinoids, ostracodes, and especially trilobites appear. From the Mäeküla Member the following trilobites have been identified: *Megalaspides dalecarlicus*, *M. paliformis*, *M. norvegica*, characterizing Billingen Substage, but also the early representatives of *Encrinuroides*, *Cybele*, *Krattaspis*, *Pliomera*, *Remopleurides* (?), *Panderia*.

Conodont species of the Billingen Substage *O. lanceolatus* and *Periodon flabellum* range from the Mäeküla Member to the abovelying limestones and dolomites of the Päite Member of the succeeding Toila Formation.

The lower boundary of the Volkhov Stage is marked by the appearance of *Microzarkodina flabellum*, *Baltoniodus triangularis* and *B. navis* in the following Saka Member of the Toila Formation.

The Tremadocian/Arenigian boundary beds in the Baltic—Ladoga clint area forms a glauconite-containing sedimentary cycle starting with clays of the Varangu Formation (Upper Tremadocian), turns then into clayey silts and sands in Lower Arenigian and more sandy Leetse Formation in the Middle Arenigian. All over the East Baltic area facies conditions were more or less similar, but, due to gaps, the sequences of the lithostratigraphic units are different. Most complete sections are as follows (Fig. 2): Varangu Formation in middle North-Estonia, Hunnebergian part of the Leetse Formation in NW Estonia, Billingenian part of that formation and of the base of the Toila Formation in NE Estonia and the Leningrad District.

The greatest changes in the facies fauna of the studied sections took place: 1. at the base of the Varangu Formation (base of the *D. deltifer pristinus* Zone), 2. at the base of the Mäeküla Member (upper part of the Leetse Formation, base of the *O. evae* Zone). The latter marks the beginning of the Ordovician and Silurian long-term carbonate sedimentation in the East Baltic.

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BALTIKUMI TREMADOCI JA ARENIGI PIIRIKIHTIDE KORRELATSIOONIST

On iseloomustatud Tremadoci ja Arenigi piirikihte Põhja-Baltikumi avamusala tugiläbilõigetes, kus nad on seotud Varangu ja Leetse kihistute terrigeen-glaukoniitsete setetega. Konodontide ja ka graptoliitide leviku põhjal on neid korreleeritud Stora Backori tugiläbilõikega (Skandinaavia) ja Serebrjaniki puursüdamikuga (Moskva sünekliisi lõunaosa).

Сильви МЯГИ, Вийве ВИЙРА, Хелье АРУ

О КОРРЕЛЯЦИИ ПОГРАНИЧНЫХ ОТЛОЖЕНИЙ ТРЕМАДОКА И АРЕНИГА ПРИБАЛТИКИ

Пограничные отложения тремадока и аренига в районе выхода вдоль Эстонско-Ладожского глинта связаны с терригенно-глауконитовыми отложениями варангуской и леэтсеской свит на границе вендо-кембрийского терригенного и ордовикско-силурийского карбонатного комплексов пород. По распределению конодонтов, а также граптолитов проводится их корреляция с более терригенным опорным разрезом Стура Бакор в Скандинавии и с разрезом скв. Серебряники в южной части Московской синеклизы (рис. 1, 2). Дается первоначальный список трилобитов, появляющихся в базальных слоях карбонатных отложений, связанных с конодонтовыми зонами *Prioniodus elegans* и *Oepikodus evae*.