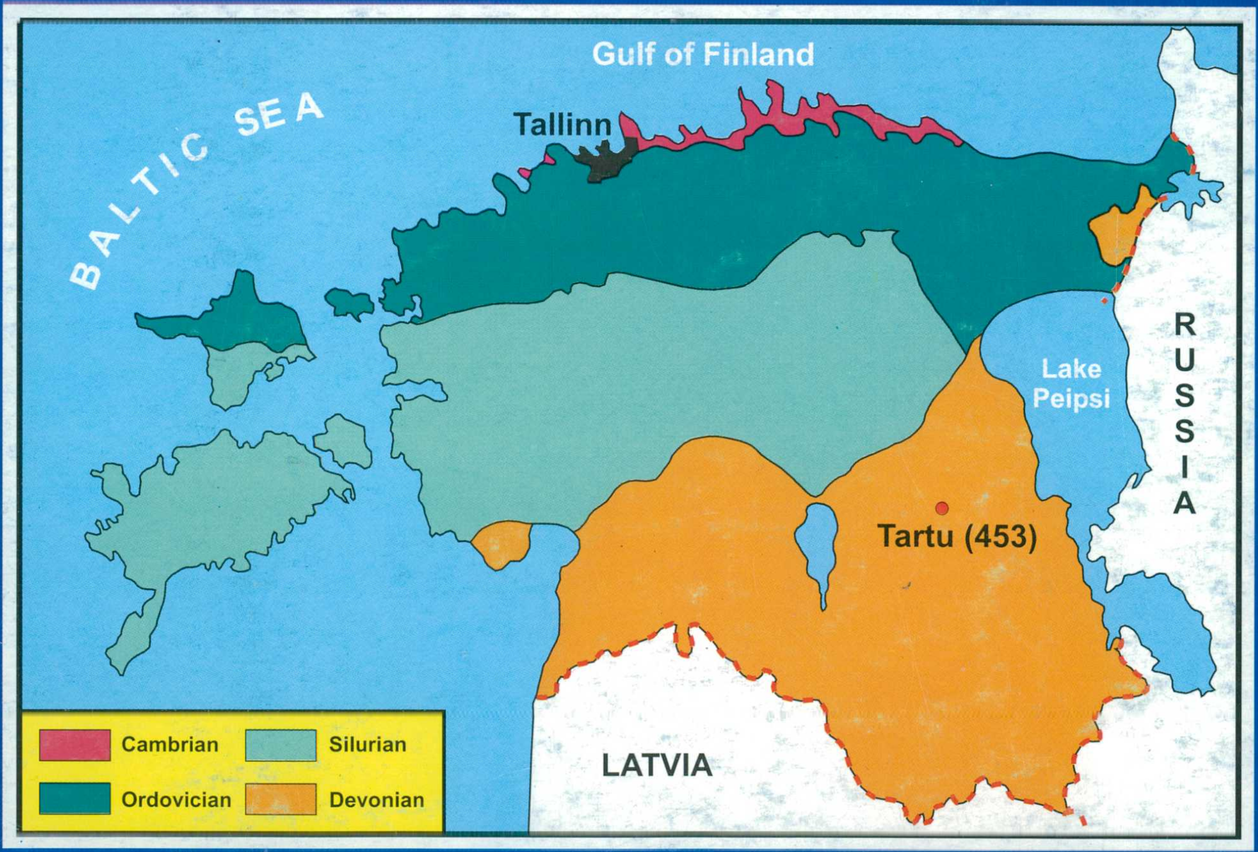
EESTI GEOLOOGIAKESKUS
GEOLOGICAL SURVEY OF ESTONIA

ESTONIAN GEOLOGICAL SECTIONS

BULLETIN 1

TARTU (453) DRILLCORE



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CONTENTS

PREFACE

During the last 20 - 30 years, in the course of geological studies connected with the mapping and prospecting for mineral resources and groundwater supplies, hundreds of cores have been drilled on Estonian territory. However, the high-quality material obtained has been examined in greatly variable thoroughness depending upon the particular geological task. The drillcores still available provide a unique opportunity for detailed study of the Lower Palaeozoic sequence in Estonia. To evaluate the core material, comprehensive study of the key sections was initiated by the Geological Survey of Estonia.

The selected cores will be described in detail. The lithological description will be supplemented with photos of some, lithologically most characteristic intervals of the drillcores (so-called photo-log). For the stratigraphically most crucial intervals additional micropalaeontological and lithological studies will be carried out.

The present issue is the first in a series of monographic reports on the most important Palaeozoic sections in Estonia.

INTRODUCTION

The 431 m deep Tartu (453) borehole was drilled near the southern border of Tartu (not far from the railway station of Variku; Fig.1) in 1992 in the course of studying the groundwater supplies of the town. The borehole penetrates almost the whole cover of sedimentary rocks in the region. The sequence from the Cambrian up to the Middle Devonian strata is represented in the core (Fig. 2). The Devonian beds are overlain by about 14 m thick Quaternary sediments.

The information presented below is a result of cooperative studies of many specialists from several institutions. The description of the Cambrian strata is based on unpublished data of Ain Põldvere. Tõnis Saadre described the lower part of the Ordovician (from its lower boundary up to the Kukruse Stage) and Anne Põldvere the strata above, up to the Devonian. Tõnis Saadre also took the photos of the core. Anne Kleesment provided the lithology of the Devonian strata (description, mineralogical and grain-size analyses), Juozas Valiukevičius identified acanthodians, Tõnu Meidla ostracodes, Garmen Bauert and Heikki Bauert chitinozoans, Svend Stouge

Figure 1. Location of the studied cores

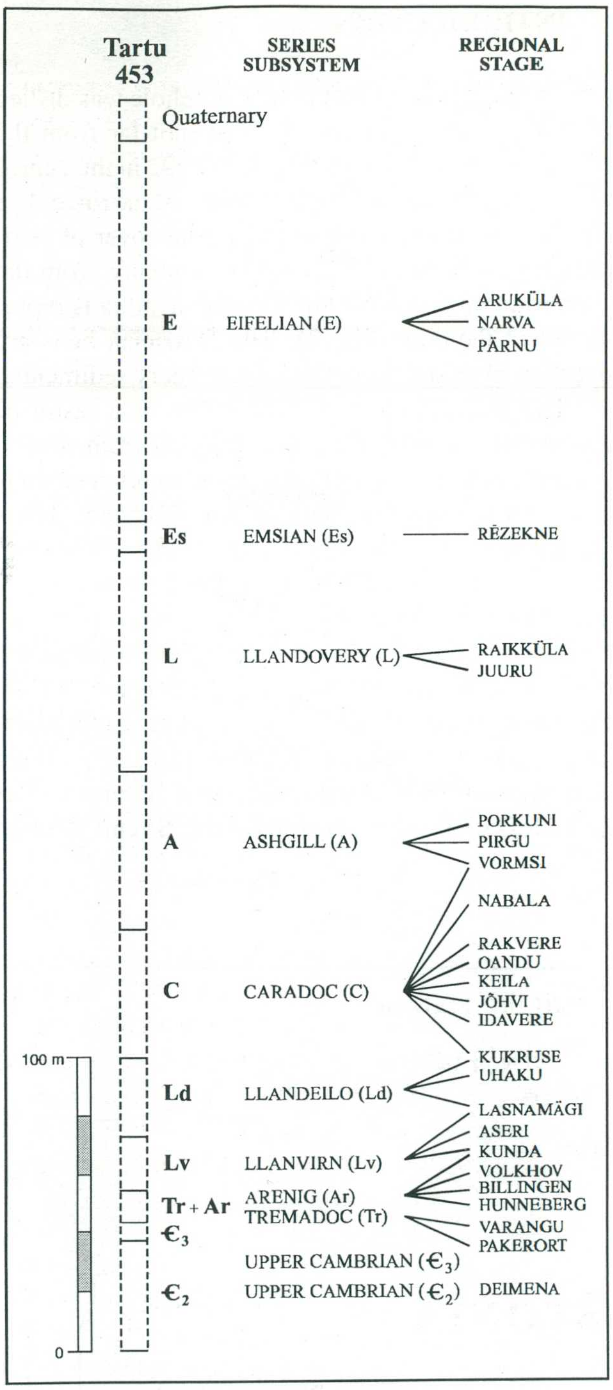

Figure 2. Generalized stratigraphy of the Tartu (453) core

conodonts and Ivo Paalits acritarchs.

The core is a property of the Geological Survey of Estonia. Currently it is housed at the Institute of Geology, University of Tartu. The manuscript of this paper is stored at the Depository of Manuscript Reports (Geological Fund) of the Geological Survey of Estonia.

Acknowledgements. The authors are grateful to Asta Oraspõld and Rein Einasto (Institute of Geology at Tallinn Technical University) for valuable comments and discussions about the stratigraphy and relevant terminology. Jaak Nõlvak (Institute of Geology at Tallinn Technical University) helped with the interpretation of the distribution of chitinozoans. Heikki Bauert prepared the layout and Ene Pärn provided technical assistance. Anne Noor and Saima Peetermann corrected the English text. Particular thanks are addressed to all colleagues who kindly helped us at several stages of work.

GENERAL GEOLOGICAL SETTING

In general outline, the bedrock succession in Estonia can be divided into three parts (in ascending order): the mainly terrigenous part of Vendian - Tremadoc age, the Ordovician - Silurian carbonate strata and the Devonian, predominantly terrigenous rocks.The composition and thickness of the sedimentary sequence, as a rule, depends upon the tectonic development of the crystalline basement and the location of structural and facies zones, the boundaries of which changed in time (Männil, 1966; Põlma, 1982; Kaljo *et al.*, 1970).

The sedimentation of the lower, terrigenous part of the sequence was discontinuous due to periodic transgressions and regressions related to the general tectonic evolution of the East European Platform (Mens & Pirrus, 1997a). As a rule, the lens-like bodies of Cambrian quartz sandstones and claystones are separated by considerable gaps. In the Tartu core (South-East Estonian Confacies Belt; Mens *et al.*, 1993) the thickness of the exposed Middle and Upper Cambrian strata (the Paala and Petseri formations, respectively) reaches up to 50 m (Appendix 1, sheets 16 - 17; only about 6.2% of the established thickness is represented by core).

During the Ordovician the nowadays Baltoscandian area constituted the northern part of an epicontinental marine basin (Fig. 3), surrounded from the north, east and south by the Fennosarmatian land (Põlma, 1982; Männil, 1966; Jaanusson, 1995; Nestor & Einasto, 1997). The large-scale biogeographical and facies differentiation within the Ordovician Palaeobasin of Baltoscandia is well expressed in the concept of confacies belts (Jaanusson, 1976; Fig. 3). Based on the general character of carbonate sedimentation, two epochs (corresponding to the Billingen to Keila, and Oandu to Porkuni time) were recognized in the post-Tremadoc Ordovician in the East Baltic (Põlma, 1982). The Tremadoc, but also early Arenig time, was still characterized by terrigenous sedimentation. In the Caradoc, near the Keila - Oandu boundary reefs appeared, and the deposition of pure lime mud was initiated in shelf areas (Einasto, 1995). The sediments which formed in shallow water conditions occur in the nowadays outcrop area, while those formed in deeper environments characterize Central and South Estonia. In main part of the distribution area in Estonia the Ordovician rocks are overlain by Silurian strata, but in South-East Estonia they are unconformably covered by Devonian terrigenous rocks. In the Tartu core the measured thickness of Ordovician sediments is 152 m (Appendix 1, sheets 10 - 16).

On the basis of distinct lateral facies changes of the Silurian rocks the Middle and South Estonian confacies belts have been distinguished (Kaljo, 1977; Fig. 4). The Middle Estonian Confacies Belt is dominated by various lime- and dolostones rich in shelly fauna. The South Estonian Confacies Belt consists mostly of marl- and mudstones with a less variable deeper-water shelly fauna, graptolites and planktonic microfossils. Silurian carbonate rocks overlie the Ordovician strata conformably; the boundary is marked by a lithological change. Generally, the Silurian sequence resembles the Ordovician one. The specific features of the Silurian are: greater thicknesses, wider facies variability and distinct cyclicity of sediments (Kaljo *et al.*, 1970; Nestor, 1997). In the Tartu core the total thickness of the Silurian deposits reaches 76 m (Appendix 1, sheets 7 - 10).

During the Devonian, Estonian territory was covered by a shallow epicontinental sea, characterized by sedimentation of terrigenous material transported from the north. The restricted early Devonian sedimentary basin expanded gradually during the middle - late Devonian. The sandstones of the Lower Devonian Rēzekne Stage have been recorded only in South Estonian drillcores, but at the end of the Eifelian the whole Estonian territory was supposedly covered by the deposits of Devonian age (Kleesment, 1997). The rocks of the Pärnu Stage are probably represented by deposits of an underwater delta (Kleesment, 1991), the sandstones of the Aruküla Stage (mainly red-coloured) supposedly formed from the erosional material brought to the basin from the land located to the north-west and north-east of the basin (Kleesment, 1997). The total thickness of Devonian rocks in Tartu core is about 140 m (Appendix 1, sheets 1 - 7).

The Devonian rocks are overlain with 14 m thick Quaternary cover.

BASIC CONCEPTS AND METHODOLOGY

Description and terminology

The description of the Tartu core is presented in the form of a table including the main lithological features of the rock (Appendix 1). To specify the degree of dolomitization of the carbonate rocks, 3% hydrochloric acid was used. The content of clay, the commonest terrigenous component in carbonate rocks, was estimated visually, and later controlled by chemical analysis. The results are presented following the classification of Oraspõld (1975a): by the content of insoluble residue of 10 - 15%, the rock is described as slightly argillaceous, by 15 - 20% medium argillaceous, and by 20 - 25% highly argillaceous.

The descriptions of the textures of carbonate rocks are based on the traditional Estonian classification of carbonate rocks (Vingissaar *et al.*, 1965; Loog & Oraspõld, 1982). However, to allow a better understanding of the terminology, the comparison of the

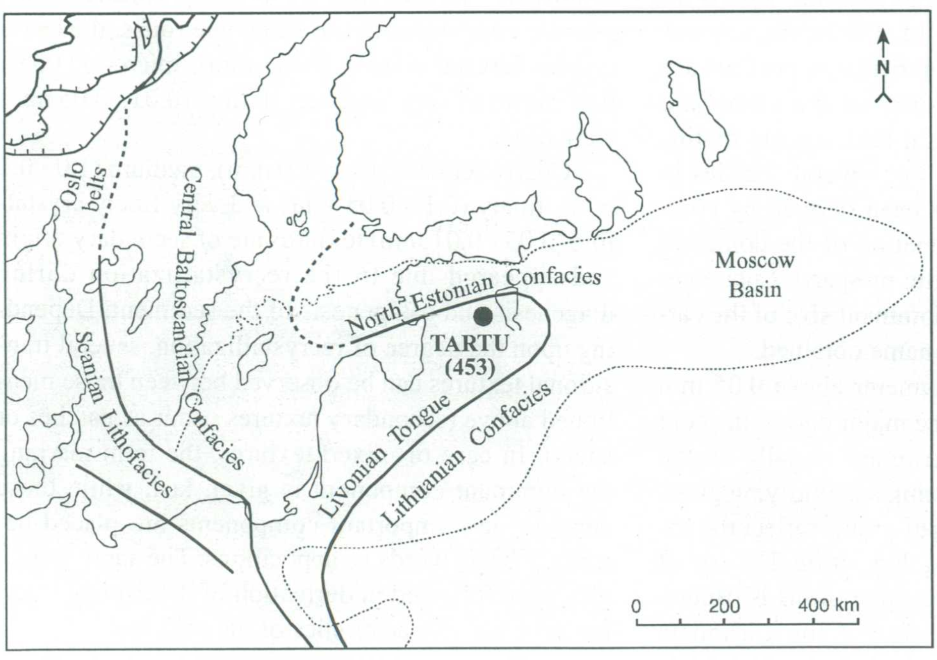

Figure 3. Baltic Ordovician confacies belts (by Jaanusson, 1995)

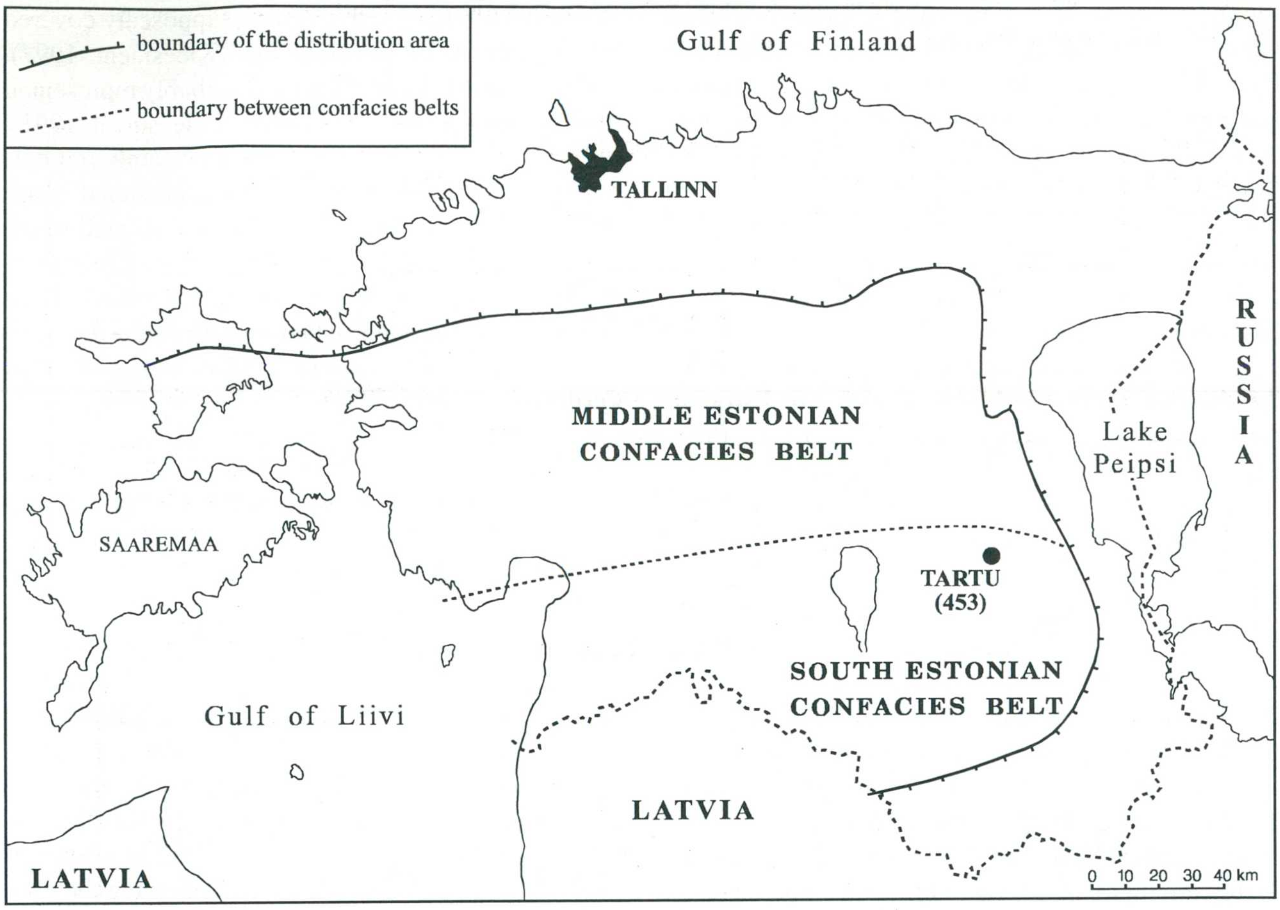

Figure 4. Silurian confacies belts and the distribution of Lower Silurian rocks (by Kaljo, 1977)

Estonian classification with Dunham's classification (Dunham, 1962) is given in Table 1. Owing substantial differences in these classifications, direct translation of the names of rocks would cause problems in understanding the terms. To avoid misunderstandings, the content of carbonaceous clasts (including bioclasts) is given, if possible, in percent.

In the classification used in Estonia (Vingisaar *et al.*, 1965; Loog & Oraspõld, 1982), the relative amounts of the clastic and micritic components are crucial to identify the textures of the carbonate rocks. Accordingly, four main textures are distinguished (I to IV in Table 1). For several decades in Estonia the rock names have been derived by combining the appropriate abbreviation of the dominant allochem with those of micritic or sparry calcite cement. A suffix denoting the dominant size of the carbonate grains is added to the name obtained.

The particles with the diameter above 0.05 mm are described as grains. For the major part of the core the amount of grains is determined visually on the slabbed surfaces of the core using a magnifying glass. The amount and composition of grains reflect the environmental conditions during deposition. The size of the chemogenic or biochemogenic ooliths is usually less than 1 mm, while the size of the carbonate intraclasts exceeds 1 mm. Rounded pellets of different origin, consisting mainly of microcrystalline calcium carbonate, are mostly less than 0.1 mm in diameter. The micritic component of chemogenic, biochemogenic or polygenic origin in carbonate rocks (Fig. 5) consists of particles less than 0.05 mm in diameter. They were deposited in stable hydrodynamic conditions. To describe the primary texture of the micritic component in the carbonate rocks, the terms crypto- (crystal sizes < 0.005 mm), micro- (0.005 - 0.01 mm) and very finely crystalline (0.01 - 0.05 mm) were used.

Coarse (crystal size > 1.0 mm), medium (1.0 - 0.1 mm), finely (0.1 - 0.05 mm) and very finely crystalline (0.05 - 0.01 mm) textures are of secondary origin and appeared due to the recrystallization during diagenesis and catagenesis of the sediment. Depending upon the degree of recrystallization, several transitional textures can be observed between those mentioned above (secondary textures occur as patches or spots). In case of mixed textures, the term marking the dominant component is given last, while those denoting less important components are placed before the basic words as appositions. The same principles were followed in derivation of descriptive terms for the other characteristics of the rock too.

TABLE 1. Comparison of the main textures used in the Estonian classification of carbonate rocks (Loog & Oraspõld, 1982) with those in Dunham (1962).

Main texture	Allochems (%)	Grain size (Ø; mm)	Principal allochems	Name of rock according to Dunham, 1962
I	< 10			mudstone
II	10 - 25	> 1.0	coarse bioclasts	wackestone or floatstone
		< 1.0	fine bioclasts	wackestone or floatstone
			ooliths	wackestone
		> 1.0	rudites (intraclasts)	wackestone or floatstone
		< 1.0	arenites (intraclasts)	wackestone or floatstone
III	25 - 50	> 1.0	coarse bioclasts	pack-, (wacke-), grainstone
		< 1.0	fine bioclasts	pack-, (wacke-), grainstone
			ooliths	pack-, (wacke-), grainstone
		> 1.0	rudites (intraclasts)	pack-, rud-, grainstone
		< 1.0	arenites (intraclasts)	pack-, (wacke-), grainstone
IV	> 50	> 1.0	bioclasts	rudstone, boundstone

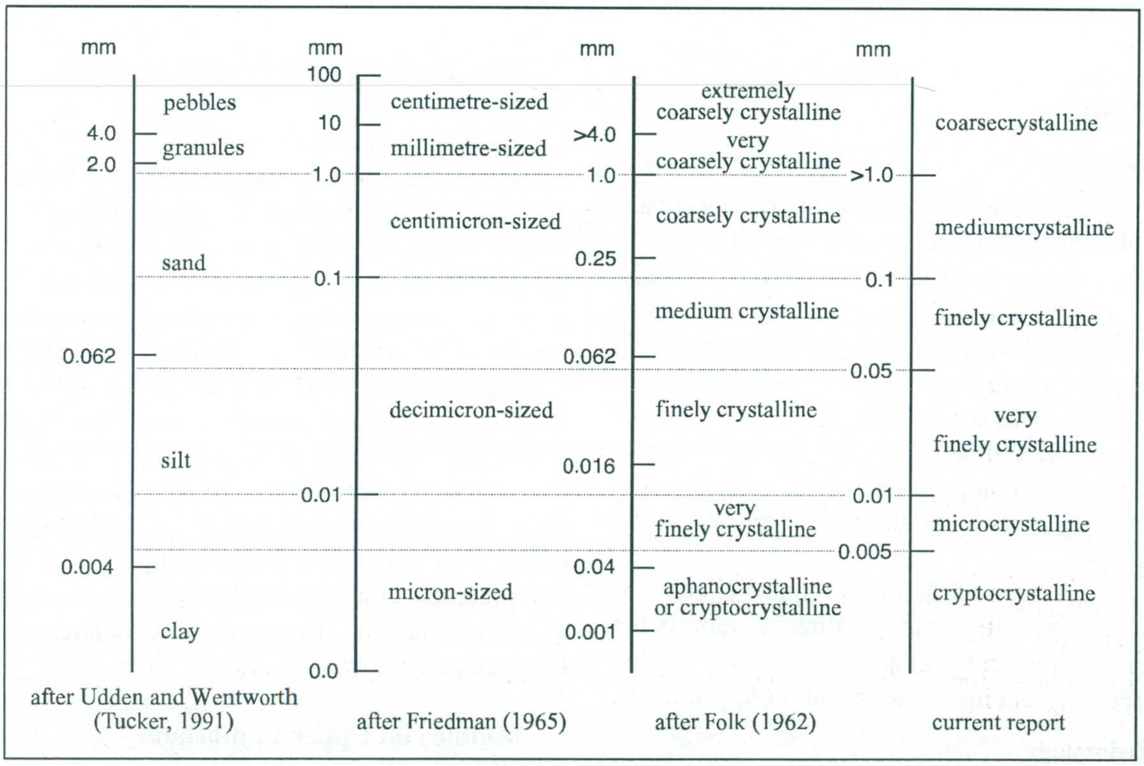

Figure 5. Terminology used to describe the size of crystals and grains in the sedimentary rocks

During sedimentation several external (discontinuity surfaces, ripple marks, mud cracks, stylolites) and internal structures (layers, nodules) of beds were formed. The variation of these structures in the Tartu core is illustrated in Plates 1 - 3. Discontinuity surfaces, mud cracks and stylolites are also included in the description (Appendix 1). To characterize the internal structures, the terms thick- (thickness of bed 10 - 50 cm), medium- (2 - 10 cm), thin- (0.2 - 2 cm) and microbedded (< 2 mm) are used. Intervals without visually observable bedding are referred to as massive. The bedding may be described as horizontal, wavy or cross-bedding. Very often carbonate rocks (particularly the varieties containing clay) have nodular structures which are divided into seminodular and nodular ones. Seminodular structure means that a carbonate rock is characterised by a number of irregularly diverging laminae or patches of argillaceous material. In case of a nodular structure, the limestone/marlstone ratio is roughly 1:1 or marlstone dominates, and the limestone nodules are separated from each other. Based on the size of the nodules in the rock, thick-nodular (vertical diameter of nodules > 5 cm), medium-nodular (2 - 5 cm), or thin-nodular (< 2 cm) structures are identified. Irrespective of the bedding features, the contacts between different types of rock are either distinct or indistinct. The sediments subjected to extensive reworking of infaunal organisms are referred to as bioturbated. The classification of sandstones is based on the 5-fractional classification of Pettijohn *et al.* (1987), where the diameter of the finest sand particles is 0.05 mm instead of 0.0625 mm of Pettijohn (1949) and Švanov (1969). In this paper the following fractions and terms are used: the size of grains > 1 mm - very coarse sand, 1 - 0.5 mm - coarse sand, 0.5 - 0.25 mm - medium sand, 0.25 - 0.1 mm - fine sand, 0.1 - 0.05 mm - very fine sand, 0.05 - 0.01 mm - coarse silt, 0.01-0.005 mm - fine silt and < 0.005 mm - clay.

Methods

Lithology

Sieving, elutriation and pipette analyses were applied to determine the grain-size composition of the Devonian terrigenous rocks (Appendices 2, 3). The mineral composition of the sediment was studied in the very fine sand fraction. Light and heavy minerals were separated using bromoform (Appendices 4 - 6). To classify the rocks according to the mineral composition, the classification of Pettijohn *et al.* (1987) was used. The general composition and the ratio of transparent allothigenous minerals were identified in the heavy fraction.

The composition of the noncarbonate allochems, but also the composition and variation of grains in the Ordovician - Silurian boundary interval were studied on thin sections and insoluble residues (Appendix 7).

Palaeontology

The scales of acanthodians (Appendix 8) were separated as a by-product of the mineralogical analyses. All samples from the Devonian rocks are stored at the Institute of Geology at Tallinn Technical University.

The four acritarch samples, collected from the Upper Cambrian rocks (Appendix 9), were processed in the Palynological Laboratory of the Institute of Geology and Paleontology, Berlin Technical University, using standard methods. The slides with acritarchs are stored in the Geological Museum of the Institute of Geology, University of Tartu.

Ostracodes were investigated from 58 samples collected from the Billingen to Kunda, Keila to Nabala and Pirgu to Juuru stages (Appendix 10). The weight of samples varied mostly between 300 and 700 g. All samples were treated using standard laboratory methods. Ostracodes are stored at the Institute of Geology, University of Tartu.

From the Ordovician and Silurian rocks of 210 samples were processed to study chitinozoans (Appendix 11). The weight of the samples was about 200 - 500 g. Samples were dissolved in acetic acid. Most of these residues were also used to study conodonts. The collection of chitinozoans is stored at the Institute of Geology at Tallinn Technical University.

Conodonts were identified from 65 samples from Lower to Middle Ordovician strata (Appendix 12). Generally, the conodont elements are well preserved. Their Colour Alteration Index (CAI, Epstein *et al.*, 1977) is 1, indicating a burial temperature less than 50° C.

DISCUSSION AND CONCLUSIONS

Palaeogeographically the Tartu (453) borehole is located in the northern periphery of the Baltic Depression (= the Livonian Tongue) (Männil, 1966; Männil & Meidla, 1994; Jaanusson, 1995), called also the transitional zone (Põlma, 1967). Due to such geographic position, many intervals of the section are lithologically transitional between those of the North Estonian and Central Baltoscandian Confacies belts, which causes problems in correlations (Fig. 3). Analyses of the distribution of acritarchs, ostracodes, conodonts and chitinozoans have resulted in several corrections in the stratigraphy. However, for some levels the data available at the moment allow of several interpretations. Further studies are needed to make adequate conclusions. These problematic intervals will be discussed below.

Middle and Upper Cambrian

The Middle and Upper Cambrian rocks have sporadic distribution in Estonia. Therefore the occurrence of strata of this age in the Tartu core is rather uncommon. Preliminary stratigraphical analysis of this interval was based on the gamma-logging of the well. Also, the data from the neighbouring boreholes, and the experience obtained during the litho- and biostratigraphical studies of the Cambrian strata in the transitional facies (Mens *et al.*, 1990, 1993) were considered.

In the Tartu core, between the Middle Cambrian Paala Beds (quartz sandstones) and the carbonate rocks of the Lower Ordovician Zebre Formation, there occurs a complex of terrigenous rocks (381.8 - 388.0 m). According to the lithological features this complex can be divided into four parts (Appendix 1, sheet 16).

1. The lowermost part, the interval 383.0 - 388.0 m, is represented by a complex of greenish grey sand- and siltstones, containing at some levels brownish argillaceous seams. The samples from these seams yielded acritarchs.

2. Sandy siltstones are overlain by a bed (382.4 - 383.0 m) of greenish microbedded silty claystones, rich in mica. Two samples from this bed (at 382.5 m and at 382.9 m) contained numerous acritarchs (Appendix 9).

3. The next part (382.2 - 382.4 m; = the Kallavere Formation) of this complex is represented by quartz sandstones containing (in the lower half) scattered grains of glauconite. As this type of rock is not suitable for palynological analyses, the interval was not sampled and, accordingly, its stratigraphical position is still problematic.

4. The uppermost part (381.8 - 382.2 m; = the Leetse Formation) is represented by strongly cemented glauconitic quartz sandstone.

All samples studied contained the same taxa of acritarchs, but their content per sample varied. The association of acritarchs discovered (*Cymatiogalea dentalea* Paalits, *C. virgulata* Martin, *Dasydiacrodium setuensis* Paalits, *Leiofusa stoumonensis* Vanguestaine, *Veryhachium incus* Paalits) is characteristic of the Petseri Formation (Paalits, 1992; Volkova, 1990; Volkova *et al.*, 1981) and has been correlated with the Upper Cambrian *Olenus* Zone (Mens *et al.*, 1993). So far the strata of the Petseri Formation have been recorded from South-East Estonia, North-East Latvia and the northern districts of the Pskov Region only. The data from the Tartu core allow us to suggest that, most probably, the Upper Cambrian terrigenous rocks occur also in the area north of Tartu. It is noteworthy that the tripartite lithological subdivision of the Petseri Formation, recognized in South-East Estonia (Paalits, 1992; Volkova *et al.*, 1981, Mens & Pirrus, 1997b), is partly applicable also for the Tartu core.

Ordovician

The boundary between the Volkhov and Kunda stages

The Lower Ordovician strata are poorly studied in South Estonia. The position of the boundary between the Volkhov and Kunda stages is still under discussion. In Latvia, this level has been correlated with the boundary between the Kriukai and Šakyna members of the Ciecere Formation (Ulst *et al.*, 1982). Later, the Kriukai and Šakyna members were treated as formations (Männil, 1990; Männil & Meidla, 1994). In the Tartu core the contact between these formations has been identified at 371.4 m (Appendix 1, sheet 15). Here the Kriukai Formation consists of seminodular to thin-bedded, in some intervals medium-bedded, brownish red argillaceous limestones (Pl. 3, fig. 30). However, in the type section (Šakyna core, interval 1362.4 - 1388.0 m; Ulst *et al.*, 1982) marlstone dominates in these strata. In the Tartu core the Šakyna Formation (370.5 - 371.4 m) is represented by greenish grey limestones containing 1 - 2% of glauconite. It is overlain by reddish brown limestones (with some greenish grey interbeds and goethitic ooliths) of the Baldone Formation (Pl. 3, fig. 29).

To determine the age of the Kriukai, Šakyna and Baldone formations, ostracodes, chitinozoans and conodonts were studied. Fourteen samples from 18 collected from the interval of 369.6 - 381.7 m yielded ostracodes. Ostracodes are very rare in the lower part of the Kriukai Formation. Only in one sample (380.75 - 380.90 m) a probable specimen of *Tallinnellina primaria*?, characteristic of the Volkhov Stage (Meidla & Sarv, 1990), was found (Fig. 6). The appearance of *Laterophores ansiensis* (sample 374.25 - 374.40 m) and *Pinnatulites procerus* (sample 373.50 - 373.60 m) in the upper part of the Kriukai Formation seems to indicate already the Kunda age for these strata. In Latvian (Gailite, 1971; Ulst *et al.*, 1982) and Swedish sections (Schallreuter, 1994) both mentioned taxa have not been found in the strata below the Kunda Stage. Also, in North Estonian sections *Pinnatulites procerus* is known to appear not earlier than the Kunda Stage (Sarv, 1959), and has often been considered as characteristic of the upper part of this stage (referring to the late Kunda time - Männil & Meidla, 1994).

Together with *L. ansiensis* and *P. procerus*, *Ogmoopsis bocki* is found. In Latvian sections the last taxon occurs in the Volkhov Stage (Ulst *et al.*, 1982). However, this species has also been recorded from the Šakyna Member. This member has been correlated with the lowermost part of the Kunda Stage in Latvia and Estonia (Ulst *et al.*, 1984; Hints *et al.*, 1993; Nõlvak, 1997), but, based on Paškevičius (1976), in Lithuania the lowermost part of this unit may also be of late Volkhov age. The unusual co-occurrence of taxa, known to characterize the stratigraphically separated levels (Meidla & Sarv,1990), in the Tartu core probably indicates that the interval under discussion is missing (corresponds to a gap) in the northern sections. The distribution of ostracodes suggests that quite possibly the boundary between the Volkhov and Kunda stages in the Tartu core lies in the interval of 373.6 (374.4) - 375.2 m, i.e. in the upper part of the Kriukai Formation (Appendix 1, sheet 15).

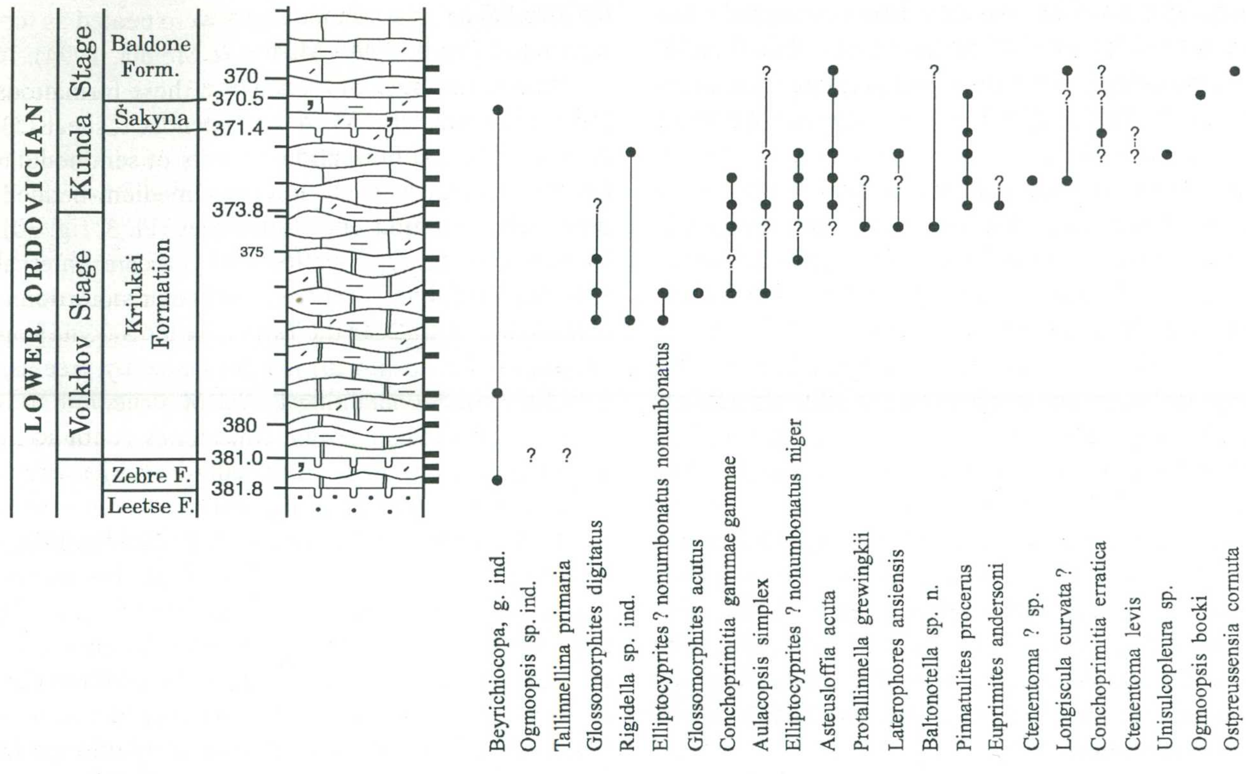

Figure 6. Distribution of ostracodes in Tartu (453) core. Volkhov to Kunda stages (T. Meidla)

The distribution of conodonts (Appendix 13) supports the conclusions drawn on the basis of the ostracodes. *Paroistodus originalis* and *Microzarkodina parva* which characterize the Volkhov Stage (Lindström, 1971; Löfgren, 1978; Bagnoli & Stouge, 1997) disappear at 374.8 m. The appearance of *Baltoniodus clavatus* (sample 372.52 - 372.65 m), *Lenodus* sp. A (sample 373.06 - 373.15 m) and the occurrence of *Drepanoistodus stougei*, occurring in Scandinavia together with *Amorphognathus variabilis*, probably indicate the Kunda age for the uppermost part of the Kriukai Formation in the Tartu core (Appendix 1, sheet 15; Appendix 13).

Although the lack of chitinozoans in the red-coloured rocks has considerably restricted their use for biostratigraphical correlations in South Estonia and Latvia (Ulst *et al.*, 1982), the data available from theTartu core seem to support the above conclusions. The only samples yielding chitinozoans (370.70 - 370.85 m and 371.10 - 371.25 m; Appendix 14) come from the 0.9 m thick greenish grey argillaceous limestones of the Šakyna Formation. Among others the upper sample contains *Cyathochitina regnelli* appearing in the Kunda Stage (Nõlvak & Grahn, 1993) and the lower one *C. hunderumensis* known also only from the lowermost beds of the Kunda Stage (Grahn *et al.*, 1996).

Following the above considerations, the lower boundary of the Kunda Stage in the Tartu core is drawn at a depth of 373.8 m.

The boundary between the Keila and Oandu stages

The upper part of the Keila Formation (interval 296.6 - 304.8 m; Appendix 1, sheets 12 - 13) is characterized by an intercalation of marls (=marlstones) and argillaceous limestones. In the interval of 297.5 - 299.0 m the content of marl in the sequence reaches up to 60%. The overlying Lukštai Formation (288.4 - 296.6 m; interval of 288.6 - 292.5 m core is missing) is dominated by greenish argillaceous or calcitic marlstones with interbeds of finely to very finely crystalline limestones (Pl. 2, fig. 19). The 10 - 20 cm thick layers of marlstones (with indistinct contacts) contain rare lenses and nodules of limestone. The more carbonate intervals of the formation are bioturbated, with abundant aggregates of fine bioclasts (20 - 30%) distributed unevenly across the bedding surfaces. In several cores in South Estonia (e.g. Häädemeeste, Abja, Viljandi, Kaagvere; Fig. 1), the marlstones of the Oandu Stage contain up to 4 m thick interbeds of siltstone. The distribution of these beds is limited to some regions only (Ainsaar, 1995). A silty interval was recognized also in the Tartu core, but here in the boundary beds of the Keila and Oandu stages (293.0 - 299.0 m).

From the interval of 283.50 - 302.44 m ostracodes were studied in 20 samples. The occurrence of *Pelecybolbina graesgardensis* in the sample from 299.20 - 299.35 m shows that most probably this sample and three ones below it represent the upper part of the Keila Stage. The fauna of ostracodes recognized in this interval is typical of the transitional zone (Fig. 7).

The samples from the silt-containing marlstones (interval 296.6 - 298.3 m) revealed abundant of *Tetrada (Tetrada) pseudoiewica* (Fig. 7). In general, this interval is characterized by an association of ostracodes (including *Tetrada*, *Polyceratella*, *Distobolbina*), which indicates a remarkable influence of the North Estonian (relatively shallow-water?) faunas. According to Sidaravičiene (1992), *T. (T.) pseudoiewica* is known from the Keila (and Oandu ?) Stage in Lithuania. In the same publication, she attributed some of the specimens, figured by Sarv (1959) as *Tallinnopsis (=Tetrada) iewica*, to *T. (T.) pseudoiewica*. These specimens come from the uppermost Keila Stage of North Estonia. Also several other taxa from this interval (*Consonopsis consona*, *Polyceratella aluverensis*, *Klimphore bimembris*) indicate that the strata under discussion were formed before Oandu time. Accordingly, the lower part of silty marlstones in the Tartu core corresponds to the upper part of the Keila Stage. The Keila age of this interval is confirmed also by the occurrence of the chitinozoan *Spinachitina cervicornis* (Appendix 14; Nõlvak & Grahn, 1993). Judging from the distribution of ostracodes known up to now (Meidla, 1996), the analogues of the uppermost part of the Keila Stage (interval of 296.6 - 298.3m) in the Tartu core are evidently missing in northern Estonia.

The lower part of the Lukštai Formation is characterized by a faunal assemblage including taxa characteristic of the transitional facies belt in Central Estonia and indicating the Oandu age for these strata (Fig. 7; Appendix 14).

The boundary between the Rakvere and Nabala stages

In Central Estonia, the lower part of the Nabala Stage is represented by glauconite-bearing argillaceous limestones of the Mõntu Formation. The most characteristic feature of this formation is the occurrence of glauconite grains. Traditionally, the lower boundary of the Mõntu Formation has been correlated with the lower boundary of the Nabala Stage (Männil, 1990; Männil & Meidla, 1994; Nõlvak, 1997).

In the Tartu core, the slightly argillaceous glauconitic limestones of the Mõntu Formation (283.2 - 286.5 m) are separated from the underlying micritic to very finely crystalline limestones of the Rägavere Formation (286.5 - 288.4 m; Pl. 2, fig. 18) by a rough, slightly phosphatic discontinuity surface (at 286.5 m; Appendix 1, sheet 12). Nine discontinuity surfaces, also mainly with phosphatic, less often with pyritic impregnation, occur in the Mõntu Formation. The diameter of glauconite grains ranges between 0.1 and 0.5 mm, their maximum content is recorded in the interval of 285.3 - 285.8 m (Pl. 2, fig. 17).

So far, the strata with glauconite have considered to be of Nabala age (Kaagvere, Otepää-2, Laeva-18; Meidla, 1996). However, at the same time the discontinuity surfaces characteristic of the Mõntu Formation in the Tartu core (and recorded also in the same formation in the Otepää-2 core) are missing in the strata of this formation in the Kaagvere and Laeva-18 cores. Instead, in these sections similar discontinuity surfaces occur in the Rägavere Formation (Meidla, 1996).

In Central and South Estonia, the lower boundary of the Nabala Stage is marked by the disappearance of *Pelecybolbina pelecyoides* and the appearance of *Uhakiella curta* (Meidla & Sarv, 1990; Meidla, 1996). These taxa have not been found in the Tartu core. However, *Daleiella admiranda*, characteristic of the upper part of the Rakvere Stage (Tudu Member), occurs here also in the lowermost part of the Mõntu Formation (samples 286.70 - 286.80 m and 285.91 - 286.02 m; Fig. 7). Accordingly, the distribution of *D. admiranda* allows us to presume that the lowermost part of the Mõntu Formation in the Tartu core is of Rakvere age. Also, the distribution of chitinozoans does not contradict this possibility. *Armoricochitina reticulifera* and *Cyathochitina costata*, indicating the Nabala age (Nõlvak & Grahn, 1993) appear in the sample 285.40 - 285.50 m (Appendix 14). Supposing that the maximum glauconite content (interval 285.3 - 285.8 m) corresponds to the Nabala Stage, we may suggest that the boundary between the Rakvere and Nabala stages lies in the interval of 285.8 - 286.5 m, that is, in the lowermost 0.7 m of the glauconite-bearing limestones of the Mõntu Formation. However, as the Tartu core is so far the only one where the age of the lowermost part of the Mõntu Formation is problematic, and as only one taxon (*D. admiranda*) indicates a possible older age for this interval, we decided to leave the exact position of the boundary between stages open and to indicate the probable boundary interval (285.8 - 286.5 m) instead.

Pirgu Stage, Halliku Formation

The Halliku Formation, about 32.3 m thick in the Tartu core, is represented by an intercalation of argillaceous limestones and calcitic marlstones (Appendix 1, sheets 10, 11; Pl. 2, fig. 14). Its lower boundary is marked by a distinct contact between red calcitic marlstones of the Jonstorp Formation and greenish grey argillaceous limestones of the Halliku Formation. There occur a number of varicoloured burrows just below and above that boundary. The Halliku Formation has about the same thickness also in the Kaagvere (34.6 m; interval 197.9 - 232.5 m) and

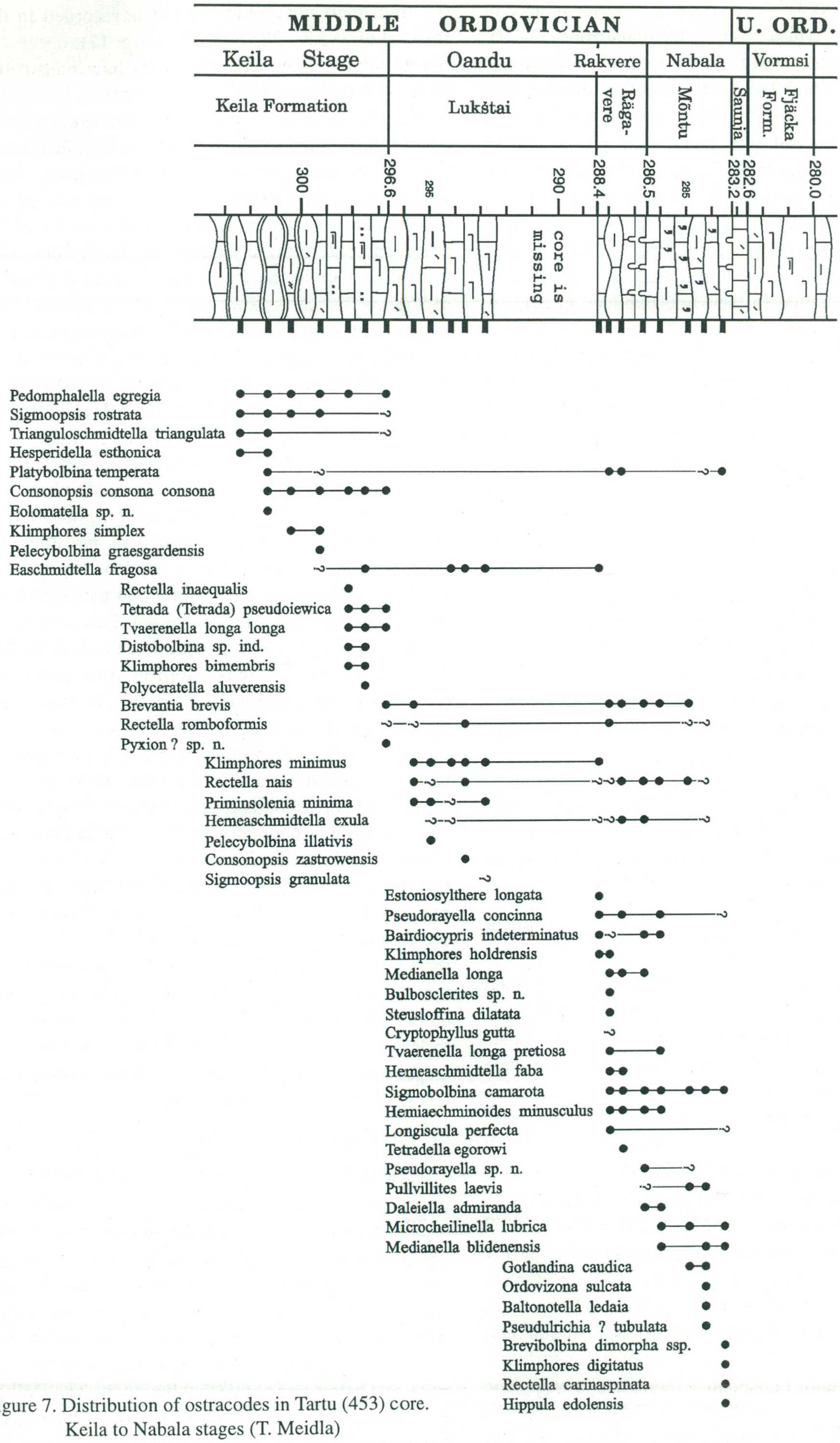

Figure 7. Distribution of ostracodes in Tartu (453) core.
Keila to Nabala stages (T. Meidla)

Otepää (30.4 m; interval 378.2 - 408.6 m) cores (Oraspõld, 1975a). However, the thickness of the formation varies greatly in South Estonia, probably due to rapid changes in the conditions of sedimentation.

According to Jaak Nõlvak (pers. comm.), based on the distribution of the chitinozoans *Spinachitina taugourdeaui* and *Conochitina rugata*, the upper part of the Halliku Formation (interval 232.5 - 248.95 m; Appendix 14) in the Tartu core is represented by the rocks which are younger than those in the stratotype area (see Oraspõld & Põldvere, 1992). *S. taugourdeaui*, which has been identified only in the upper part of the Pirgu and the lower part of the Porkuni stages (Nõlvak & Grahn, 1993), appears in the studied core already at a depth of 248.95 m. *Conochitina rugata* occurs in the lower part of the Halliku Formation (interval 249.30 - 263.75 m). It has been recorded from the Adila Formation (in the North Estonian sections) and from the Halliku Formation (in the vicinity of Ruskavere; Nõlvak, pers. comm). Additional palaeontological investigations are needed to clarify the age of the upper part of the Halliku Formation in the Tartu section. The occurrence of silty material and interbeds of calcitic marlstone in the limestone in the interval of 244.0 - 246.1 m is also unusual for the Halliku Formation.

Ostracodes studied from the interval of 227.00 - 266.55 m (20 samples) indicate a gradual decrease in the number of taxa in the upper part of the Pirgu Stage (Fig. 8).

Porkuni Stage and the Ordovician - Silurian boundary

The extensive latest Ordovician glacio-eustatic regression caused an interruption in the sedimentation and an intense abrasion of sediments in the shallow-water regions of the Baltoscandian Palaeobasin (Oraspõld, 1975b; Einasto, 1995). The youngest Ordovician strata in the East Baltic, preserved in the Baltic Depression only, are represented by lithologically highly variable rocks of the Saldus Formation. Their stratigraphic position is still problematic. As all data connected with the youngest Ordovician strata are of high stratigraphical value, a detailed description of these strata in the Tartu core is given.

In 1992 P. Kattel studied a number of thin sections and insoluble residues in order to specify the composition and amount of the grain material in the rocks from the Ordovician - Silurian boundary interval in the Tartu core (Appendix 7). Palaeontological studies revealed that, as usual, ostracodes and chitinozoans are missing in the samples from the Saldus Formation.

The lower boundary of the Saldus Formation (at 232.5 m) is marked by a 10 cm thick bed of conglomerates (Appendix 1, sheet 10; Pl. 2, fig. 13). Similar conglomerates have been recorded also in the Otepää and Viljandi cores (Oraspõld, 1975b). The amount of the granular component (clasts and detritus) in the conglomerate exceeds 50%. The diameter of the clasts reaches up to 2 cm. They consist mainly of pure microcrystalline limestone, are poorly rounded or only their edges are abraded. Clasts may be completely pyritized or possess only pyritized surfaces. The cement in the conglomerate is very finely crystalline, lenses of marlstone are observed in some places. The lower boundary of the conglomerate (marked by a non-impregnated discontinuity surface) is treated as the lower boundary of the Saldus Formation.

The conglomerate is overlain by a 20 cm thick bed of slightly argillaceous micro- to very finely crystalline microlaminated limestone with rare skeletal debris and grains of pyrite. Up to 10 cm deep pyritized mud-cracks can be observed. An indistinct pyritic pattern occurs also on the bedding surfaces. The upper surface of the bed described above (at 232.2 m) is marked by a weakly impregnated smooth discontinuity surface with rare pockets.

Three lithologically distinct intervals were recognized higher in the Saldus Formation.

1. The interval of 231.4 - 232.2 m is represented by massive greenish grey calcitic marlstones and argillaceous limestones with fine bioclasts and well-rounded quartz grains (in some beds up to 30%; diameter < 0.25 mm; Pl. 2, fig. 13). Rare grains of glauconite (diameter about 0.05 mm) and pyrite occur as well. At 232.0 m numerous oncoids (diameter 0.5 - 0.1 cm) and rounded clasts of pure limestone (diameter up to 0.5 cm) were recorded. These clasts have pyritic impregnation and are sometimes oriented. The cement is microcrystalline. In the upper part of the interval dolomitized interbeds occur.

2. The interval of 231.0 - 231.4 m is characterized by argillaceous oolitic-rudaceous limestone, containing over 50% of grains (in some beds the amount of concentric ooliths, up to 1 mm in diameter, may reach more than 10%, rounded clasts with a diameter of up to 3 mm may form about 40%). Rare well-rounded quartz grains (diameter 0.1 - 0.6 mm), microbioclasts and pellets are present. The cement is very finely crystalline. Laminae of brownish grey marlstone are numerous.

3. The upper part of the Saldus Formation (interval 230.4 - 231.0 m) consists of yellowish grey argillaceous micritic-oolitic limestone, containing in some beds up to 50% of ooliths, up to 1 mm in diameter, and rare well-rounded clasts with a diameter of 0.5 - 1.0 (1.5) cm. Fine skeletal debris, pellets and well-rounded quartz grains (0.01 - 0.5 mm in diameter) occur rarely. The cement is very finely crystalline. At some levels films and very thin interbeds of

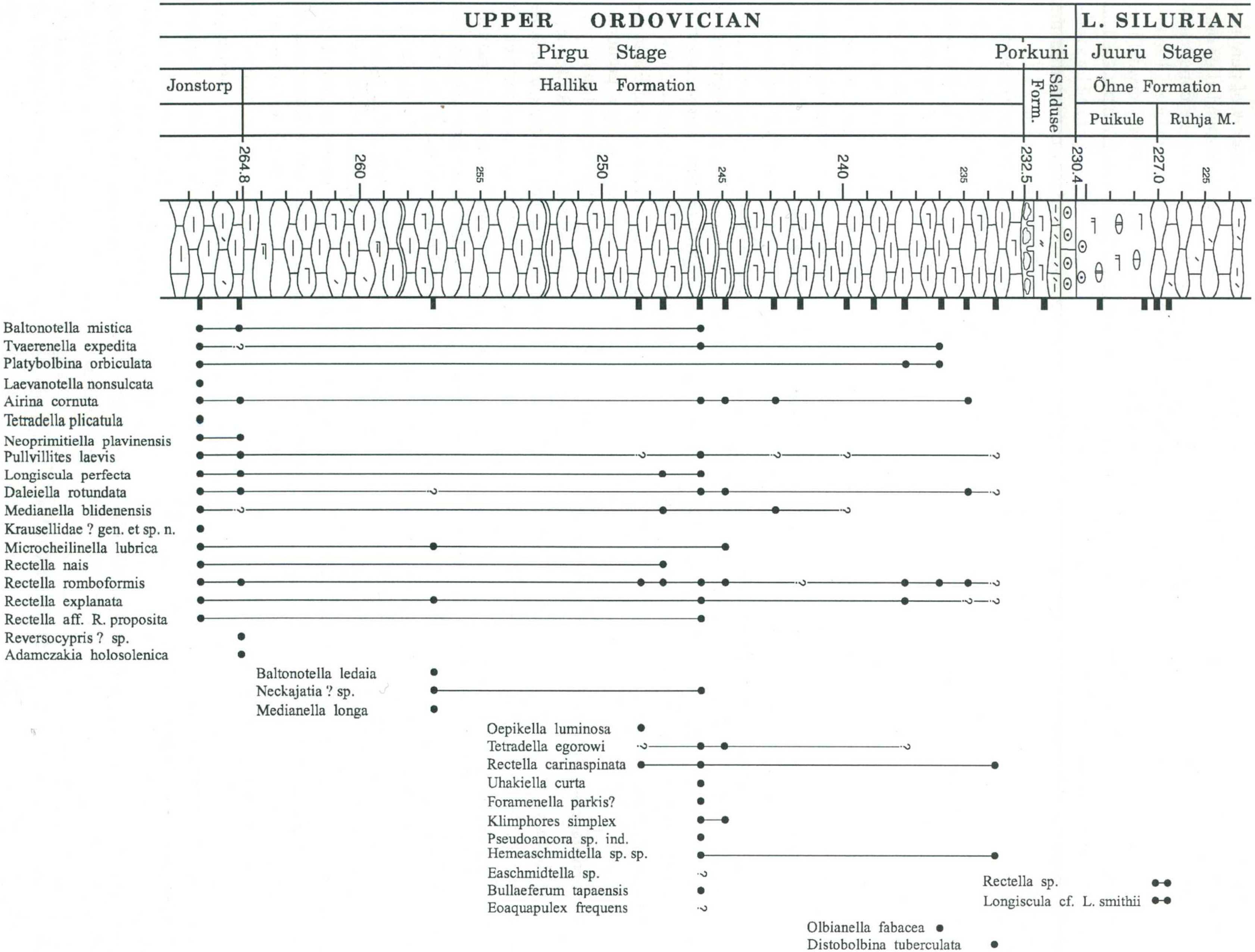

Figure 8. Distribution of ostracodes in Tartu (453) core. Pirgu to Juuru stages (T. Meidla)

marlstone were observed. A distinct wavy contact at 230.4 m is considered to mark the possible Ordovician - Silurian boundary. Above this boundary ooliths were found up to 229.6 m. In the nearby Kaagvere and Otepää cores, the Ordovician - Silurian boundary is marked by discontinuity surfaces (Oraspõld, 1975b).

Devonian

Due to rare occurrence of fauna in the terrigenous rocks, the stratigraphy of the Devonian sequence is mainly based on the lithological and mineralogical criteria (Appendices 2 - 6; Kleesment, 1994, 1995). In the Tartu core the Lower Devonian Rēzekne, and Middle Devonian Pärnu, Narva and Aruküla stages (all of them represented by formations with the same names) were recognized. The Rēzekne Formation (Appendix 1, sheets 6 - 7; Pl. 1, fig. 6) consists mainly of grey sandstones, in the mineral composition similar to those of the Pärnu Stage. The sandstones of the Rēzekne Formation overlie unconformably the dolostones of the Saarde Formation (Raikküla Stage, Lower Silurian).

The Pärnu Stage is dominated by relatively soft poorly cemented light grey and pinkish grey sandstones (interval 127.0 - 142.6 m; Appendix 1, sheet 6; Pl. 1, fig. 5). Only in the upper part of this interval carbonaceous cement was noticed in the rock.

The interval of the core corresponding to the Pärnu Formation was badly damaged during drilling - only about 10% of the sequence is preserved. However, the Tori and Tamme substages can still be distinguished. The sandstones of the Tamme Substage are partly cemented by dolomite and, as a result, quite compact, while the Tori Substage is represented by soft rocks. Mineralogically the sandstones in the both formations are subarcoses, with a high content of ilmenite and transparent detrital minerals (garnet dominates). The lower boundary of the Pärnu Stage is a distinct contact between the dolomitic marlstones of the Rēzekne Formation below and the sandstones of the Tori Substage above.

The Vadja Substage of the Narva Stage (Appendix 1, sheet 5) is relatively thick in the Tartu core - 21 m, (106.0 - 127.0 m; Pl. 1, fig. 4) and consists mainly of sedimentary breccia (up to 41% of the substage's volume). The rest of its section is represented by intercalation of typical dark grey platy dolomitic claystone (32%), grey or somewhat mottled dolomitic marlstone (15%) and yellowish grey nodular dolostone (12%). The mineralogical composition of only one sample was analysed. Unfortunately, the amount of very fine sand and of detrital heavy minerals in particular was very small. However, a high content of very fresh, non-weathered magnetite and a relatively high content of amphiboles of similar preservation refer to short-distance transport of the sedimentary material. The lower boundary of the substage is distinct - dark grey dolomitic shaly claystones of the Vadja Substage overlie the dolomitic sandstones of the upper part of the Pärnu Stage.

The upper part of the Leivu Substage of the Narva Stage (Appendix 1, sheets 4, 5; Pl. 1, fig. 3) is represented by mottled massive dolomitic marlstone (35% of the volume) and red silty claystone (10%). The rest of the section consists of thin-bedded dolomitic marlstone with interbeds of dolostone (9%) and grey claystone (2%). Sand- (3%) and siltstones (2%) form thin interbeds in the upper- and lowermost parts of the substage. In the mineral composition the Leivu Substage differs remarkably from the overlying Kernavė Substage - in its heavy fraction sphalerite, pyrite, Fe-hydroxide and magnetite occur, and garnet dominates among the transparent minerals. The lower boundary of the Leivu Substage is distinct - on the dolostones forming the upper part of the Vadja Substage lies a thin layer of heterograined sandstone marking the base of the Leivu Substage.

The Kernavė Substage of the Narva Stage (Appendix 1, sheets 2 - 4) is also unusually thick (48.8 m) in the Tartu core. Commonly its thickness ranges from 15 to 30 m, very rarely exceeding 40 m. Lithologically this substage is represented by an intercalation of reddish grey and grey sandstones (39%), siltstones (26%), claystones (19%) and dolomitic marlstones (16%) (Pl. 1, fig. 2). In comparison with the Aruküla Stage, the number of interbeds of grey dolomitic sand- and siltstones is higher in the Kernavė Substage. Also, the sandstones are more fine-grained here than in the Aruküla Stage. The lower boundary is non-typical - the yellowish red sandstones of the Kernavė Substage overlie the reddish brown shaly claystones of the Leivu Substage. The latter unit overlies the mottled massive dolomitic marlstones (usually forming the upper part of the Leivu Substage). The lower boundary of the Kernavė Substage is, as a rule, defined by changes in the mineralogical composition of the rocks: domination of garnet and a remarkably high titanite content recorded below that level are never observed in the Kernavė Substage. Quite often similar changes in the mineralogical composition of rocks can be noticed also within the Leivu Substage and have been used to separate the members of this substage (Kleesment, 1995). In the interval of 50.0 - 90.0 m scales of the acanthodians were found, *Acanthodes*? sp. A and *Acanthodes*? sp. D being most common (Appendix 8).

The Aruküla Stage (14.0 - 45.0 m) is represented by its lower part, the Viljandi Beds, in the Tartu core (Appendix 9, sheets 1, 2; Plate 1, Fig. 1).

The Viljandi Beds are dominated by reddish brown, very fine grained, thin-bedded sandstones with argillaceous cement (59%), alternating with mottled, mainly reddish brown silty claystones (26%), red and grey siltstones (9%), mottled dolomitic marlstones (5%) and grey sandstones (0.5%). The interval 15.0 - 24.4 m revealed scales of acanthodians. *Acanthodes*? sp. A, *Acanthodes*? sp. D, *Cheiracanthus brevicostatus*, *Ptychodictyon rimosum*, *P. sulcatum* and *Rhadinacanthus multisulcatus* were identified (Appendix 8). The lower boundary of the stage is relatively distinct: the mottled silty dolomitic marlstones of the Narva Stage are overlain by reddish brown fine-grained sandstones of the Aruküla Stage. This boundary is reflected also in the mineralogical composition of rocks: in the Aruküla Stage staurolite appears, the amount of zircon, quartz and garnet increases, and that of apatite and tourmaline decreases.

Devonian rocks are covered by Quaternary sandy loam tills, 14 m in thickness (Appendix 1, sheet 1).

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APPENDIX 1

Tartu (453) core description
(Anne Põldvere, Anne Kleesment, Tõnis Saadre)

The description is given in a standardized form. The tables are divided into vertical columns based on the type of information. The values occuring rarely are given in brackets.

SERIES — Geological time units.

LOCAL STRATIGRAPHIC UNITS — Stages, formations and members.

CORE BOX NO./FIGURES — Numbers of boxes, location of the intervals of core illustrated (Plates 1–3).

DEPTH/SAMPLES — Levels of the boundaries and sampling depths: A, acritarchs; Ac, acanthodians; C, conodonts; Ch, chitinozoans; G, granulometric samples; I, insoluble residues; M, mineralogical samples; O, ostracodes; T, thin sections.

LITHOLOGY — Legend see on next page.

SEDIMENTARY STRUCTURES — Bedding, thickness of beds: micro- (< 0.2 cm), thin- (0.2–2 cm), medium- (2–10 cm) and thick-bedded (10–50 cm); massive – visible bedding is missing.

MARL BEDS — The most frequent thicknesses of the marl beds; in brackets – infrequent thicknesses. Colours were identified on damp core. Contacts between marlstone and other types of rock may be distinct (D) or indistinct (IND).

MARL CONTENT (%) — The content of marl in the described interval was estimated visually.

ACCESSORY MINERALS AND OOLITHS — The amount of these particles was identified visually.

SHORT DESCRIPTION — The colour of rocks was identified on damp core; the dominant size of crystals (in italics) was estimated visually: cryptocrystalline (size of crystals) < 0.005 mm; microcrystalline 0.005–0.01 mm; very finely crystalline 0.01–0.05 mm; finely crystalline 0.05–0.1 mm and medium crystalline 0.1–1 mm. Clastic fractions (also in italics) are described as follows: clay (size of particles) < 0.005 mm; fine silt 0.005–0.01 mm; coarse silt 0.01–0.05 mm; very fine sand 0.05–0.1 mm; fine sand 0.1–0.25 mm; medium sand 0.25–0.5 mm and coarse sand 0.5–1.0 mm. The percentage of allochems, e.g. bioclasts, intraclasts, ooliths and pellets is also indicated. Main types of rocks are in bold. In descriptions also the rock types according to Dunham (1962) are given (in parentheses).

LEGEND

- till
- limestone (very finely- or finely crystalline)
- dolomitic limestone
- sandy limestone
- glauconitic limestone
- dolostone
- argillaceous dolostone
- silty dolostone
- marlstone (in general)
- calcitic marlstone
- argillaceous marlstone
- dolomitic marlstone
- calcitic dolomitic marlstone
- claystone
- silty claystone
- siltstone
- argillaceous siltstone
- sandstone
- calcitic sandstone
- dolomitic sandstone
- K-bentonite layer

- breccia
- crypto- and microcrystalline (aphanitic) limestone

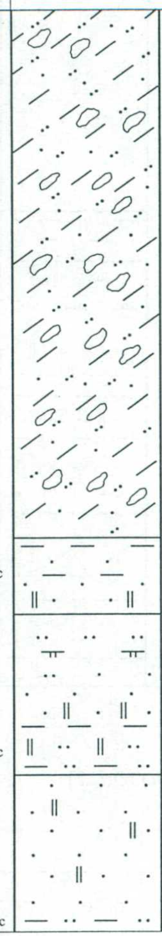
skeletal limestones:

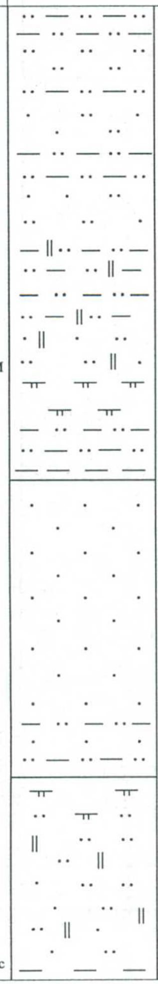
- grains 10-25% (wackestone)
- grains 25-50% (packstone)
- grains >50% (rudstone)
- fine bioclasts, pyritized
- coarse bioclasts, pyritized
- a, b, c: horizontal bedding; thin- (a), medium- (b) and thick-bedded (c)
- wavy bedding
- nodular
- thin intercalation
- a, b: nodules with distinct (a) or indistinct (b) contacts
- stylolites
- discontinuity surfaces
- 4: number of discontinuity surfaces
- mud-cracks
- mud-chips
- veins

- caverns
- burrows, pyritized
- pyritic mottles
- Q: quartz grains
- glauconite grains
- ooliths
- intraclasts
- kerogen
- pyrite
- calcite
- silicification
- micas (in general)
- mottled, red-coloured and yellow streak
- stromatolites
- stromatoporoids
- brachiopods
- cephalopods
- calcareous algae
- echinoderms
- ostracodes

TARTU (453) CORE DESCRIPTION

Location: latitude 6469.70 km, longitude 5481.70 km. Length of core 431 m. Elevation of the top above sea level 65.29 m.

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Pleistocene (Quaternary)		1		0.0							Uppermost 30 cm - soil cover. Mottled **till**, mainly represented by sandy-loam *coarse-grained* material with non-rounded clasts
Eifelian	Aruküla Stage Aruküla Formation			14.0	G,M,Ac		Horizontal bedding; thin- to medium-bedded				Intercalation of reddish brown *very fine-grained* **sandstone** and argillaceous **claystone**
		2		16.0	G,M,Ac		Horizontal and wavy bedding; thin- to medium-bedded	10 - 30 cm D or IND mottled; reddish brown and grey	15		Intercalation of reddish brown and greenish grey **siltstone**, grey *very fine-grained* and silty **sandstone**, reddish brown **claystone** and mottled dolomitic **marlstone**
				20.3			Horizontal and wavy bedding; thin-bedded				Yellowish and pinkish grey, *very fine- and fine-grained* **sandstone**
				24.4	G,M,Ac						

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Eifelian	Aruküla Stage Aruküla Formation	3 4	1	24.4	G,M		Horizontal bedding; indistinctly thin-bedded	20 - 30 cm D and IND reddish brown with violet grey partings	10	Biotite	Intercalation of reddish brown **claystone** and silty to *very fine-grained* **sandstone** with reddish brown, partly grey **siltstone** and dolomitic **marlstone**
		5		37.0			Indistinctly inclined, parallel bedding; medium- to thin-bedded			Biotite	Reddish brown, *very fine- and fine-grained* **sandstone**
	Narva Stage Narva Formation Kernavė Substage	6		45.0	G,M,Ac		Horizontal lenticular bedding; thin-bedded, dolomitic marl massive	10 - 60 cm reddish brown with grey partings	10	Biotite	Intercalation of reddish brown **claystone** and *fine- to coarse-grained* **siltstone** with mottled dolomitic **marlstone**

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Eifelian	Narva Stage Narva Formation Kernavė Substage	6					☞				☞ follow up
		7		58.4	G,M,Ac		Horizontal planar and wavy bedding; thin- to medium-bedded, dolomitic marl massive	10 - 100 cm D (IND) mottled, grey and reddish brown	20	Biotite	Reddish brown, silty or *fine- to very fine-grained* **sandstone** with interbeds of mottled dolomitic marlstone, grey and reddish brown siltstone and claystone
		8		65.0	G,M,Ac		Horizontal indistinctly wavy and planar bedding; medium- to thin-bedded, dolomitic marl massive	20 - 50 cm IND violet grey	10	Biotite	Intercalation of reddish brown and grey **claystone**, greenish grey **siltstone,** *very fine-grained* or silty **sandstone** and violet grey dolomitic **marlstone**
		9		73.8			Indistinctly wavy and planar bedding	20 - 40 cm, IND, mottled violet grey and reddish brown	70		**Dolomitic marlstone** with interbeds of grey siltstone, *very fine-grained* or silty sandstone and mottled claystone

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Eifelian	Narva Stage Narva Formation Kernavė Substage						☞				☞ follow up
		10 11	2	77.3	G,M		Disrupted wavy and horizontal bedding; thin- to medium-bedded	5 - 50 cm D (IND) violet grey and reddish brown mottled	10	Biotite	Yellowish and reddish brown *very fine-grained* or silty **sandstone** with interbeds of mottled dolomitic marlstone, reddish brown claystone and siltstone
		12		89.0	G,M,Ac		Horizontal indistinctly planar bedding; medium- to thick-bedded			Muscovite, biotite	Reddish brown *fine-grained* **sandstone** and **siltstone**
	Narva Stage Narva Formation Leivu Substage			93.8	G,M		Planar thin- to medium-bedded				Reddish brown **arenaceous claystone** with interbeds of grey siltstone and *very fine-grained* sandstone
		13		96.0			Wavy bedding; massive to medium-bedded	20 - 40 cm IND grey, violet grey and reddish brown	100		Grey, violet grey and reddish brown mottled **dolomitic marlstone**
		14	3	100.2							

PLATES 1-3

Selected intervals of Tartu core

(depth increases from left to right)

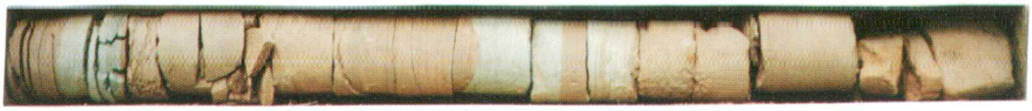


Figure 1. **Aruküla Formation**; 32.2 - 33.2 m.

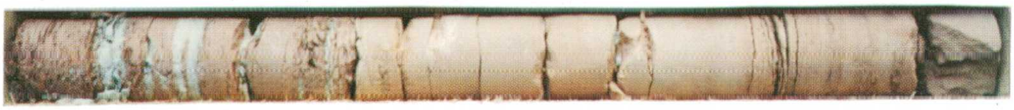


Figure 2. **Narva Formation. Kernave Substage**; 85.0 - 88.5 m.

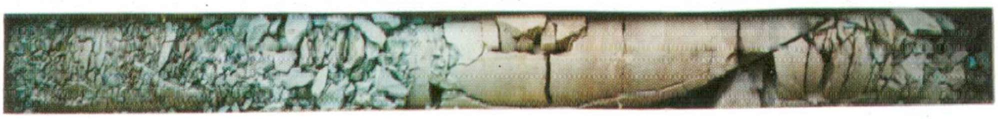


Figure 3. **Narva Formation. Leivu Substage**; 100.9 - 101.9 m.

Figure 4. **Narva Formation. Vadja Substage**; 122.5 - 123.5 m.

Figure 5. **Pärnu Formation. Tamme to Tori substages**; 137.4 - 142.6 m.

Figure 6. **Rezekne Formation**; 142.6 - 154.0 m.

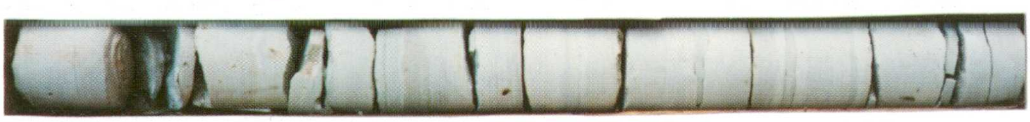


Figure 7. **Saarde Formation**; 154.4 - 155.4 m.

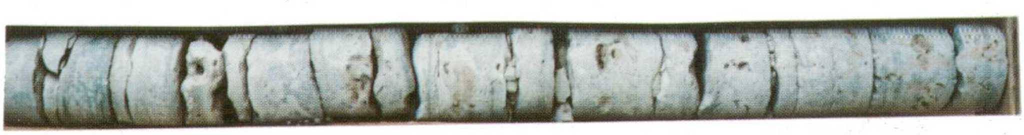


Figure 8. **Saarde Formation**; 175.1 - 176.0 m.

Figure 9. **Õhne Formation**; 210.3 - 211.5 m.

Figure 10. **Õhne Formation. Rozeni Member**; 220.5 - 221.6 m.

Selected intervals of Tartu core

(depth increases from left to right)

Figure 11. **Õhne Formation. Ruhja Member**; 225.4 - 226.4 m.

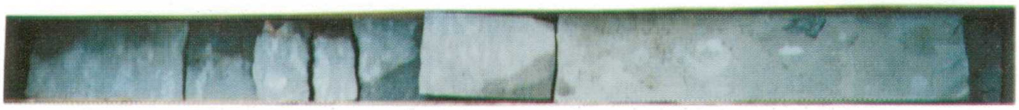


Figure 12. **Õhne Formation. Puikule Member**; 227.4 - 228.4 m.

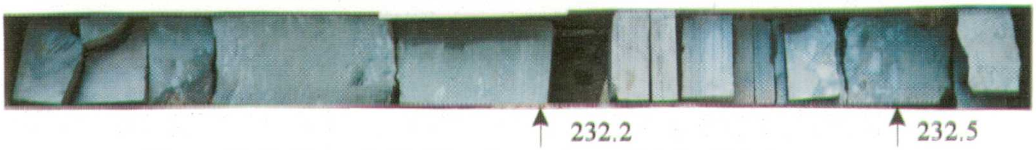


Figure 13. **Salduse to Halliku formations**; 231.5 - 232.6 m.

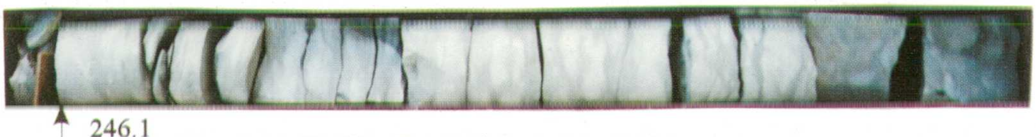


Figure 14. **Halliku Formation**; 246.1 - 247.1 m.

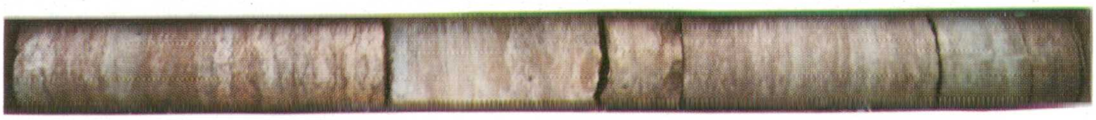


Figure 15. **Jonstorp Formation**; 271.7 - 272.7 m.

Figure 16. **Fjäcka to Saunja formations**; 281.9 - 282.8 m.

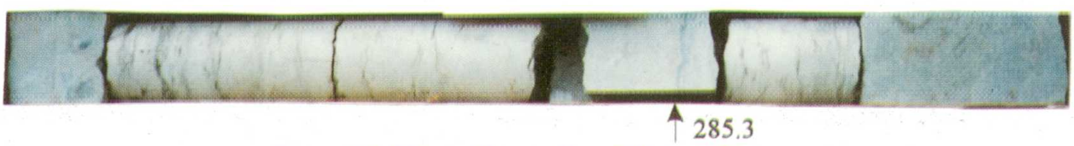


Figure 17. **Mõntu Formation**; 284.6 - 285.6 m.

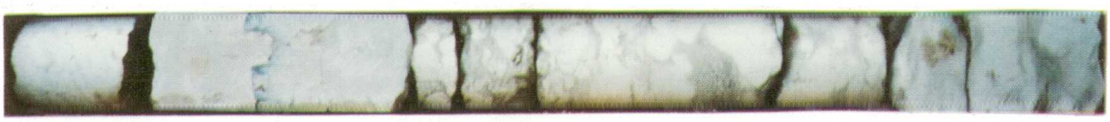


Figure 18. **Rägavere Formation**; 286.7 - 287.6 m.

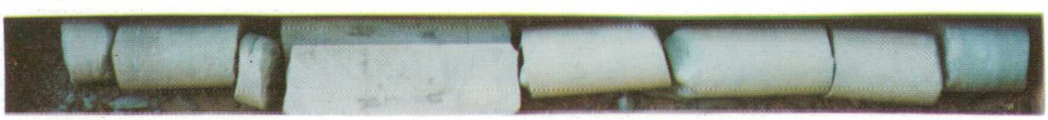


Figure 19. **Lukštai Formation**; 295.5 - 296.5 m.

Figure 20. **Keila Formation**; 311.5 - 312.5 m.

Plate 3

Selected intervals of Tartu core

(depth increases from left to right)

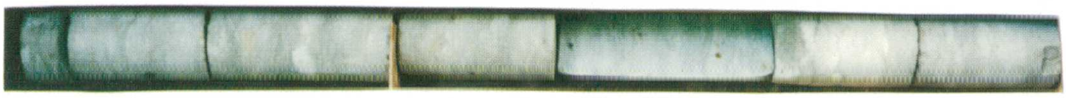


Figure 21. **Jõhvi Formation**; 315.5 - 316.5 m.

Figure 22. **Vasavere Formation**; 318.5 - 319.5 m.

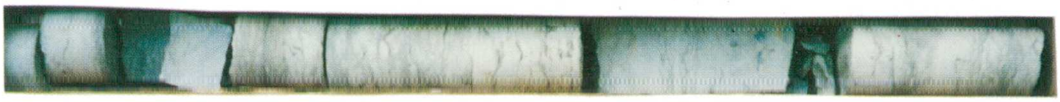


Figure 23. **Tatruse Formation**; 322.6 - 323.6 m.

Figure 24. **Dreimani Formation**; 336.7 - 337.7 m.

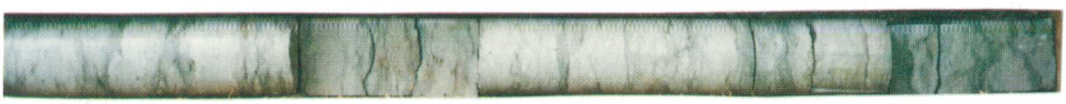


Figure 25. **Kõrgekallas Formation**; 341.6 - 342.5 m.

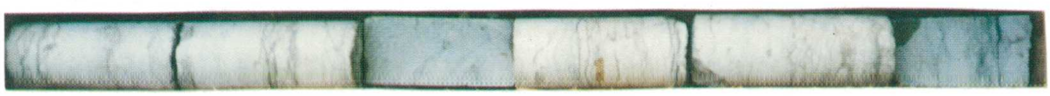


Figure 26. **Väo Formation**; 352.2 - 353.2 m.

Figure 27. **Stirnas Formation**; 354.1 - 355.0 m.

Figure 28. **Segerstad Formation**; 359.8 - 360.8 m.

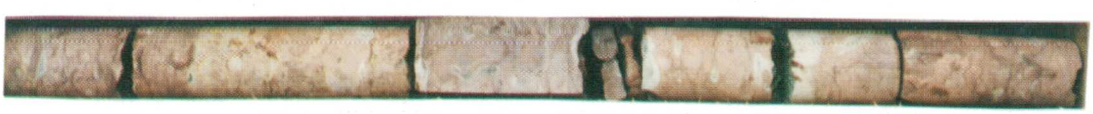


Figure 29. **Baldone Formation**; 367.5 - 368.7 m.

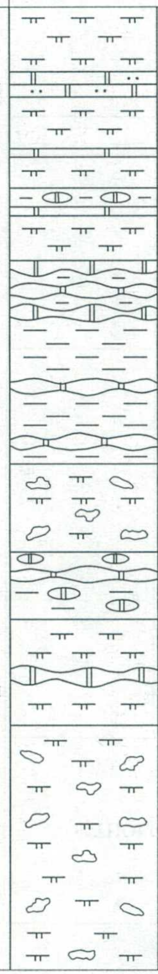
381.0

Figure 30. **Kriukai to Zebre formations**; 380.3 - 381.2 m.

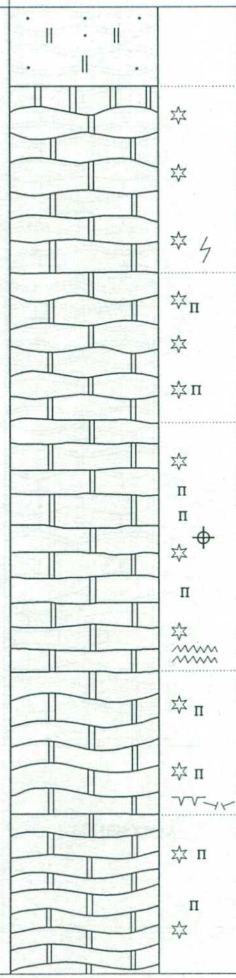
381.8

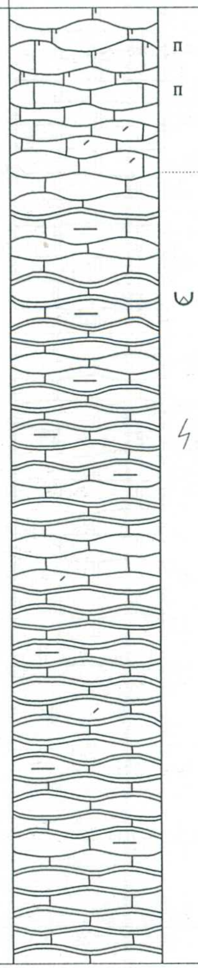
382.2

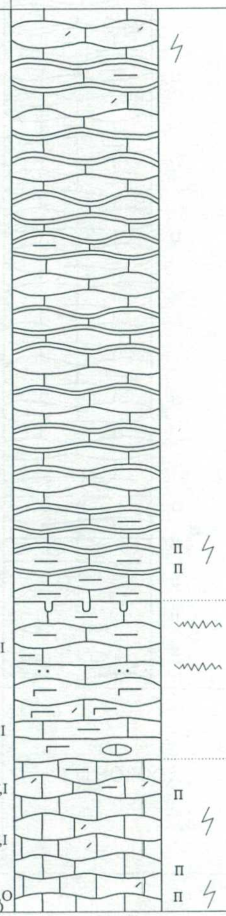
Figure 31. **Zebre to Kallavere formations**; 381.2 - 382.2 m.

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Eifelian	Narva Stage Narva Formation Leivu Substage	14, 15	3	106.0	G,M		Horizontal bedding; medium- to thin-bedded, dolomitic marl massive	20 - 80 cm D or IND grey	75	Quartz grains	Grey **dolomitic marlstone** with interbeds of *crypto- to microcrystalline* dolostone and arenaceous claystone. Basal 10 cm pinkish grey dolomitic **sandstone**
	Narva Stage Narva Formation Vadja Substage	15, 16		113.4			Wavy bedding; thin- to medium-bedded or irregularly nodular	20 - 40 cm IND grey with reddish brown partings mottled	20	Dolomite	Intercalation of dark grey **dolomitic claystone** with grey and mottled (grey with reddish brown partings) dolomitic **marlstone** and yellowish grey fractured *crypto- to microcrystalline* **dolostone**
		17		115.7			Thick- to medium-bedded and lenticularly nodular	20 - 40 cm IND dark grey	> 90		Sedimentary **breccia**: arenaceous dolomitic marlstone with unsorted pebbles of *micro- to very finely crystalline* dolostone, dolomitic marlstone and siltstone
				117.5			Thin-bedded and nodular				Grey **claystone** with interbeds of yellowish grey nodular *microcrystalline* dolostone
		18		120.3	G,M		Nodular and breccial	20 - 40 cm IND dark grey	60		Intercalation of arenaceous **dolomitic marlstone** and yellowish grey fractured *crypto- to microcrystalline* **dolostone**
		19	4	127.0			Wavy bedding; thick- to medium-bedded or massive, basal part platy or thin-bedded	0.2 - 2.0; < 200 cm IND dark grey	90		Sedimentary **breccia**: arenaceous dolomitic marlstone with unsorted pebbles of *microcrystalline* dolostone, dolomitic marlstone and siltstone, thin interbeds of yellowish grey cavernous dolostone and dark grey platy claystone

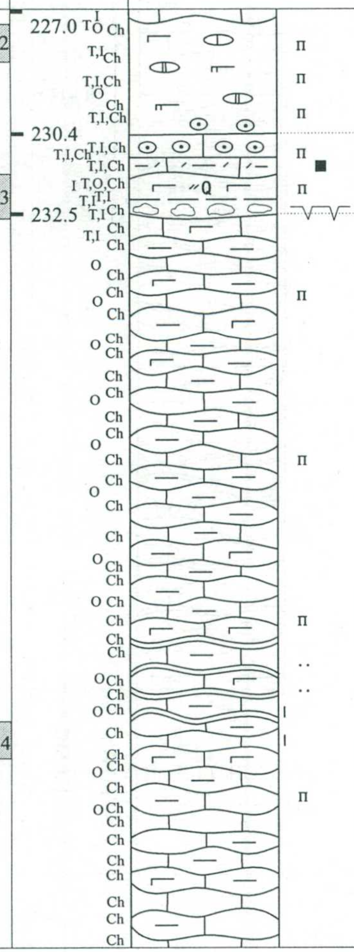
SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Eifelian	Pärnu Stage Pärnu Formation Tamme Substage	20		127.0	G,M		Indistinctly discontinuous bedding; medium-bedded				Light grey *medium- to fine-grained* **sandstone**. Upper 20 cm cavernous with dolomitic cement, in lower part loose with irregular patches of dolomitic cement
	Pärnu Stage Pärnu Formation Tori Substage		5	137.5	G,M		Indistinctly discontinuous bedding				Pinkish grey *very fine- to fine-grained* weakly cemented **sandstone**
Emsian	Rēzekne Stage Rēzekne Formation			142.6			Thin-bedded	20 - 40 cm; D; grey	100		Arenaceous **dolomitic marlstone** with interbeds of grey claystone
			6	143.6	G,M		Indistinctly horizontal bedding;				Whitish grey (with yellowish tinge) *very fine- to fine-grained*, weakly cemented **sandstone**

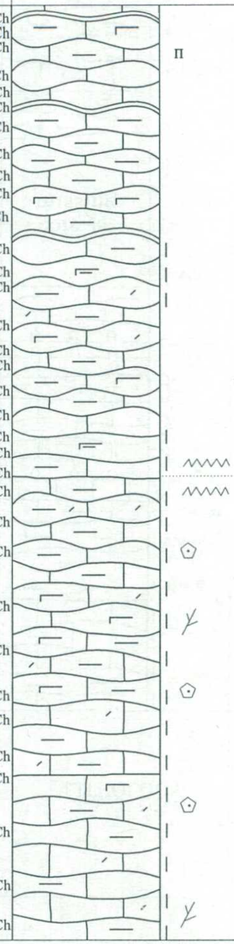
SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
		21	6				☞				☞ follow up
Llandovery	Raikküla Stage Saarde Formation	23	7	154.0			Wavy bedding; medium- and thick-bedded	0.5 - 2 cm (4 - 6 cm) D greenish light grey	< 10		Whitish beige (with brownish tinge) or light grey (in places with violet tinge) *micro- and very finely crystalline* **dolostone** (grains < 10%). Upper 0.5 m *very finely and microcrystalline*
		24		159.0			Wavy bedding; medium-bedded	0.5 - 3 cm (5 cm) IND greenish light grey	< 10		Beigish grey and grey (with violet and pyrite mottles) *micro- and very finely crystalline* **dolostone** (grains < 10%)
		25, 26		153.0			Horizontal bedding; medium-bedded	0.5 - 3 cm (4 cm) D greenish grey	20 - 30		Grey, with pyritic mottles *micro- to very finely crystalline* **dolostone** (grains < 10%)
		27		159.7			Wavy bedding; medium-bedded	0.5 - 2 cm D greenish dark grey or brownish grey	< 5		Brownish light grey or grey *micro- to very finely crystalline* **dolostone** (10 - 25% grains)
		28	8	173.5 – 177.5			Wavy bedding; rugged medium-bedded with rare thin beds	< 0.5 cm IND dark grey	< 10		Grey with dispersed pyrite mottles *very finely crystalline* **dolostone** (grains < 10%)

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Llandovery	Raikküla Stage Saarde Formation	29		177.5			Wavy bedding; thin- (medium-) nodular, rugged, medium- to thin-bedded	0.3 - 1.0 cm D bright green	< 10		Light grey *crypto- to microcrystalline* (locally *very finely crystalline*) **limestone** with partly dolomitized darker interbeds. Grains in limestone < 10%, rarely up to 30%. (Mudstone)
	Juuru Stage Õhne Formation	30 31 32 33 34		182.0			Wavy bedding; thin- to medium-nodular	0.3 - 2 cm (3 cm) D greenish grey	40 - 60		Greenish grey **marlstone** with **limestone** nodules. In nodules: grey or greenish grey slightly argillaceous *finely crystalline* **limestone** (grains < 10%, rarely in places 25 - 50%). In some intervals (up to 30% of formation) the content of thin- to medium-nodular limestones exceeds 60%. (Mudstone)

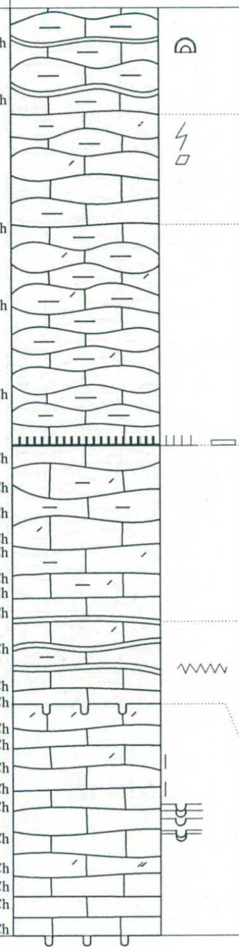
SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Llandovery	Juuru Stage Õhne Formation	35 36 37 38 39					☞				☞ follow up
	Juuru St. Õhne Fm. Rozēni Member	40	10	218.8	T,I I		Wavy bedding; thin- to medium-bedded or medium- to thin-nodular	0.3 - 3.0 cm IND greenish grey, in places reddish	< 10 > 50 60 - 70 < 60	Hematite	Intercalation of light grey (in places reddish) variously argillaceous *finely to very finely crystalline* **limestone** (grains 10 - 30%) and **marlstone**. (Wackestone)
	Juuru St. Õhne Fm. Rtija Member	41	11	223.0 227.0	T,I T,I T,I,O		Wavy bedding; medium- to thin-nodular	0.3 - 2 cm D grey, in places brownish	< 10	Pyrite and quartz grains	Light grey, with yellow tinge, upper 0.5 m slightly argillaceous, *very finely crystalline and microcrystalline* **limestone** with grains (10 - 20%) only in upper part . (Mudstone)

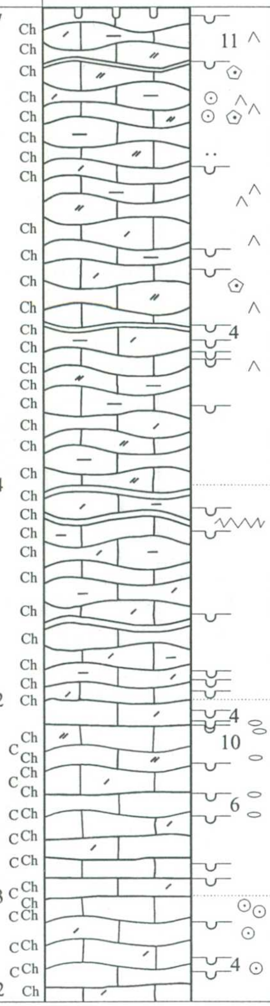
SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m) / SAMPLES / LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Llandovery	Juuru St. Õhne Fm Puikule M.	42	12	227.0 – 230.4	Horizontal bedding; massive with some thin nodules	> 50 cm IND greenish grey	> 70	Pyrite and quartz grains	Greenish grey, in the middle part dolomitic **calcitic marlstone** with fine horizontally oriented pyritic mottles, contains rare nodules of yellowish grey *micro- to very finely crystalline* limestone (grains < 10%, in the lower part 10 - 20%)
Ashgill	Porkuni St. Salduse Fm.	42–43	13	230.4 – 232.5	Horizontal bedding; massive (microbedded)	< 0.3 to > 50 cm IND greenish or brownish grey	> 50	Quartz, glauconite, pyrite	Yellowish grey *micro- and very finely crystalline* **argillaceous limestone** (grains in the upper part up to 50%, usually 30%; quartz grains up to 30%) with interbeds of calcitic marlstone. (Packstone or rudstone)
Ashgill	Pirgu Stage Halliku Formation	43, 44, 45, 46, 47	14	232.5 –	Wavy bedding; thin- to medium-nodular	< 0.3 and 0.3 - 2.0 cm IND grey with greenish tinge with pyritic spots and violet mottles; (D)	10; < 50; 10	Pyrite grains	Grey medium- to slightly argillaceous *micro- and very finely crystalline* **limestone** with pyritic spots and, in places, with violet mottles. (Mudstone)

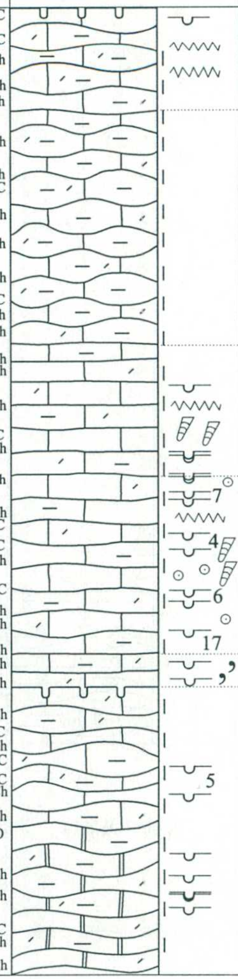


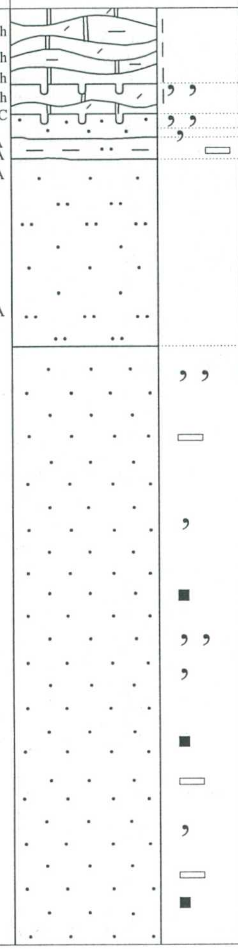
SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Ashgill	Pirgu Stage Halliku Formation	48 49 50			Ch Ch Ch Ch Ch Ch Ch Ch Ch O Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch		☞	IND	10 10 - 40		☞ follow up ⇦ Interval 260.9 - 261.2 m is bioturbated (grains up to 20%)
	Pirgu Stage Jonstorp Formation	51 52 53	15	264.8	O Ch Ch Ch O Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch		Wavy bedding; irregularly thin-nodular or thin-bedded	< 2 cm IND or D grey or reddish violet with yellow streaks	< 30		Reddish violet, with yellow streaks or greenish yellow spots, slightly to highly argillaceous *very finely crystalline* **limestone** (grains 10 - 25%, rarely > 25%). (Wackestone)

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Ashgill	Pirgu Stage Jonstorp Fm.	54			Ch, Ch		☞				☞ follow up
Ashgill	Vormsi St. Fjäcka Fm.		16	280.0	Ch, Ch, Ch, Ch, Ch, Ch		Wavy bedding; massive, in places rugged- or medium-bedded	< 0.5 to > 50 cm IND or D greenish	> 50		Greenish **argillaceous and calcitic marlstone** with interbeds of greenish grey (with yellow streaks) *very finely crystalline* limestone. Limestone contains pyritized skeletal debris (grains < 10%, in the lower part up to 40%). (Mudstone)
Caradoc	Nabala St. Saunja Fm.	55		282.6	Ch, O Ch		Wavy bedding; medium-seminodular	< 0.5 cm D grey	< 5		Beigish light grey *crypto- and microcrystalline* **limestone** with calcite-filled primary and secondary veins. (Mudstone)
Caradoc	Nabala St. Mõntu Fm.		17	283.2	O Ch, O, Ch, O Ch		Wavy bedding; medium-bedded	< 0.5 to 3.0 cm IND or D; greenish	< 5	Glauconite	Grey slightly argillaceous *finely to very finely crystalline* **limestone** with limonitized or pyritized discontinuity surfaces. (Wackestone)
Caradoc	Rakvere St. Rägavere Fm.	56	18	286.5	O Ch, O Ch, O Ch, Ch		Wavy bedding; thin- to thick-bedded or irregularly thin- to medium-nodular	< 0.5 to 2.0 cm IND greenish or grey	< 5		Yellowish grey or grey *finely or very finely crystalline* **limestone.** Upper 0.4 m bioturbated. (Mudstone)
Caradoc	Oandu Stage Lukštai Formation	57	19	288.4	O, O Ch, O Ch, O Ch, O, Ch	core is missing	Wavy bedding; medium- to thick-bedded (with lenses and nodules)	10 - 20 cm IND greenish dark grey	30 - 60	Pyrite	Intercalation of **argillaceous and calcitic marlstone** with interbeds of light grey *finely to very finely crystalline* **argillaceous limestone**. (Wackestone and mudstone)
Caradoc	Keila Stage Keila Formation	58, 59		296.6	O Ch, O Ch, O Ch, O, Ch, O Ch, O Ch		Wavy bedding; medium-nodular (medium-bedded)	1.0 - 5.0; (7.0) cm IND dark grey	< 30		Intercalation of **marlstone** and grey *very finely crystalline* **argillaceous limestone**. (Wackestone and mudstone)

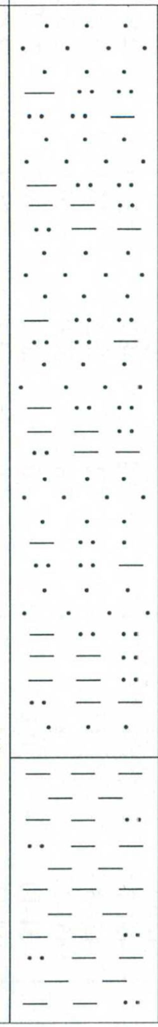
SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Caradoc	Keila Stage Keila Formation.	59		0	Ch Ch		☞				☞ follow up
		60		304.8	Ch		Wavy bedding; medium-bedded or thin-nodular	< 0.2 or 2 - 5 cm D dark grey	20		Light grey, in places slightly argillaceous, *very finely crystalline* **limestone** (grains < 20%) with calcite-filled secondary veins. (Wackestone)
		61	20	307.8	Ch Ch		Wavy bedding; irregularly thin- to medium-nodular, in places medium-bedded	< 10 cm IND greenish dark grey	10 - 20		Intercalation of grey slightly to highly argillaceous *very finely crystalline* **limestone** (grains < 10%, in places 20%; mudstone) and **marlstone**. The lower boundary is marked by a K-bentonite (thickness 7 cm).
	Jõhvi Stage Jõhvi Formation	62	21	313.7	Ch Ch Ch Ch Ch Ch Ch Ch		Wavy bedding; thin- to medium-nodular or medium-bedded	< 0.2 cm up to 2.0 (5 - 7) cm IND greenish dark grey	20 - 30 (40)		Intercalation of grey *very finely crystalline* (grains < 10%, in places 20%; mudstone) **limestone** and **marlstone**
	Idavere Stage Vasavere Fm.	63	22	318.4	Ch Ch Ch		Wavy bedding; thin- to medium-bedded or irregularly medium-nodular	2 (5) cm D (IND) dark grey	10 - 20		Grey slightly argillaceous *very finely crystalline* **limestone** (grains < 10%, in places 20%) with numerous interbeds of marlstone and burrows. (Mudstone)
	Idavere Stage Tatruse Fm.	64	23	320.6	Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch		Wavy bedding; thick- to medium-bedded with rare medium to thin seminodules	< 0.2 up to 2 cm D (IND) dark grey	5		Grey with yellow streaks, in places argillaceous, *finely and very finely crystalline* **limestone** (grains 10 - 25%, in places 30%) with phosphatized and pyritized discontinuity surfaces. (Wackestone)
				326.7							

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES / LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Caradoc / Llandeilo	Kukruse stage, Dreimani Formation	65, 66, 67, 68	24	326.7 – 339.4		Wavy bedding; medium-bedded to seminodular	3 - 5 cm D (IND) greenish grey, (brownish grey)	10 - 30 (30 - 40)	Goethitic ooliths	Grey pure to medium argillaceous *very finely to finely crystalline* **limestone** (grains > 10%; wackestone). In the upper part goethitic ooliths or pyritized coarse skeletal debris occur. In some beds marlstone is slightly kuckersineous. Characteristic are slightly phosphatized discontinuity surfaces
Llandeilo	Lasnamägi & Uhaku stages, Kõrgekallas Formation	69, 70	25	339.4 – 345.2		Wavy bedding; seminodular to medium-bedded	< 0.2 up to 2 cm (5 cm) D greenish dark grey	10 - 20		Greenish grey slightly argillaceous *very finely crystalline* **limestone** (grains > 10%; wackestone) with some beds of beigish grey *microcrystalline* limestone (mudstone) and whitish burrows. Discontinuity surfaces are phosphatized or pyritized
Llandeilo	Lasnamägi & Uhaku stages, Väo Formation	70, 71		345.2 – 350.3		Wavy bedding; medium- to thick-bedded	< 0.2 up to 2 cm D greenish grey	5 - 10		Beigish light grey pure to slightly argillaceous *micro- to very finely crystalline* **limestone** (grains > 25%) with phosphatized and pyritized discontinuity surfaces. (Wackestone)
Llanvirn	Väo Formation	72	26	350.3 – 353.2		Wavy bedding; medium-bedded (thin-bedded to seminodular)	< 0.2 up to 0.5 cm	< 5	Goethitic ooliths	Greenish light to dark grey pure to slightly argillaceous *very finely crystalline* **limestone** (grains < 30%; wackestone or packstone). Discontinuity surfaces are slightly pyritized

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Llanvirn	Stimas Fm.	72 73	27	353.2	C C C Ch C Ch C,Ch		Wavy bedding; seminodular	< 0.2 up to 1 cm IND reddish grey or dark grey	25 - 30		Alternatingly red and greenish grey slightly argillaceous *very finely crystalline* **limestone** (grains > 10%) with burrows and greenish spots. (Wackestone)
	Aseri Stage Segerstad Formation	73 74	28	355.9	C C,Ch C,Ch C C Ch Ch Ch C C,Ch C Ch		Wavy bedding to low angle cross-bedding; thin-nodular (to seminodular)	< 0.2 or 3 cm D dark brownish red	40 - 50		Intercalation of dark brownish red argillaceous *very finely crystalline* **limestone** (grains > 10%; wackestone, with mudstone interbeds) and **calcitic marlstone**. In places occur greenish spots. Insoluble residue of calcitic marlstone is < 50%
	Kunda Stage Šakyna & Baldone formations	75		362.2	C,Ch C,Ch C C,Ch C C,Ch		Wavy bedding; medium- to thick-bedded	< 0.2 up to 1 cm D (IND) reddish greenish grey	5 - 10		Light reddish brown, with some greenish grey interbeds and spots, *very finely crystalline* **limestone** (grains > 10%; wackestone) with burrows. Discontinuity surfaces are limonitized
Arenig		76	29	365.8	C C,Ch C C,Ch C C C,Ch C C,Ch O Ch C O C,Ch		Wavy bedding; medium-bedded (thick-bedded)	< 0.2 cm IND greenish or reddish dark grey	< 5	Goethitic ooliths > 20%	Reddish brown, in the lower part intercalated by greenish grey beds, slightly to medium argillaceous *very finely crystalline* **limestone** (grains > 10%; wackestone). Frequent limonitized discontinuity surfaces and burrows are characteristic
		77		370.5 371.4	O C,Ch C Ch C O O Ch C O C		Wavy bedding; medium- to thick-bedded	< 0.2 cm IND grey	< 5	Glauconite 1 - 2%	Dark grey pure to slightly argillaceous *finely crystalline* **limestone** (grains < 30%; wackestone). Indistinct phosphatized and pyritized discontinuity surfaces are characteristic
	Volkhov Stage Kriukai Formation	78 79		373.8	O Ch C,Ch O O C Ch O C,Ch C O C,Ch C,Ch		Wavy bedding.; seminodular to thin-bedded, in places medium-bedded	< 0.2 (1) cm D (IND) reddish or greenish dark grey	5 - 10		Brownish red slightly to medium argillaceous *very finely crystalline* **limestone** (grains > 10%; wackestone). Below 375.0 m, the rock is dolomitized, porous and cavernous. Discontinuity surfaces are mainly limonitized. The lower boundary is marked by a very distinct discontinuity surface with amphora-shaped borings

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Arenig & Tremadoc	Kriukai Fm.	79			C C O O C,Ch; C O C,Ch		☞				☞ follow up
			30	381.0	C O Ch; C O Ch		Wavy bedding; medium-bedded	< 0.2 up to 1 cm IND, reddish brown	< 10	Glauconite	Brownish red *very finely to finely crystalline* **dolostone** (grains > 10%) with some greenish grey interbeds and a few yellow stripes or spots
	1 / 2 / 3	80	31	381.8; 382.2	O C; C		Wavy bedding			Glauconite 20 - 30%	Greenish grey *fine-grained* medium- (upper 15 cm) to strongly-cemented **glauconitic quartz sandstone**
				382.4	A; A		Wavy bedding				
Upper Cambrian	Petseri Formation			383.0	A		Horizontal bedding; microbedded			Glauconite	Brownish grey *coarse-grained (*with calcitic cement), in the lower part argillaceous **quartz sandstone**
										Mica	Greenish light grey **silty claystone** with intercalations of sandstone
					A		Wavy bedding; cross-bedded				Greenish grey (in places beigish) medium-cemented medium-sorted *fine-grained* **quartz sand- and siltstone** with fragments of lingulate brachiopods
Middle Cambrian	Paala Beds			388.0			Horizontal bedding			Glauconite and pyrite grains	Light beige weakly cemented *very fine-grained* **quartz sandstone**
				404.0							

1. Varangu to Billingen stages, Zebre Formation
2. Varangu to Billingen stages, Leetse Formation
3. Pakerort Stage, Kallavere Formation

SERIES	LOCAL STRATIGRAPHIC UNITS	CORE BOX NO	FIGURES	DEPTH (m)	SAMPLES	LITHOLOGY	SEDIMENTARY STRUCTURES	MARL BEDS	MARL CONTENT (%)	ACCESSORY MINERALS AND OOLITHS	SHORT DESCRIPTION
Middle Cambrian	Paala Beds	80		404.0							Light grey medium-cemented **sandstone and argillaceous siltstone** with interbeds of claystone
				424.0							Greenish grey mottled **claystone** with interbeds of argillaceous siltstone
				431.0							

APPENDIX 2

Samples from Devonian strata

Sample	Sampled interval (m)	Regional Stage
453-1	15.00 – 15.30	Aruküla
453-2	19.70 – 19.75	Aruküla
453-3	24.30 – 24.40	Aruküla
453-4	34.00 – 34.50	Aruküla
453-5	43.20 – 43.40	Aruküla
453-6	50.00 – 50.30	Narva
453-7	61.00 – 61.20	Narva
453-8	70.10 – 70.50	Narva
453-9	79.50 – 80.00	Narva
453-10	89.50 – 90.00	Narva
453-11	95.30 – 95.35	Narva
453-12	103.40 – 103.50	Narva
453-13	119.60 – 119.80	Narva
453-14	132.00 – 132.50	Pärnu
453-15	142.30 – 142.60	Pärnu
453-16	144.00 – 146.00	Rēzekne

APPENDIX 3

Grain-size distribution of rocks in Devonian strata (in percent)
(A. Kleesment)

Sample	> 1 mm	1–0.5 mm	0.5–0.25 mm	0.25–0.1 mm	0.1–0.05 mm	0.05–0.01 mm	0.01–0.005 mm	< 0.005 mm
451-1	-	+	+	12.6	46.1	32.9	3.1	5.3
451-2	+	0.1	0.9	46.0	29.8	12.0	7.0	4.2
451-3	-	+	1.3	66.6	14.1	8.7	6.1	3.2
451-4	+	0.1	0.2	17.6	41.8	22.8	15.6	1.9
451-5	-	+	0.3	54.7	31.0	9.9	2.1	2.0
451-6	-	-	+	5.7	35.2	41.9	8.6	8.6
451-7	-	+	+	11.8	48.7	32.0	4.0	3.5
451-8	-	+	+	6.2	45.5	36.1	8.0	4.2
451-9	-	+	+	7.8	67.0	20.4	3.0	1.8
451-10	+	0.1	0.1	1.0	20.2	49.3	24.8	4.5
451-11	-	-	+	6.4	61.1	25.7	3.8	3.0
451-12	+	+	+	0.1	0.3	9.5	36.1	54.0
451-13	+	+	0.1	0.4	0.2	5.6	sum of both=93.7	
451-14	+	2.5	31.4	43.5	6.3	5.0	6.3	5.0
451-15	+	+	1.7	40.3	34.6	16.3	4.1	3.0
451-16	+	+	3.6	51.8	36.0	3.5	2.1	3.0

+ less than 0.1; - not found

APPENDIX 4

Light minerals, heavy minerals and dolomitic component in Devonian strata (in percent)
(A. Kleesment)

Sample	Light minerals								Heavy minerals	Dolomitic component
	Quartz	Orthoclase	Plagioclase	Microcline	Muscovite	Biotite (green)	Biotite (brown)	Weathered mica		
451-1	72.6	22.6	0.3	0.3	1.2	3.0	-	-	0.18	2.0
451-2	88.6	9.3	-	-	0.6	1.2	0.3	-	0.51	18.4
451-3	76.9	12.3	0.3	-	1.5	9.0	-	-	0.30	18.0
451-4	88.6	10.8	-	-	-	0.6	-	-	0.20	22.9
451-5	73.3	20.7	-	-	2.1	3.9	-	-	0.55	+
451-6	67.9	28.9	0.9	-	2.0	0.3	-	-	0.22	17.0
451-7	72.7	24.6	1.2	0.3	0.6	0.6	-	-	0.28	1.2
451-8	81.7	14.1	0.6	0.6	2.7	-	0.3	-	0.15	15.1
451-9	78.4	19.8	0.6	0.3	0.3	0.6	-	-	0.03	4.6
451-10	62.8	32.4	0.9	-	3.0	0.9	-	-	0.31	7.5
451-11	72.2	22.1	0.3	0.3	1.5	3.6	-	-	0.24	2.1
451-12	61.6	30.9	1.2	-	4.2	1.5	0.3	0.3	2.9	1.5
451-13	65.5	24.6	0.3	-	7.8	1.8	-	-	0.52	24.0
451-14	86.5	11.7	1.5	0.3	-	-	-	-	0.01	34.0
451-15	84.3	13.6	1.2	0.6	-	0.3	-	-	0.28	9.5
451-16	84.3	14.2	1.2	-	-	0.3	-	-	0.26	-

+ less than 0.1; - not found

APPENDIX 5

Heavy minerals in Devonian strata (in percent)
(A. Kleesment)

Sample	Biotite (brown)	Biotite (green)	Chlorite	Muscovite	Baryte	Sphalerite	Pyrite	Fe-hydroxides	Leucoxene	Ilmenite Magnetite	Transparent detrital minerals
453-1	1.2	16.2	0.8	1.6	-	-	-	2.4	6.8	37.6	33.4
453-2	-	4.0	1.1	-	-	-	-	1.6	7.0	52.3	34.0
453-3	1.4	13.5	1.0	+	-	-	-	3.0	9.0	33.4	38.6
453-4	0.4	52.8	1.6	+	-	-	-	3.6	6.2	20.4	15.0
453-5	1.0	44.0	0.2	-	-	-	-	2.8	3.6	20.6	27.8
453-6	1.0	45.0	3.6	0.8	-	-	-	3.2	11.2	15.8	19.4
453-7	0.8	52.6	2.0	13.4	-	-	-	4.6	3.8	13.6	9.2
453-8	2.0	33.2	2.2	6.8	0.2	-	1.0	0.4	6.4	23.6	24.2
453-9	1.6	62.6	1.0	2.4	-	-	-	8.2	4.8	11.6	8.0
453-10	+	30.0	1.4	57.2	-	-	0.2	3.0	2.0	1.4	4.6
453-11	3.6	64.2	0.6	19.2	-	-	0.2	3.8	3.4	3.0	2.0
453-12	16.6	56.4	1.2	13.2	-	-	-	5.4	0.2	5.2	1.8
453-13	1.2	6.2	-	-	1.6	5.8	21.8	32.8	1.4	27.8	1.4
453-14	0.6	10.1	0.6	3.4	-	-	0.6	8.0	3.1	42.6	31.0
453-15	1.8	2.2	+	+	-	-	0.4	2.4	3.6	40.8	48.8
453-16	+	0.6	-	0.6	-	-	0.2	0.6	4.4	32.6	60.0

+ less than 0.1; - not found

APPENDIX 6

Heavy transparent detrital minerals in Devonian strata (in percent) (A. Kleesment)

Sample	Garnet	Zircone	Tourmaline	Staurolite	Apatite	Rutile	Titanite	Anatase	Weathered Ti-min-s	Monazite	Amphibole	Corundum
453-1	12.2	19.1	26.0	-	39.1	2.2	-	-	1.1	0.3	-	-
453-2	43.0	19.2	10.4	2.8	22.0	1.2	-	-	0.6	0.6	0.2	-
453-3	38.0	10.8	18.6	4.0	28.0	0.6	-	-	-	-	-	-
453-4	19.0	19.3	27.4	2.9	28.4	2.7	-	-	-	0.3	-	-
453-5	38.0	14.4	11.8	0.6	33.8	1.4	-	-	-	-	-	-
453-6	4.0	6.0	23.0	-	65.2	1.0	-	0.6	0.2	-	-	-
453-7	6.2	7.6	27.6	-	56.2	1.2	0.2	-	1.0	-	-	-
453-8	19.8	14.8	25.6	-	35.1	1.9	0.2	-	2.4	0.2	-	-
453-9	5.4	0.5	35.0	-	58.6	0.5	-	-	-	-	-	-
453-10	12.5	8.8	30.7	-	45.1	2.3	-	-	0.6	-	-	-
453-11	48.3	9.2	17.2	-	19.6	2.3	2.3	-	-	-	-	-
453-12	58.0	17.5	9.1	0.8	3.1	3.8	4.6	-	3.1	-	-	-
453-13	15	15	23	-	-	-	-	-	-	-	47	-
453-14	57.4	17.8	16.8	-	2.0	2.0	-	-	2.0	1.0	-	1.0
453-15	55.4	19.6	17.2	-	4.6	1.6	0.8	0.4	-	-	0.4	-
453-16	66.8	14.8	12.4	-	4.8	0.2	-	-	1.0	-	-	-

- not found

APPENDIX 7

Thin sections and samples of insoluble residue from Silurian strata (P. Kattel, 1992)

Sample	Thin section interval (m)	Insoluble residue interval (m)	Insoluble residue (%)	Regional Stage
1	219.63–219.71	219.68–219.71	40.7	Juuru
2	-	222.05–222.10	73.0	Juuru
3	223.65–223.75	223.65–223.75	17.9	Juuru
4	225.00–225.10	224.95–225.00	36.9	Juuru
5	226.65–226.68	226.65–226.68	30.1	Juuru
6	227.40–227.60	227.40–227.60	28.0	Juuru
7	228.45–228.55	228.45–228.55	26.8	Juuru
8	229.30–229.40	229.30–229.40	24.6	Juuru
9	230.20–230.40	230.20–230.40	26.1	Juuru
10	230.70–230.80	230.70–230.80	28.3	Porkuni
11	231.05–231.13	231.05–231.13	25.3	Porkuni
12	231.40–231.55	231.40–231.55	31.9	Porkuni
13	231.80–232.00	231.80–232.00	17.0	Porkuni
14	232.05–232.15	232.05–232.15	21.0	Porkuni
15	232.30–232.40	232.30–232.40	12.1	Porkuni
16	232.45–232.55	232.45–232.55	10.3	Pirgu to Porkuni
17	233.20–233.40	233.20–233.40	20.3	Pirgu

APPENDIX 8

Acanthodians in Devonian strata (J. Valiukevičius)

SPECIES	SAMPLES						
	15.0–15.3 m	19.7–19.75 m	24.3–24.4 m	50.0–50.3 m	61.0–61.2 m	70.1–70.5 m	89.5–90.0 m
Acanthodes ? sp. A		x	x	x	x	x	x
Acanthodes ? sp. B	x						x
Acanthodes ? sp. D	x	x	x			x	x
Cheiracanthoides proprius							x
Cheiracanthus brevicostatus	x	x	x				
C. longicostatus							x
Cheirolypis sp.		x					
Crossopterygii gen. indet		x					
Diplacanthus carinatus							x
Dipteridae gen. indet.							x
Glyptolepis sp.							x
Markacanthus alius			x				
M. costulatus							x
Onychodus sp.	x	x					
Osteolepididae gen. indet							x
Placodermi gen. indet.	x	x	x				x
Psammosteidae gen. indet.	x	x	x				x
Ptychodictyon rimosum		x	x	x			
P. sulcatum		x	x				
Rhadinacanthus balticus							x
R. multisulcatus		x	x				
Unidentified fragments of ichthyofauna	x		x				

APPENDIX 9

Acritarchs in Upper Cambrian strata (I. Paalits)

Sample	Sampled level (m)
T-1	382.5
T-2	382.9
T-3	383.4
T-4	387.0

Identified taxa

Cymatiogalea aspergillum Martin
C. dentalea Paalits
C. virgulta Martin
C. wironia Paalits
Dasydiacrodium setuensis Paalits
Leiofusa stoumonensis Vanguestaine
Leiofusa sp.
Micrhystridium sp.
Poikilofusa sp.

Raphesphaera turbata (Martin) Volkova
Stelliferidium cortinulamorphum Paalits
S. aff. *pseudoornatum* Pittau
Timofeevia lancarae (Cramer & Diez) Vanguestaine
T. pentagonalis (Vanguestaine) Vanguestaine
T. phosphoritica Vanguestaine
Veryhachium incus Paalits

APPENDIX 10

List of ostracode samples (T. Meidla)

I series of samples			II series of samples		
Sample	Sampled level (m)	Regional Stage	Sample	Sampled interval (m)	Regional Stage
453-1	227.0	Juuru	453-1	283.50–283.60	Nabala
453-2	226.6	Juuru	453-2	284.30–284.40	Nabala
453-3	227.5*	Juuru	453-3	284.90–285.10	Nabala
453-4	229.35*	Juuru	453-4	285.91–286.02	Nabala
453-6	231.65*	Porkuni	453-5	286.70–286.80	Rakvere
453-8	233.7	Pirgu	453-6	287.50–287.60	Rakvere
453-9	234.9	Pirgu	453-7	286.00–286.10	Nabala
453-10	236.0	Pirgu	453-8	286.50–286.60	Rakvere
453-11	237.4	Pirgu	453-9	292.75–292.90	Oandu
453-12	238.75*	Pirgu	453-10	293.55–293.65	Oandu
453-13	239.9	Pirgu	453-11	294.90–295.10	Oandu
453-15	241.85	Pirgu	453-12	294.10–294.25	Oandu
453-16	242.85	Pirgu	453-13	295.60–295.75	Oandu
453-18	244.9	Pirgu	453-14	296.60–296.75	Keila
453-19	245.95	Pirgu	453-15	297.35–297.50	Keila
453-21	247.5	Pirgu	453-16	298.15–298.30	Keila
453-22	248.45	Pirgu	453-17	299.20–299.35	Keila
453-30	257.0	Pirgu	453-18	300.27–300.40	Keila
453-38	264.95	Pirgu	453-19	301.15–301.30	Keila
453-39	266.55	Pirgu	453-20	302.32–302.44	Keila
			453-21	369.60–369.70	Kunda
			453-22	370.30–370.40	Kunda
			453-23	370.85–370.95	Kunda
			453-24	371.45–371.60	Kunda
			453-25	372.15–372.25	Kunda
			453-26	372.80–372.90	Kunda
			453-27	373.50–373.60	Kunda
			453-28	374.25–374.40	Volkhov
			453-29	375.20–375.35	Volkhov
			453-30	376.20–376.30	Volkhov
			453-31	376.95–377.05	Volkhov
			453-32	378.00–378.10	Volkhov
			453-33	379.15–379.30	Volkhov
			453-34	379.50–379.60	Volkhov
			453-35	380.00–380.10	Volkhov
			453-36	380.75–380.90	Volkhov
			453-37	381.25–381.40	Varangu- to
			453-38	381.60–381.70	Billingen

*no ostracodes

APPENDIX 11

List of chitinozoan samples (Garmen Bauert & Heikki Bauert)

Sampled interval (m)	Regional Stage	Sampled interval (m)	Regional Stage
227.60–227.80	Juuru	256.55–256.70	Pirgu
228.50–228.70	Juuru	257.10–257.25	Pirgu
229.05–229.20	Juuru	257.80–257.95	Pirgu
229.65–229.90	Juuru	258.70–258.85	Pirgu
230.10–230.30	Juuru	259.20–259.30	Pirgu
230.90–231.07	Porkuni	259.75–259.85	Pirgu
231.20–231.35	Porkuni	260.60–260.75	Pirgu
231.65–231.80	Porkuni	261.15–261.30	Pirgu
232.25–232.40	Porkuni	261.80–261.95	Pirgu
232.80–232.95	Pirgu	262.55–262.70	Pirgu
233.30–233.45	Pirgu	263.10–263.20	Pirgu
233.90–234.10	Pirgu	263.60–263.75	Pirgu
234.50–234.65	Pirgu	264.15–264.30	Pirgu
235.20–235.45	Pirgu	264.65–264.80	Pirgu
235.75–235.85	Pirgu	265.20–265.30	Pirgu
236.20–236.35	Pirgu	265.80–265.95	Pirgu
236.70–236.85	Pirgu	266.85–267.00	Pirgu
237.10–237.30	Pirgu	268.25–268.35	Pirgu
237.70–237.80	Pirgu	269.45–269.60	Pirgu
238.35–238.50	Pirgu	270.50–270.60	Pirgu
239.05–239.30	Pirgu	271.30–271.40	Pirgu
239.65–239.80	Pirgu	272.05–272.20	Pirgu
240.35–240.45	Pirgu	272.70–272.90	Pirgu
241.00–241.20	Pirgu	274.10–274.25	Pirgu
241.85–242.00	Pirgu	275.60–275.80	Pirgu
242.20–242.35	Pirgu	276.75–276.90	Pirgu
242.85–243.00	Pirgu	277.50–277.65	Pirgu
243.30–243.40	Pirgu	278.80–278.90	Pirgu
243.80–243.95	Pirgu	279.80–279.90	Pirgu
244.30–244.40	Pirgu	280.10–280.30	Vormsi
244.90–245.00	Pirgu	280.55–280.65	Vormsi
245.20–245.35	Pirgu	281.15–281.30	Vormsi
245.60–245.80	Pirgu	281.90–282.00	Vormsi
246.30–246.45	Pirgu	282.20–282.30	Vormsi
246.90–247.00	Pirgu	282.74–282.85	Nabala
247.30–247.45	Pirgu	283.28–283.43	Nabala
247.80–248.00	Pirgu	283.73–283.82	Nabala
248.30–248.55	Pirgu	284.60–284.70	Nabala
248.90–248.95	Pirgu	285.40–285.60	Nabala
249.30–249.45	Pirgu	285.80–285.92	Nabala
249.95–250.10	Pirgu	286.45–286.60	Rakvere to Nabala.
250.30–250.40	Pirgu	286.90–287.00	Rakvere
250.80–250.90	Pirgu	287.40–287.55	Rakvere
251.30–251.45	Pirgu	288.40–288.55	Oandu
252.00–252.15	Pirgu	293.20–293.35	Oandu
252.45–252.55	Pirgu	294.25–294.45	Oandu
252.95–253.05	Pirgu	295.20–295.40	Oandu
253.20–253.40	Pirgu	296.20–296.35	Oandu
253.95–254.05	Pirgu	296.90–297.10	Keila
254.40–254.55	Pirgu	297.85–298.00	Keila
254.95–255.05	Pirgu	298.85–299.00	Keila
255.40–255.55	Pirgu	299.85–300.00	Keila
256.10–256.30	Pirgu	300.70–300.85	Keila

Appendix 11 continued

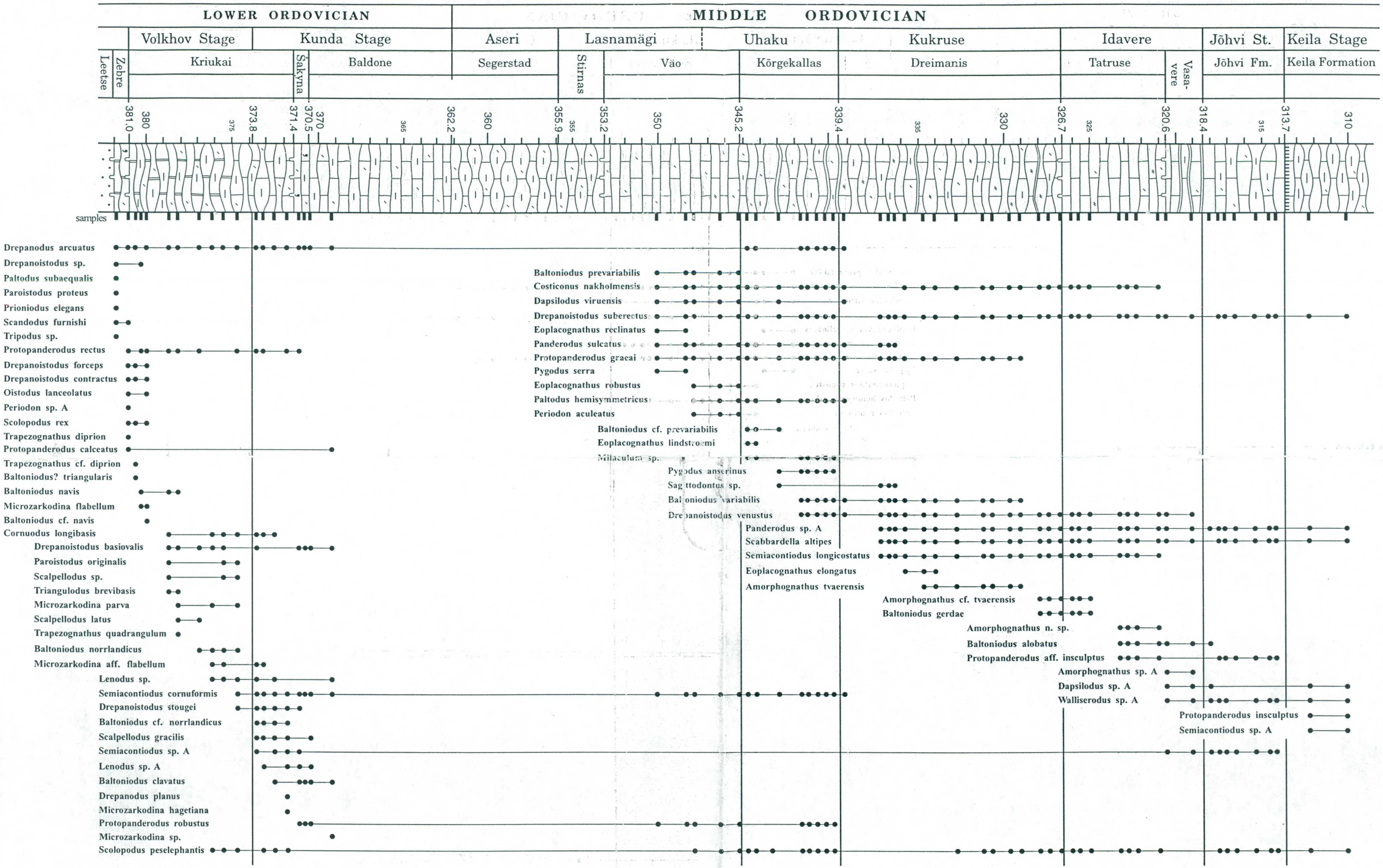
Sampled interval (m)	Regional Stage	Sampled interval (m)	Regional Stage
301.75–302.00	Keila	342.95–343.08	Lasnamägi to Uhaku
302.90–303.00	Keila	343.69–343.81	Lasnamägi to Uhaku
304.40–304.60	Keila	344.21–344.35	Lasnamägi to Uhaku
307.97–308.16	Keila	344.73–344.88	Lasnamägi to Uhaku.
309.97–310.16	Keila	345.25–345.42	Lasnamägi to Uhaku
312.13–312.28	Keila	346.25–346.40	Lasnamägi to Uhaku
314.12–314.32	Jõhvi	346.74–346.90	Lasnamägi to Uhaku
314.69–314.80	Jõhvi	347.10–347.26	Lasnamägi to Uhaku
315.32–315.50	Jõhvi	347.84–348.00	Lasnamägi to Uhaku
316.06–316.27	Jõhvi	348.36–348.55	Lasnamägi to Uhaku
316.50–316.68	Jõhvi	348.90–349.07	Lasnamägi to Uhaku
317.06–317.22	Jõhvi	349.61–349.79	Lasnamägi to Uhaku
317.50–317.66	Jõhvi	350.10–350.25	Lasnamägi to Uhaku
318.08–318.21	Jõhvi	350.57–350.76	Lasnamägi to Uhaku
319.09–319.20	Idavere	350.95–351.08	Lasnamägi to Uhaku
320.08–320.25	Idavere	351.84–352.00	Lasnamägi to Uhaku
320.50–320.67	Idavere	352.52–352.66	Lasnamägi to Uhaku
321.03–321.22	Idavere	353.00–353.15	Lasnamägi to Uhaku
321.73–321.83	Idavere	354.50–354.60	Lasnamägi to Uhaku
322.29–322.42	Idavere	355.05–355.20	Lasnamägi to Uhaku
322.69–322.85	Idavere	355.70–355.90	Lasnamägi to Uhaku
323.21–323.40	Idavere	356.75–356.90	Aseri
324.05–324.27	Idavere	357.50–357.65	Aseri
324.86–325.03	Idavere	358.60–358.80	Aseri
325.40–325.56	Idavere	359.40–359.60	Aseri
325.95–326.07	Idavere	360.35–360.50	Aseri
326.70–326.86	Kukruse	361.35–361.45	Aseri
327.30–327.51	Kukruse	361.80–361.95	Aseri
327.86–328.02	Kukruse	362.55–362.65	Kunda
328.43–328.60	Kukruse	362.95–363.05	Kunda
329.00–329.18	Kukruse	363.90–364.05	Kunda
329.63–329.82	Kukruse	365.00–365.10	Kunda
330.10–330.32	Kukruse	365.85–366.00	Kunda
330.64–330.77	Kukruse	366.65–366.75	Kunda
331.18–331.36	Kukruse	368.00–368.20	Kunda
332.65–332.84	Kukruse	369.15–369.30	Kunda
333.49–333.72	Kukruse	369.75–369.90	Kunda
334.00–334.11	Kukruse	370.40–370.50	Kunda
334.59–334.72	Kukruse	370.70–370.85	Kunda
335.19–335.35	Kukruse	371.10–371.25	Kunda
335.70–335.85	Kukruse	372.00–372.15	Kunda
336.34–336.50	Kukruse	372.90–373.05	Kunda
336.68–336.81	Kukruse	374.15–374.30	Volkhov
337.13–337.27	Kukruse	374.65–374.80	Volkhov
337.90–338.08	Kukruse	376.35–376.50	Volkhov
338.49–338.60	Uhaku to Kukruse	376.85–377.00	Volkhov
339.06–339.23	Lasnamägi to Uhaku	378.15–378.25	Volkhov
339.71–339.88	Lasnamägi to Uhaku	378.60–378.80	Volkhov
340.18–340.28	Lasnamägi to Uhaku	379.75–380.00	Volkhov
340.68–340.83	Lasnamägi to Uhaku	380.25–380.40	Volkhov
341.33–341.48	Lasnamägi to Uhaku	380.90–381.00	Volkhov
341.82–341.98	Lasnamägi to Uhaku	381.40–381.55	Varangu to Billingen

APPENDIX 12

List of conododont samples (S. Stouge)

Sampled interval (m)	Regional Stage	Sampled interval (m)	Regional Stage
309.97–310.16	Keila	339.71–339.88	Lasnamäe to Uhaku
312.13–312.28	Keila	340.18–340.28	Lasnamäe to Uhaku
314.12–314.32	Jõhvi	340.68–340.86	Lasnamäe to Uhaku
314.65–314.80	Jõhvi	341.33–341.48	Lasnamäe to Uhaku
315.32–315.50	Jõhvi	341.42–341.82	Lasnamäe to Uhaku
316.50–316.68	Jõhvi	342.95–343.08	Lasnamäe to Uhaku
317.06–317.22	Jõhvi	344.21–344.35	Lasnamäe to Uhaku
317.50–317.66	Jõhvi	344.73–344.88	Lasnamäe to Uhaku
318.08–318.21	Jõhvi	345.25–345.42	Lasnamäe to Uhaku
319.09–319.20	Idavere	346.25–346.40	Lasnamäe to Uhaku
320.50–320.67	Idavere	347.84–348.00	Lasnamäe to Uhaku
321.03–321.22	Idavere	348.36–348.55	Lasnamäe to Uhaku
322.29–322.42	Idavere	350.10–350.25	Lasnamäe to Uhaku
322.69–322.85	Idavere	369.15–369.30	Kunda
323.21–323.40	Idavere	370.40–370.50	Kunda
324.86–325.03	Idavere	370.70–370.85	Kunda
325.40–325.56	Idavere	371.10–371.25	Kunda
325.95–326.07	Idavere	371.90–371.98	Kunda
326.60–326.76	Kukruse to Idavere	372.52–372.65	Kunda
327.30–327.51	Kukruse	373.06–373.15	Kunda
327.86–328.02	Kukruse	373.60–373.69	Kunda
329.00–329.10	Kukruse	374.72–374.80	Volkhov
329.63–329.82	Kukruse	375.50–375.60	Volkhov
330.64–330.77	Kukruse	376.10–376.20	Volkhov
331.18–331.36	Kukruse	376.85–377.00	Volkhov
332.65–332.84	Kukruse	378.15–378.25	Volkhov
334.00–334.11	Kukruse	378.60–378.80	Volkhov
334.59–334.72	Kukruse	380.10–380.16	Volkhov
335.70–335.83	Kukruse	380.25–380.40	Volkhov
336.34–336.50	Kukruse	380.65–380.70	Volkhov
336.68–336.81	Kukruse	381.00–381.04	Varangu to
337.13–337.27	Kukruse	381.85–381.95	Billingen
339.06–339.27	Kukruse		

APPENDIX 13



Distribution of conodonts in the Tartu (453) core (S. Stouge)

Distribution of chitinozoans in the Tartu (453) core

(G. Bauert & H. Bauert)