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**THE ORDOVICIAN SYSTEM
OF THE EAST EUROPEAN PLATFORM AND
TUVA (SOUTHEASTERN RUSSIA)**

Correlation charts and explanatory notes

A.

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PLATFORM (ESTONIA, LATVIA, LITHUANIA,
BYELORUSSIA, PARTS OF RUSSIA, THE UKRAINE
AND MOLDOVA)

by Ralf Männil and Tõnu Meidla

B.

THE ORDOVICIAN SYSTEM OF TUVA
(SOUTHEASTERN RUSSIA)

by E. V. Vladimirkaya and A. V. Krivobodrova

Sponsored by the International Subcommittee on Ordovician Stratigraphy

Barry D. Webby, Chairman

S. Henry Williams, Secretary

Edited by Barry D. Webby, Reuben J. Ross Jr. and Yong Y. Zhen

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FOREWORD

The Ordovician System of the East European Platform (Estonia, Latvia, Lithuania, Byelorussia, parts of Russia, Ukraine and Moldova), and Tuva (SE Russia) is the third chart and explanatory notes in the series covering the territory of much of the former Soviet Union. It also represents the ninth publication of Ordovician correlation charts and explanatory notes produced in the IUGS Publication Series, and sponsored by the Subcommission on Ordovician Stratigraphy of the IUGS Commission on Stratigraphy. This volume is divided into two unequal parts. The first describes the rock units, and stage and series subdivisions of the East European Platform, and was being prepared by Dr Ralf Männil, foundation Vice Chairman of the Ordovician Subcommission from 1974-84, and a Titular member prior to his death in 1990, and was completed early in 1992 by Dr Tõnu Meidla, a colleague of Dr Männil's, also from the Institute of Geology of the Estonian Academy of Sciences. The second, much smaller contribution deals with the Ordovician stratigraphic subdivisions of Tuva, a small area in the eastern part of the Altai-Sayan mountain region of Siberia, near the Mongolian border, and was prepared by Drs E.V. Vladimirovskaya and A.V. Krivobodrova of VSEGEI in St. Petersburg, Russia. This Tuva section of the volume was edited by Reuben J. Ross Jr., and this gives me an opportunity to publicly acknowledge Rube's editorial contributions to this series, initiated during his term as Chairman of the Ordovician Subcommission, and involving, almost single-handedly, editing and assembling the eight previously published Ordovician correlation charts (see IUGS Publication Nos. 1, 6, 8, 11, 12, 21, 22 and 26, published between 1980 and 1988). -- BDW

A. THE ORDOVICIAN SYSTEM OF THE EAST
EUROPEAN PLATFORM
(ESTONIA, LATVIA, LITHUANIA, BYELORUSSIA,
PARTS OF RUSSIA, THE UKRAINE AND MOLDOVA)

by

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TABLE OF CONTENTS

	<u>page</u>
ABSTRACT	2
INTRODUCTION	2
DESIGN OF THE CORRELATION CHART	3
SYSTEMIC BOUNDARIES	5
THE CAMBRIAN-ORDOVICIAN BOUNDARY	5
THE ORDOVICIAN-SILURIAN BOUNDARY	6
CORRELATION WITH THE BRITISH STANDARD	6
CHRONOSTRATIGRAPHIC DIVISIONS	7
SERIES AND SUBSERIES	7
STAGES	9
NOTES FOR COLUMNS IN THE CORRELATION CHART	15
ALPHABETICAL LIST OF ROCK UNITS	18
REFERENCES	41

ILLUSTRATIONS

Figure 1. Location of regional successions.	4
Figure 2. Subdivision of the Kallavere Formation.	25
Chart 1. Correlation chart for the Ordovician System of the East European Platform. See <u>end pocket</u>	

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ABSTRACT

A correlation chart of the Ordovician strata for the western part of the East European Platform is presented with accompanying explanatory notes. The contribution comprises an updated English version of the Ordovician Correlation Chart which was accepted officially by the Interdepartmental Stratigraphic Committee of the USSR in 1984, and published subsequently in Russian (Resheniya ..., 1987).

INTRODUCTION

The study of the Ordovician rocks in the western part of the East European Platform was initiated in the nineteenth century. The introductory research was restricted to the Ordovician outcrop belt in northern Estonia and north of the Sankt Peterburg region; later the first boreholes were made, giving access to the Ordovician rocks within the subsurface area. The first Ordovician correlation chart for the western part of the East European Platform was officially accepted in 1962 (Resheniya ..., 1965). Subsequently, in the 1970s and 1980s, the correlation charts of the East Baltic, Byelorussia and Ukraine were added. These charts together with supplementary materials form the basis of the Ordovician Correlation Chart of the East European Platform, which was issued by the Interdepartmental Stratigraphic Committee of the USSR (Resheniya ..., 1987), here contributed as an updated English version. The Ordovician chart includes contributions from more than 20 authors, and has been edited mainly by R. Männil.

The present updated English version of the Ordovician correlation chart of the East European Platform covers the same territory as the formerly issued, official USSR correlation chart of 1987, except that the eastern subregions of Timan-Pechora and Orenburg have been excluded, because they are marginal parts of the neighbouring paleobasin (the Ural Basin). The westernmost part of the East European Platform (west of the previous territory of the USSR) has been excluded, as in this former compilation, though the same Ordovician chronostratigraphic units can be applied in such regions as north-eastern Poland. Consequently, the present chart with explanatory notes documents the Ordovician succession of the central and western parts of the East European Platform, but only within the regions of the former Soviet Union.

Predominantly carbonate Ordovician strata are preserved across a vast tract of country, virtually continuously from the North Estonian coast line (on the southern slopes of the Baltic Shield) in the north to the western slopes of the Ukrainian Shield in the south, and from the north-eastern part of Poland and the Kaliningrad Region in the west to the surroundings of Moscow in the east. In the East Baltic and adjacent areas, the Ordovician succession is almost complete, usually with local gaps. In the Sankt Peterburg and Novgorod regions the Harju (Upper Ordovician) age strata seem to be absent. In the Moscow Syncline the complete Ordovician succession occurs only in the central part. Over the rest of the territory the Harju age strata are missing. Small segregated areas with an incomplete Ordovician succession occur in the south-western marginal part of the East European Platform, in Podolia, Volyny, Moldova, and in south-western Byelorussia.

Usually the strata are moderately to highly fossiliferous, containing mainly shelly fossils, conodonts and chitinozoans, but locally also graptolites. A number of K-bentonite beds occur in the East Baltic sequence and at some levels these seem to be of remarkable correlative importance (see Bergström *et al.*, 1991).

For the main distribution sector of the Ordovician on the East European Platform the term "Baltic Basin" has been largely adopted in the last decades. The term specifies the epicontinental basin between the Caledonian geosyncline of Scandinavia and the erosional boundary of deposits in the east. Within the paleobasin various lithofacies are arranged in belts, which are characterized by a comparatively stable complex of litho- and biofacies characteristics. Jaanusson (1976, 1979) has called these "confacies belts". In general they reflect differences in depth, but their actual nature seems to be much more complicated than that of simple depth zonation (see Jaanusson, 1973). Earlier the terms "facies zone" (Männil, 1966) or "structural-facial zone" (Põlma, 1973) were used in analogous meaning, but in this present contribution the term "confacies belt" is preferred.

A special territorial subdivision has been elaborated for the formal correlation chart (see Figure 1). This subdivision reproduces the confacies boundaries reasonably well, but is influenced also by the administrative boundaries - used in the geological surveys of the former Soviet Union. The confacies subdivision is more universal than the territorial subdivision, but a set of corresponding terms has not yet been formulated for the entire region. Up to now they have been adopted for Baltoscandia only. In Figure 1, the areas 1-3, 7, and partly 8, represent the North Estonian Confacies Belt, 5-6 and a part of 8, the Lithuanian Confacies Belt, and 4, the Livonian Tongue of the Central Baltoscandian Confacies Belt (after Jaanusson, 1976). Although Männil (1966) has proposed also the "Moscow facies zone" (for the Moscow Confacies Belt), this terminology has not been used herein.

The authors gratefully acknowledge the valuable advice of D. Kaljo. Highly appreciated also is the aid of colleagues L. Hints and J. Nõlvak. In addition we thank Mrs. A. Noor for revising the English manuscript.

A final word about the authorship of this contribution. The late Dr Ralf Männil was the main author of the Ordovician correlation chart of the East European Platform (Resheniya ..., 1987). Consequently, as a Titular Member of the Ordovician Subcommittee, he was invited in the early 1980s to organize the compilation of an updated English version of the chart. In August 1990, shortly before his death, Dr Männil asked Dr T. Meidla to take over the project and handed over his incomplete description of rock units, the draft chart and some fragmentary notes. After a brief period of collaboration, Dr Meidla was left to complete the compilation. Dr Meidla has, in preparing this final draft of the chart and explanatory notes, attempted to keep to R. Männil's original concept of the chart. However a few changes have of been necessary, so this present compilation and the earlier, official USSR chart are not identical. [This manuscript was received by the Editor in May 1992].

DESIGN OF THE CORRELATION CHART

The present paper is based on the last of two most important formal correlation charts, compiled in the former USSR for the East European Platform in accordance with special official rules (Resheniya ..., 1965; Resheniya ..., 1987 - for a short review, see Männil, 1989).

The present chart lists the Ordovician rock units from 12 regions of the East European Platform. These regions are more-or-less the same as those adopted for the compilation of the

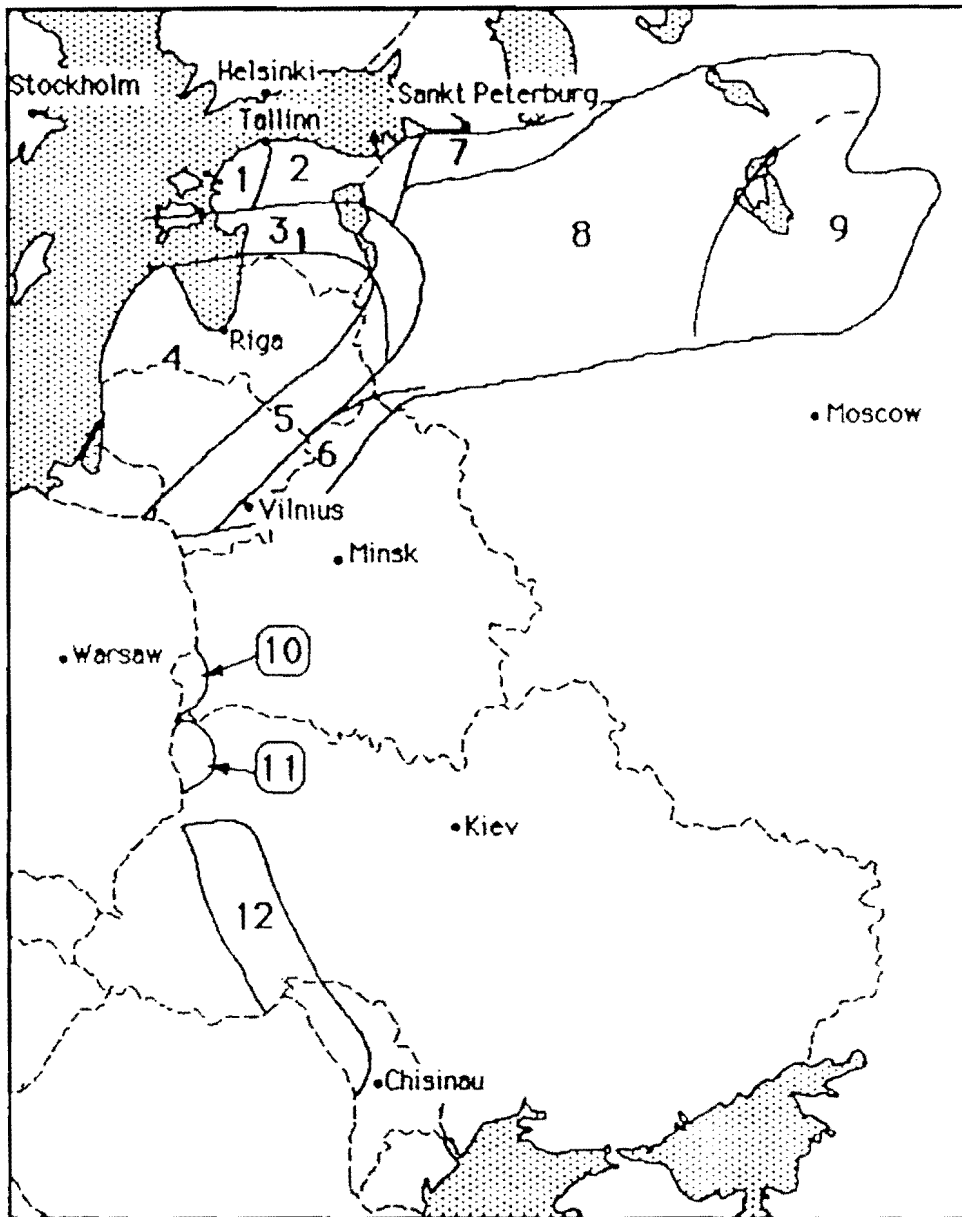


Figure 1. Location of regional successions in the midwestern (East Baltic-St.Peterburg), central Russian and southwestern marginal areas of the East European Platform. Locality numbers correspond to the column numbers shown in the correlation chart.

earlier, official USSR Ordovician correlation chart of the East European Platform (Resheniya ..., 1987). The column numbers coincide with the location numbers used in Figure 1, and the same numbers are also used in the accompanying descriptions of the rock units.

All the described formations and groups are listed in the columns. In some cases the members are also added, but usually they are listed in the description of a particular formation to keep the chart simpler and less confused. The biostratigraphical data as well as the identifications of rock types are left off the chart for the same reason; they too are included in the descriptions of the rock units. Symbols applied in the chart are traditional (unconformities are indicated by wavy lines, hiatuses by vertical ruled lines, etc.).

The left-hand margin provides the chronostratigraphic subdivision of the Ordovician. It comprises the three-fold division of the system into the Lower, Middle and Upper Ordovician, first introduced by Raymond (1916) and now, in a modified form, largely adopted in the given area. Also included are columns showing the British series, graptolite zonation and the regional standard subdivisions. Correlation with the British standard, and the regional series, subseries and stage subdivisions are discussed below.

SYSTEMIC BOUNDARIES

THE CAMBRIAN-ORDOVICIAN BOUNDARY

In the Ordovician correlation chart of the East European Platform (Resheniya ..., 1987) the Cambrian-Ordovician boundary was drawn according to the preliminary decision of the Interdepartmental Stratigraphic Committee of the USSR at the base of the *Cordylodus proavus* Zone. In the East Baltic the base of the Pakerort Stage is traditionally considered as the Cambrian-Ordovician boundary. As shown by Kaljo *et al.* (1986) these levels do not coincide. In their paper, two possible boundary levels were suggested, both stratigraphically higher than the base of the *C. proavus* Zone. The first, at the base of the Pakerort Stage in northern Estonia, coincides more or less exactly with the base of the *Cordylodus andresi* Zone and is marked by major hiatuses. The second one, the base of the *Cordylodus intermedius* Zone, is considerably higher than both the above-mentioned levels. While the global aspects of the Cambrian-Ordovician boundary are still under review, we prefer to maintain the boundary level, following customary practise and usage in the region, at the level of the base of the Pakerort Stage.

In the northern Sankt Peterburg region, the base of the *Cordylodus andresi* Zone lies within (or at the base of) the Lomashka Formation (Kaljo *et al.*, 1986). In the Novgorod and Yaroslavl regions the Cambrian-Ordovician boundary seems to occur at the base or within the Bugino Formation, from which *Rhabdinopora flabelliforme* has been reported (Rybnikova & Strikovskaya, 1984). In the East Baltic, outside northern Estonia, the Kallavere Formation has yielded the *Cordylodus angulatus* - *C. rotundatus* Zone conodonts (Ulst *et al.*, 1982) and inarticulates of the *Obolus apollinis* group (Laskov *et al.*, 1984). Both have a comparatively higher position in the section than *Cordylodus andresi* (Kaljo *et al.*, 1986) and suggest the northern Estonian sequence with *C. andresi* in the lower part of the Kallavere Formation to be the most complete section in the East Baltic region. In Byelorussia rare occurrences of sandstones, which are tentatively considered to be of lowermost Ordovician age and overlain by the fossiliferous Leetse Formation, have yielded oboloid fragments or phosphate pebbles. In Western Volyn the boundary level lies within the Vyzhivka Formation, from the top part of which *Obolus apollinis* has been reported. Regrettably the occurrences of *Obolus apollinis* in the Ordovician subsurface area must be treated as questionable, because earlier identifications

of these inarticulates are not in accord with the modern species concept (Puura & Holmer, in press).

In eastern Volyny, Podolia and Moldova the Cambrian-Ordovician boundary is marked by a hiatus corresponding to the Lower, and the greater part of the Middle, Ordovician.

THE ORDOVICIAN-SILURIAN BOUNDARY

In the officially accepted stratigraphical scheme (Resheniya ..., 1987) the boundary between the Ordovician and Silurian is drawn at the lower limit of the *Parakidograptus acuminatus* Zone. The topmost part of the Ordovician within the research area, as well as the lowermost part of the Silurian, have not yielded graptolites. The boundary is mostly defined by the appearance of other fossils, like brachiopods, chitinozoans, corals, conodonts, trilobites, etc. The taxonomic composition of these fossil groups changes dramatically on the boundary level (Nestor *et al.*, 1991).

Due to the Late Ordovician eustatic event, the uppermost Ordovician is more-or-less incomplete in most districts. In the East Baltic and north-western Byelorussia (columns 1-6) the Silurian rocks lie unconformably on Porkuni-age strata. In the Sankt Peterburg and Novgorod regions (columns 7, 8), as well in the south-western districts (columns 10-12), the Upper Ordovician is missing or represented with its lowermost part only. In the Yaroslavl region (column 9) the sequence seems to be the most problematic. The palaeontological information suggests that the Poshekhonye Formation ranges from the Upper Ordovician to the Devonian (see Prokofjev & Kuznetsov, 1982).

CORRELATION WITH THE BRITISH STANDARD

British series have been displayed systematically on the left-hand side of correlation charts, compiled in the former USSR. The differences between the international and the Russian stratigraphical terminology have been summarized by Ross (1984). In accordance with the practice of Russian stratigraphy, British series have traditionally been used as the subdivisions of the unit of subsystem category, with the Tremadoc and Arenig belonging to the Lower Ordovician, the Llanvirn, Llandeilo and Caradoc to the Middle Ordovician, and the Ashgill to the Upper Ordovician (Nikitin, 1984). The selection of global stratotypes for the bases of series in the Ordovician System should resolve relationships to the British standard and chronostratigraphical subdivisions for Russian usage.

In accordance with the official standpoint of the Stratigraphic Committee of the former USSR, the series boundaries in the chart are based on graptolite zones. The graptoloid zonation of the East Baltic is of Latvian-Scandinavian origin. Only a few markers allow its direct correlation to the northern Estonian stratotype sequence. Therefore the series boundaries should be treated here as rather arbitrary ones. By a formal decision of the USSR Stratigraphic Committee, the boundary between the Llandeilo and Caradoc is tentatively equated with the *Nemagraptus gracilis* - *Climacograptus peltifer* (*Diplograptus multidens*) zonal boundary, and the Caradoc-Ashgill boundary with the *Dicranograptus clingani* - *Pleurograptus linearis* zonal boundary (Postanovlenie ..., 1977).

CHRONOSTRATIGRAPHIC DIVISIONS

SERIES AND SUBSERIES

Schmidt (1881) distinguished "Schichtengruppen" "A", "B", "C", "D", "E" and "F", which may be interpreted as a subdivision of the Ordovician System into six series (although "A" included strata belonging to the Pakerort and Varangu stages, as well as some beds of Cambrian age). Öpik (1930) introduced a four-fold subdivision of the Ordovician System, into the *Obolus*-Conodont-, *Asaphus*-, *Chasmops*- and *Isotelus*-Series. In the 1940s these subdivisions were named the Iru, Tallinn, Viru and Harju Series, according to the respective type areas. Subsequently, the number of series was reduced, with the two lowest units being joined under the name Oeland Series (Kaljo *et al.*, 1958). The series boundaries were discussed by Jaanusson (1960a; 1960b), and these studies led to the currently adopted series classification. In the officially accepted USSR correlation chart (Resheniya ..., 1987) these series were referred to as superstages.

Units of the subseries category were introduced by Rõõmusoks (1956) and Alikhova (1960). In the present chart the subseries have been adopted in a revised form, as proposed by Männil (1990).

Oeland Series

The name has been introduced by Kaljo *et al.* (1958) to designate in Baltoscandia the Lower Ordovician of Raymond (1916). The unit comprises a succession from the base of the Ordovician System to the top of the Kunda Stage (= *Didymograptus artus* Zone). The type area is on the Island of Öland, Sweden. The series is subdivided into two subseries called the Iru and Ontika s Subseries.

Iru Subseries. The name was introduced by Luha (1940) to replace the term "*Obolus*-Conodont-Series" of Öpik (1930). Primarily the unit included the whole terrigenous basal part of the East Baltic Ordovician, previously classified by Schmidt (1881) as the top of the Cambrian. In a revised form the subseries includes only the strata of Tremadocian age. The type section lies 10 km east of Tallinn.

Ontika Subseries. This subseries corresponds to "Schichtengruppe B" of Schmidt (1881). The name was introduced by Kaljo *et al.* (1958). The type section is 148 km east of Tallinn (Mägi, 1984; 1990). The lower boundary of the subseries is defined as coinciding with the base of the Latorp Stage (see below).

Viru Series

The base of the series coincides with the boundary between "Schichtengruppe B" and "Schichtengruppe C" of Schmidt (1881) and is marked by a change in macrofauna - disappearance of *Megistaspis*, *Antigonambonites*, etc. below, to the first occurrence of *Asaphus* (*Neoasaphus*), *Echinosphaerites*, etc., above (Alikhova, 1957; Rõõmusoks, 1956). In terms of the graptolite zonation, the series includes strata from the base of the *Didymograptus murchisoni* Zone to the top of the *Dicranograptus clingani* Zone (Jaanusson, 1960a; 1960b). The type area is the province of Virumaa, northeastern Estonia. The series is subdivided from base to top into the Purtse, Kurna and upper (unnamed) subseries.

Purtse Subseries. The subseries was introduced by Rõõmusoks (1956), and corresponds approximately to "Schichtengruppe C" of Schmidt (1881). The type sections are located in the surroundings of the Purtse River, 130 km east of Tallinn (Rõõmusoks, 1970). The unit incorporates the Aseri, Lasnamägi, Uhaku and Kukruse Stages characterized by an abundant and diverse fauna.

Kurna Subseries. It approximately corresponds to the "Schichtengruppe D" of Schmidt (1881). The name was introduced by Männil (1958a). The lower boundary is drawn at the base of the Idavere Stage which is marked by the appearance of a new macrofauna and coincides with or lies near to the lower limits of the *Diplograptus multidentatus* Zone, and the *Prioniodus gerdae* Subzone (Männil, 1984). The type area is located in the neighbourhood of Tallinn (Rõõmusoks, 1956; 1970).

Upper (unnamed) subseries. The unit has been introduced by Männil (1990) without assigning a name. The subseries incorporates the Oandu and Rakvere Stages and corresponds to the lower half of the Pljussa Series of Alikhova (1960). The base of the Oandu Stage has long been recognized in northern Estonia as a well-marked level with the appearance of a new fauna including the first representatives of stromatoporoids, tabulate corals, rhynchonellid brachiopods, and numerous other taxa, among them trilobites, brachiopods, nautiloids etc. (Jaanusson, 1945; Rõõmusoks, 1957; 1970; Männil, 1960; 1966). This level can also be identified within the Lithuanian Confacies Belt, and it also seems to correlate well with the base of the Woolston Stage ("Upper Longvillian") of South Shropshire (Männil, 1968). At the same time, within the Central Baltoscandian Confacies Belt, the level can only be recognized with difficulty.

Previously a number of authors (e.g., Jaanusson, 1945; Rõõmusoks, 1957; Alikhova, 1960) have considered the rocks of this unnamed subseries to belong to the basal Upper Ordovician (Harju Series).

Harju Series

This series corresponds approximately to the "*Isotelus*-Series" of Öpik (1930), and the Upper Ordovician of Raymond (1916) and many subsequent authors. The name was introduced by Luha (1940). The type area is within the Harju District, in the surroundings of Kohila. The division has been defined by Jaanusson (1960a; 1960b) as a sequence extending from the base of the *Pleurograptus linearis* Zone (=the lower boundary of the upper substage of the Nabala Stage - see Männil, 1976) to the top of the Ordovician System. However, in the currently accepted correlation chart of the East European Platform, the lower boundary of the Harju Series is drawn at the base of the Nabala Stage (Resheniya ..., 1987; Männil, 1989). According to Männil (1990), the series may be subdivided into two subseries.

Kohila Subseries. The name was introduced to designate the upper part of the Upper Ordovician as previously interpreted by Rõõmusoks (1956). Later the name was applied to the unit only partly corresponding to its previous content. The Kohila Subseries in its revised form (Kohila Subseries *sensu stricto* of Männil, 1990, table 1) consists of the Nabala and Vormsi Stages, and also corresponds to the upper half of the Pljussa Subseries of Alikhova (1960). The type area is in the Harju District, south of Tallinn.

Upper (unnamed) subseries. Männil (1990) has specified this unnamed subseries for the upper Harju division, comprising the Pirgu and Porkuni Stages. The same interval of the sequence has tentatively been referred to as Ashgill (Resheniya ..., 1965; Männil, 1966; Rõõmusoks, 1967; 1970). The lower boundary of the subseries coincides with the base of the *Dicellograptus complanatus* Zone. The upper boundary of the series coincides with the top of the Ordovician System.

STAGES

The basic chronostratigraphic units of the Ordovician succession of the East European Platform are the stages. The history of these units can be traced back to the middle of the nineteenth century. The origin of the stages usually has been associated with Schmidt (1858; 1881), although the stage terminology was introduced later. The stages were originally defined in the outcrop area by a combination of mainly palaeontological, but also lithological, features. Later the stage classification was introduced also for the subsurface area. In the last few decades a large number of stratigraphic wells have been drilled in the East Baltic and adjacent areas. Consequently, a great many "boring cores" have become available for study, and the spatial distribution of formations (and other mainly lithologically defined units or their boundaries) are nowadays well known, with these units more-or-less easily traceable in the subsurface. Nevertheless, at many stratigraphic levels, correlation of these subsurface units with the northern Estonian outcrop is not always satisfactory.

For the present correlation chart the stage is treated in a simplified form as a set of lateral formations (or members, or their parts) having, according to the faunal evidence, the same age. These composition principles seem to be the most reasonable, as from the great number of sections available only a comparatively few are, or can be, studied palaeontologically. Accordingly, the stages have maintained their complex nature but in many points the current subdivision has also been influenced by historical traditions.

In the modern, revised and emended correlation chart, the Ordovician sequence is divided into 18 stages, from the lowermost Pakerort Stage to the uppermost Porkuni Stage (Resheniya ..., 1987). The stage classification was accepted in 1985 by the USSR Stratigraphic Committee as the standard for the correlation of the Ordovician strata within most of the East European platform area.

Pakerort Stage (A_{II}). The stage was named by Raymond (1916) after the type section lying 39 km west of Tallinn. The unit is defined as the lowermost regional stage of the Ordovician System in the East European Platform area, and characterized by *Rhabdinopora flabelliforme*, *Ungula ingrica*, *Obolus apollinis*, etc. The stage incorporates sandstones and argillites of several formations. According to the current use (Kaljo *et al.*, 1986; Resheniya ..., 1987; Männil, 1990) the lower boundary of the stage approximately coincides with the base of the *Cordylodus andresi* Zone. Thickness in the East Baltic and the Sankt Peterburg region does not exceed 15 m; in the Ilmen and Moscow regions it may be considerably greater (up to 85 m). The stage corresponds to the lower Tremadoc.

Varangu Stage (A_{III}). (= *Ceratopyge* Stage: Männil, 1966; Resheniya ..., 1978). The name has recently been introduced by Männil (*in* Resheniya..., 1987). The type section is located 90 km east of Tallinn (Loog & Kivimägi, 1968; Viira *et al.*, 1970; Kleesment & Mägi, 1975; Mägi & Viira, 1976). In the East Baltic and adjacent regions of the former USSR the stage is mainly represented by clays and argillites, and can be recognized first of all by graptolite and conodont occurrences, viz., *Clonograptus sarmentosus*, "*Didymograptus*" *primigenius*, *Bryograptus*, *Kiaerograptus*, *Drepanoistodus deltifer pristinus*, *Cordylodus rotundatus*, *Cordylodus angulatus*, *Oneotodus altus*, etc. (Kaljo & Kivimägi, 1970; 1976; Mägi & Viira, 1976; Mägi *et al.*, 1989). The lower boundary of the stage coincides with the boundary between the *Rhabdinopora flabelliforme anglicum*-*Rhabdinopora flabelliforme multiithecium* Zone and the *Clonograptus sarmentosus* Zone. Thickness in the western districts usually does not exceed 10 m; in the eastern districts it can reach 20-30 m. The stage corresponds to the upper Tremadoc.

Latorp Stage (B_I). The name was introduced by Jaanusson (1960b). The type section is in Nerike, Central Sweden (Tjernvik, 1956; Jaanusson, 1960b). The stage includes glauconitic calcareous sandstones and clays; within the Central Scandinavian Confacies Belt also red-coloured clayey beds. Palaeontologically, the stage can be defined in the trilobite succession, from the base of the *Megistaspis armata* Zone to the top of the *Megistaspis estonica* Zone (Tjernvik, 1956). The lower boundary of the stage nearly coincides with the base of the *Paroistodus proteus* Zone and lies below the lower limit of the *Tetragraptus approximatus* Zone. The stage is subdivided into two substages, which in modern Swedish practice are mostly given the status of separate stages (Jaanusson, in Bruton & Williams, 1982). The lower (Hunneberg) substage corresponds to the *Megistaspis armata* to *Megistaspis planilimbata* Zones, and the upper (Billingen) substage of the *Megalaspides dalecarlicus* to *Megistaspis estonica* Zones. Thickness in the outcrop area of Estonia and the Sankt Peterburg region does not exceed 5 m; in the Jelgava depression it can reach up to 38 m.

Volkhov Stage (B_{II}). The name was introduced by Raymond (1916) after the type section on the Volkhov River in the Sankt Peterburg region. The Volkhov Stage is mainly represented by grey glauconitic limestones or dolomites; within the Central Scandinavian Confacies Belt also by reddish brown limestones and marls. Palaeontologically the stage may be defined in the trilobite succession as from the base of the *Megistaspis lata* Zone to the top of the *Megistaspis limbata* Zone. Apart from the key (zonal) fossils, the stage is also characterized by *Raurorthis parva*, *Productorthis obtusa*, *Antigonambonites* sp., *Protallinnella grewingkii*, etc. The stage is subdivided into three substages: the Saka, Vääna and Langevoja Substages (Lamansky, 1905; Orviku, 1960; Mägi, 1984). Thickness of the Volkhov Stage in the outcrop area is up to 6 m, whereas in the Jelgava depression and the Ilmen region it is usually up to 30 m thick. The stage corresponds to the lower part of the *Didymograptus hirundo* Zone.

Kunda Stage (B_{III}). This stage is represented by calcarenitic, often also oolitic, limestones and marls. The stage was named by Raymond (1916) after the type section near Kunda, 100 km east of Tallinn. It is characterized in the trilobite succession as from the base of the *Asaphus expansus* Zone to the top of the *Megistaspis gigas* Zone. The rich assemblage of index fossils comprise *Asaphus sulevi*, *Pseudoasaphus globifrons*, *Megistaspis heros*, *Orthambonites calligramma*, *Lycophoria nucella*, *Iru concava*, *Endoceras incognitum*, *Paracyclendoceras cancellatum*, *Pinnatulites procera*, *Eoplacognathus variabilis*, *Glyptograptus austrodentatus*, *Didymograptus pakrianus*, etc. On the basis of the trilobite zonation, three substages may be recognized: the lower, Hunderum (corresponding to the *Asaphus expansus* Zone), the middle Valaste (= *Asaphus "raniceps"* Zone), and the upper Aluoja Substages (= *Megistaspis obtusicauda* + *Megistaspis gigas* Zones). Thickness of the stage varies usually from 1 to 12 m in the outcrop area, and reaches 40 m thick in the subsurface area. The stage ranges from the upper part of the *Didymograptus hirundo* Zone to the *Didymograptus artus* Zone.

Aseri Stage (C_{Ia}). The name was introduced by Bekker (1922) after the type section near Aseri, 115 km east of Tallinn (Orviku, 1940; Rõõmusoks, 1970). The Aseri Stage is represented in most districts by grey, oolitic limestones and marls; in central and southern East Baltic also by reddish brown limestones and marls. The stage is typified in the trilobite succession as from the base of the *Asaphus (Neoasaphus) platyurus* Zone to the top of the *Asaphus (Neoasaphus) kowalewskii* Zone. The lower boundary of the stage is well-defined by remarkable faunal changes - disappearances of *Megistaspis*, *Paracyclendoceras*, *Pinnatulites* etc. and the first appearances of *Asaphus (Neoasaphus)*, *Echinosphaerites*, *Piretella tridactyla*, *Euprimites effusus*, etc. Thickness of the Aseri Stage does not exceed 7 m. The stage corresponds to the lower part of the *Didymograptus murchisoni* Zone (Resheniya ..., 1987).

Lasnamägi Stage (C_{Ib}). The stage was named by Orviku (1927, 1940) after the type section, the abandoned Lasnamägi quarry in Tallinn. The stage incorporates grey, in some areas also red-coloured, limestones. In the type area the lower boundary of the stage is drawn at the lower

boundary of the *Lituities Beds* (Männil, 1986). The boundary is also characterized by distinct faunal changes - appearances of *Iliaenus schroeteri*, *Orthoceras regulare*, etc. (Jaanusson, 1960b; Männil, 1966), coinciding with the base of the *Eoplacognathus foliaceus* Subzone (Bergström, 1971; Dzik, 1978; Männil, 1986) - and can therefore be recognized in most areas of the East European Platform. Thickness of the Lasnamägi Stage varies from 2.5 to 8.5 m. The stage corresponds to the upper part of the *Didymograptus murchisoni* Zone.

Uhaku Stage (C_{1c}). The name was introduced by Orviku (1927). The type section is on the Purtse and Uhaku Rivers, within the Uhaku Karst Area, 130 km east of Tallinn (Orviku, 1940; Rõõmusoks, 1970). The stage represents a marly limestone unit. In its revised form (Jaanusson, 1960b; Männil, 1966; 1976; 1986; 1990; Resheniya ..., 1987) the stage exhibits beds containing *Ancistroceras*, *Xenasaphus*, *Iliaenus intermedius*, *Gymnograptus*, etc. The lower boundary of the stage is drawn at the level of the appearance of *Gymnograptus linnarssoni* (Männil, 1986) which coincides with the boundary between the *Eoplacognathus reclinatus* and *Eoplacognathus robustus* Subzones of the *Pygodus serra* Zone. In the outcrop area the stage may be subdivided into two substages, the boundary between them marked by the first appearances of *Chasmops odini*, *Iliaenus intermedius*, *Heliocrinites balticus*, etc. This level seems to be close to the base of the *Pygodus anserinus* Zone. Previously the lower substage has been considered in the type area as the upper part of Lasnamägi Stage (Orviku, 1940; Rõõmusoks, 1960, 1970). Thickness of the Uhaku Stage usually varies from 8 to 18 m. The stage approximately corresponds to the *Glyptograptus teretiusculus* Zone.

Kukruse Stage (C_{II}). The name was introduced by Schmidt (1881: "Kukersche Schicht" or "Brandschiefer") to designate the part of the limestone sequence containing interbedded kukersite. The type section was a former excavation near the present day town of Kohtla-Järve, situated 140 km east of Tallinn. Its exact location is currently unknown. Rõõmusoks (1970, p. 126) proposed a core section close to the supposed type section as hypostratotype, but the same beds are also accessible in mines within the Estonian Field of the Baltic Oil Shale Basin. The boundaries of the Kukruse Stage have been modified by several authors (for example, see Rõõmusoks, 1970, fig. 26). At present the stage is usually interpreted as limestones and marls, in the outcrop area with interbedded kukersite, and containing *Orthograptus uplandicus*, *Amplexograptus bekkeri*, *Climacograptus kuckersianus*, *Nemagraptus gracilis*, etc. (Männil, 1976; 1986; Resheniya ..., 1987). In the type area there is a gap in the upper part of the stage (Männil & Bauert, 1984), and the lower part contains index fossils such as *Paraceraurus aculeatus*, *Hoplolichas conicotuberculatus*, *Bilobia musca*, *Paucicrura navis*, *Cyrtonotella kuckersiana*, *Kullervo panderi*, etc. (Rõõmusoks, 1957; 1960; 1970; Alikhova, 1960). The lower boundary of the Kukruse Stage is drawn in the type area at the base of the Kiviõli Member. The boundary level can be recognized by changes within several fossil groups (Männil, 1984; 1986; Rõõmusoks, 1970), and is correlated with the base of the Dreimani Formation (Ulst *et al.*, 1982); this level roughly equates with the base of the Dalby Formation in Sweden (Jaanusson, 1976). Thickness of the stage is usually 15-20 m, though in the eastern subsurface region it probably reaches up to 40 m. thick. The stage is defined in the North Atlantic conodont succession as ranging from the upper part of the *Pygodus anserinus* Zone to the lower part of *Prioniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone, and in the graptolite succession it roughly corresponds to the interval of the *Nemagraptus gracilis* Zone (Männil, 1986).

Idavere Stage (C_{III}). The stage has been named by Schmidt (1881: "Itfersche Schicht") after the type section in an old quarry (Sarv & Põlma, 1989; see also Põlma *et al.*, 1988; Rõõmusoks, 1970) near Haljala, 88 km east of Tallinn. The stage has been treated differently by several authors. According to current usage (Resheniya ..., 1987) it is characterized in the type area with limestones containing *Scopelochasmops wrangeli*, *Conolichas triconicus*, *Cyrtonotella kuckersiana frechi*, etc., and these are associated with a new faunal assemblage represented by *Platystrophia chama*, "*Oepikina*" *anijana anijana*, *Mastopora concava*,

Batostoma granulosum, *Bichilina prima*, *Tetrada memorabilis*, *Consonopsis consona*, and many others. Unfortunately the lowermost part of the Idavere Stage (as well as the upper part of the Kukruse Stage) is missing in the type area due to a hiatus. The kukersite layer X is recommended as the lower boundary of the stage in the type area (Männil, 1984; 1986; Männil & Bauert, 1984), as this level is easily recognized by appearances of *Cyathochitina* aff. *reticulifera* and "*Eremochitina*" *dalbyensis* both in outcrop and subsurface areas (Männil, 1971; 1972; 1986), as well as in Scandinavia (Laufeld, 1967; Grahn, 1981). The stage has been subdivided into two, the Ojamaa and Shundorovo Substages, the boundary between them nearly corresponding to the base of the *Prioniodus alobatus* Subzone of the *Amorphognathus tvaerensis* Zone. Thickness of the stage in Estonian sections usually varies from 4 to 12 m; in the more eastern districts it may exceed 40 m. The stage corresponds to the interval represented by lowermost part of the *Diplograptus multidens* Zone.

Jõhvi Stage (D_I). The type section of this stage is the Kämbemägi Quarry near Jõhvi, 145 km east of Tallinn (Rõõmusoks, 1970; Põlma *et al.*, 1988). The name was introduced by Schmidt (1858: "Jewe'sche Schicht") in a wide sense. According to the current use the stage is mainly represented by argillaceous limestones and marls, and the beds contain faunal elements such as *Toxochasmops maximus*, *Rollmops wenjukowi*, *Porambonites baueri*, *Clinambon anomalus*, *Hemicosmites extraneus*, *Amphorichnus*, etc. (Resheniya ..., 1987). For practical reasons the lower boundary is drawn at the level of the K-bentonite bed "b" (after Jürgenson, 1958 - see Männil, 1966). Usually *Amplexograptus* cf. *fallax* is used as a biostratigraphical tool to identify the boundary level, especially within the subsurface area (Männil, 1976; Resheniya ..., 1987), but according to the new data, the appearance of this graptoloid is in conflict with the traditional boundary level in some sections of northwestern Estonia (Hints & Nõlvak, 1990). Notwithstanding, the Jõhvi Stage can be distinguished more-or-less precisely within the type area, but it appears to be more difficult in core sections due to the scarcity of macrofossils. Thickness of the stage does not exceed 15 m in the East Baltic; the maximum thickness occurs in northwestern Estonia. In the eastern districts the thickness of marls and limestones, presumably corresponding to the Jõhvi Stage, may exceed 40 m. The stage corresponds probably to the interval represented by the middle part of the *Diplograptus multidens* Zone.

Keila Stage (D_{II}). This unit has been named by Schmidt (1881: "Kegelsche Schicht") after the type locality near Keila, 25 km south-west of Tallinn (Rõõmusoks, 1970; Põlma *et al.*, 1988). In the type area the stage is usually defined in limestones containing *Toxochasmops maximus*, *Conolichas deflexus*, *Conolichas aequilobus*, *Horderleyella ?kegelensis*, *Clinambon anomalus*, *Longvillia asmusi*, *Bolbina major*, *Polyceratella spinosa*, etc. In the northern Estonian outcrop belt the upper part of the stage is missing; the most complete sequence occurs west of Tallinn, where Keila-Oandu age carbonate mounds ("bioherms", "reefs") occur in a remarkable development (the Vasalemma Formation). The lower boundary of the stage is drawn at the level of bentonite bed "d" (after Jürgenson, 1958 - see Männil, 1966), mentioned also in publications as the "main (big) bentonite". In the East Baltic this bentonite bed is overlain by beds containing a short-ranging species "*Illichitina*" *multiplex*, the range zone of which can be used to identify this level biostratigraphically. The so-called "Skagen type" ostracode fauna appears in central Estonia (Männil, 1990), and in the corresponding marls of western Lithuania (Sidaraviene & Saulenene, 1980) at approximately this same level. Thickness of the stage varies in the East Baltic, usually from 2 to 27 m (but may be even thicker in the type area), and in eastern districts it may reach 40 m. The stage presumably ranges from the upper part of the *Diplograptus multidens* Zone to the lowest part of the *Dicranograptus clingani* Zone (Männil, 1990).

Oandu Stage (D_{III}). The name was introduced by Öpik (1934: "Oando-Schichten") based on the type section along the Oandu River, 130 km east of Tallinn (Männil, 1960; Põlma *et al.*, 1988). The formal stage has been distinguished by Männil (1958b). In the type area the stage sharply differs faunistically from the preceding stages. The Oandu age argillaceous limestones

and marls contain *Toxochasmops extensus*, *Otarozoum eichwaldi*, *Howellites wesenbergensis*, *Sowerbyella* (*Sowerbyella*) *tenera*, *Ilmarinia dimorpha*, *Dactylogonia luhai*, *Zygospira gutta*, *Eofletcheria*, *Lyopora*, *Stromatocerium* etc., and also a new association of ostracodes. The Middle Ordovician carbonate mounds known from northwestern Estonia are supposed to be partly an Oandu age assemblage (Männil, 1960). In southern Estonia and southeastern Latvia the stage is represented by marls with *Sampo*, *Skenidioides*, etc.; and within the Central Scandinavian Confacies Belt probably graptolitic argillites with *Climacograptus diplacanthus* also correspond to it. The lower boundary of the stage has long been recognized as being characterized by the appearance of a comparatively new fauna (Jaanusson, 1945; Rõõmusoks, 1957; 1970; Männil, 1960; 1966). In accordance with this the Oandu Stage has been considered by several authors as the basal Harju Series (that is, respectively, Upper Ordovician; see Rõõmusoks, 1956; Hints *et al.*, 1989). Thickness of the stage varies from 0.3-8 m. The stage corresponds approximately to the lower-middle part of the range of the *Dicranograptus clingani* Zone (Männil, 1976; Resheniya ..., 1978).

Rakvere Stage (E). The stage was first distinguished by Schmidt (1858: "Wesenberg'sche Schicht"). The type section is at Rakvere, 100 km east of Tallinn (Põlma *et al.*, 1988). In the type area this stage includes calcilutites which contain *Toxochasmops wesenbergensis*, *Howellites wesenbergensis*, *Sowerbyella raegaverensis*, "*Rafinesquina*" *inaequiclina*, *Isotelus remigium*, *Steusloffia neglecta*, *Coelosphaeridium*, *Cyclocrinus*, etc. Corresponding marls and argillaceous limestones occur within the Central Scandinavian Confacies Belt. The upper part of the stage is poorly exposed in the type area and therefore macrofauna is not completely known. Nevertheless, among the ostracodes in these beds there appear several long-ranging taxa like *Steusloffia cuneata*, *Medianella blidenensis*, *Microcheilinella lubrica*, *Daleiella* and others, which in general characterize the overlying strata. The lower half of the stage in the same area has much fauna in common with the underlying Oandu Stage. In the type area the lower boundary of the stage is tentatively drawn at the basal calcilutites, though faunal changes at this level seem to be of environmental origin. Thickness of the stage varies from 1.5-28 m. Based on rare finds of *Climacograptus diplacanthus* and *Dicranograptus clingani* (Männil, 1976), and its stratigraphic position, the stage seems to correspond to the middle-upper part of the range of the *Dicranograptus clingani* Zone (Männil, 1990).

Nabala stage (F_{1a}). It was first distinguished as a formal stage by Jaanusson (1944), but the present name was introduced later by Männil (1958c) based on the village of that name near the type section, 20 km south of Tallinn. According to current use, the stage is represented by calcilutites and marly calcarenitic limestones, sometimes glauconitic (Resheniya ..., 1987). In the type area the lower part of the stage has yielded *Wysogorskiella litviensis*, *Laticrura rostrata*, *Onniella?* *acuta*, *Ilmarinia sinuata*, *Bekkeromena*, *Trigrammaria*, *Oxoplecia*, *Eoplectodonta*, *Distobolbina nabalaensis*, *Tetradella pulchra*, *Kenophyllum canaliferum* etc., and the upper part contains *Pionodema costata*, *Boreadorthis reclusa*, *Thaerodonta*, *Dinorthis*, *Iliaenus mascei*, *Leperditella brachynotos*, *Kenophyllum subcylindricum*, etc. On the basis of these faunal differences in the type area, two substages are presently distinguished. The boundary between them is tentatively drawn at the base of the calcilutites of the Saunja Formation. The lower boundary of the Nabala Stage within the type area coincides with the lower boundary of the Paekna Formation. This lower boundary level is marked by the appearance of *Cyathochitina reticulifera* and therefore can easily be recognized at least in the East Baltic (Männil, 1971). Thickness of the stage is 2.5-35 m. The stage probably ranges from the uppermost part of the *Dicranograptus clingani* Zone to the lower part of the *Pleurograptus linearis* Zone (Männil, 1976; Resheniya ..., 1987).

Vormsi Stage (F_{1b}). The stage was named by Jaanusson (1944) after the type section on the Island of Vormsi, western Estonia (see Oraspõld, 1991; Meidla, 1983). In the type area the stage is represented by calcarenitic limestones containing a rich fauna, the most common being *Catenipora wrighti*, *Protaraea schmidtii*, *Streptelasma hiimica*, *Rhabdocyclus aequispinatus*,

Plaesiomus solaris, "*Orthis*" *lyckholmiensis*, *Triplesia insularis*, *Eoplectodonta schmidtii*, *Leurocycloceras foerstei*, *Schroederoceras hyatti*, etc. In the sections of the Central Baltoscandian Confacies Belt the equivalent beds have yielded *Tretaspis seticornis*, *Climacograptus angustus*, *Climacograptus styloideus*, *Diplograptus vulgatus*, *Diplograptus pristis*, *Rectograptus gracilis* and other graptoloids of the *Climacograptus styloideus* Zone *sensu* Skoglund (1963; see also Ulst, 1975; Ulst *et al.*, 1982). A good index fossil seems to be *Acanthochitina barbata*, the range zone of which in several regions (columns 1-5: Nôlvak, 1980, 1986) falls in the upper part of the Vormsi-age strata. In the type area the lower boundary of the Vormsi Stage is lithologically very sharp and is characterized by distinct faunal changes (Meidla *et al.*, 1990). Outside the outcrop area these changes are less distinct; for example, in the South East Baltic and adjacent areas some authors tend to regard the Nabala and Vormsi age marly beds as not divisible (Laškov *et al.*, 1984; Sidaravičiene, 1985; Modlinski, 1984). Thickness of the Vormsi Stage varies from 0.8 to 25 m. The stage corresponds to the upper part of the *Pleurograptus linearis* Zone.

Pirgu Stage (F_{1c}). The name was introduced by Jaanusson (1944) after the type section at the Atla (Pirgu) River, 40 km south of Tallinn. The stage has usually been treated as limestones containing in the lower part *Eospirigerina*, *Dicoelosia*, *Catenipora rubraeformis*, *Sarcinula venustum*, *Clathrodictyon microundulatum*, *Foramenella parkis*, etc., and in the upper part *Maclurites neritoides*, *Luhaia vardi*, *Paleofavosites alveolaris*, *Proheliolites dubius*, *Trochiscolithus micraster*, *Cystostroma estoniense*, *Brevibolbina pontificans*, etc. On the basis of these faunal differences, the stage may be divided into two substages. Within the type area the boundary between them is tentatively drawn at the base of the Adila Formation. In the subsurface area this stage comprises a great number of different limestone formations. Here the boundary between the substages is unclear, and the Pirgu-age rocks may partly be correlated with the supposed hiatus between the substages seen in the type area (see Resheniya ..., 1978; Resheniya ..., 1987). In the type area and to the south, bioherms occur in the lower part of the Pirgu Stage. According to the present practice, the lower boundary of the stage is drawn in the type area at the base of the Moe Formation, which coincides with the last appearance of *Acanthochitina barbata*. Thickness of the Pirgu Stage in the type area is 35-50 m, but outside it ranges from 10-85 m. The lower substage corresponds to the *Dicellograptus complanatus* Zone (Resheniya ..., 1987; Männil, 1990). In the uppermost part of the Pirgu Stage *Climacograptus supernus* has been established (Männil, 1976), suggesting the upper substage is equivalent to the *Dicellograptus anceps* Zone or to a part of it (Resheniya ..., 1987; Kaljo & Männil, 1990).

Porkuni Stage (F_{1j}). The stage was named by Schmidt (1858: "Borkholm'sche Schicht"). The type section is the old Porkuni quarry near Rakvere, 90 km east of Tallinn (Nestor, 1990). As presently recognized, the Porkuni Stage includes the uppermost Ordovician limestones and marls lying between the top of the Adila Formation and the top of the Ordovician System (Resheniya ..., 1987; Männil, 1990). In the type area the Porkuni-age strata contain "*Proetus*" *ramisulcatus*, *Streptis undifera*, *Schmidtomena acuteplicata*, *Ilmarinia ponderosa*, *Rafinesquina luna*, *Sceptropora estonica*, *Lichenalia concentrica*, *Platylichas margaritifera*, *Clathrodictyon gregale*, *Ecclimadictyon koigiense*, *Paleofavosites rugosus*, *Paleoporites estonicus*, *Paleotetradium*, *Paleophyllum fasciculum*, *Bulbosclerites unicornis*, *Foramenella porkuniensis*, etc. (Resheniya ..., 1987; Nestor, 1990). In southernmost Estonia, as in the other districts of the Central East Baltic, these strata roughly correspond to beds which have yielded *Dalmanitina mucronata*, *Brongniartella platynota*, *Hirnantia sagittifera*, *Dalmanella testudinaria*, etc., and a very specific association of ostracodes containing *Harpabollia*, *Aechmina* and others (Gailite, 1970). The stratigraphical relationship of these sections with other local rock units is in many cases still obscure. In eastern Latvia, eastern Lithuania and in the Pskov region, beds containing *Holorhynchus giganteus* have been previously regarded (Resheniya ..., 1987; Männil, 1990) as belonging to the lowermost Porkuni, and the marly beds resting on the Halliku or Adila Formation of central Estonia, have been considered to be about the same age.

However, this opinion has not been supported by some other authors (see for instance Kaljo *et al.*, 1988; Nõlvak *et al.*, 1989). Thickness of the stage usually does not exceed 15 m, but in some cases it can reach 30 m. The Porkuni Stage, as the topmost Ordovician, presumably ranges from the *Climacograptus extraordinarius* to the *Glyptograptus persculptus* Zones. The lowermost part may also extend down to include the topmost part of the range of the *Dicellograptus anceps* Zone.

NOTES FOR COLUMNS IN THE CORRELATION CHART

Markedly different Ordovician successions are distinguished in the various regions across the East European Platform. The facies differences between northern Estonia and western Latvia resemble patterns first recognized between northern Estonia and Sweden (Männil, 1966), and a transitional area was also subsequently recognized (Põlma, 1967). These features have served as the basis for the subdivision of the East Baltic territory in an earlier correlation chart (Resheniya ..., 1978). Wider geological surveys to adjacent areas resulted in recognition of links between the East Baltic area and the Moscow Syncline (forming the Baltic Basin *sensu lato*), and the western marginal part of the East European Platform was also represented in the later, officially adopted, USSR compilation of the correlation chart for the East European Platform (Resheniya ..., 1987). At the same time the confacial subdivisions of Jaanusson (1976; 1979) were introduced across the region.

In the present chart (Chart 1, see end pocket) each column depicts the Ordovician succession of a particular area (see Figure 1 for locations). The differences in the Ordovician successions from region-to-region across the East European Platform are illustrated, as in the previous official USSR correlation chart (Resheniya ..., 1987). Similar relationships are shown, although a further column is added for northwestern Estonia. More detailed subdivisions are recognized in some areas but no new palaeogeographic data is included.

NORTH-WEST AND NORTH ESTONIA (1, 2)

North Estonia (including the northwestern part) represents the classical outcrop area with the stratotypes of most Ordovician stages. Its eastern boundary is conventionally fixed along the eastern boundary of the oil shale basin (Resheniya ..., 1987). The Ordovician strata characteristically overlie Cambrian terrigenous rocks, and they are mostly overlain by Quaternary glacial and postglacial deposits of very limited thickness. Locally, however, south of Narva (in the eastern part of the area) they are succeeded by Devonian rocks.

The Ordovician sequence is represented by terrigenous rocks (sandstones, clays, siltstones) in the lowest part but these, by Latorp time, grade up into the characteristic Ordovician limestones of the area. In north-eastern Estonia and the westernmost part of the Sankt Peterburg region the limestones of the Kukruse Stage contain intercalations of kukersite.

The chart columns 1 and 2 display only the more important of the numerous gaps occurring in the sequence. The most continuous parts of the sequence are from the middle Kunda to lower Kukruse, the upper Idavere to Keila, and the Rakvere to lower Pirgu. In North-west Estonia (west of Tallinn - column 1) the Ordovician succession is less complete with, for example, the Oeland- and Viru-age strata thinning out towards the north-west.

The subdivision of the Ordovician strata into formations is based partly on the old, traditional units, such as "*Obolus* Sandstone", "*Dictyonema* Shale", etc., but since the 1950s, a modern nomenclature of rock units has been introduced (see Männil & Rõõmusoks, 1984). Correlation of formations in the present chart is similar to that represented in Resheniya ..., 1987, except

perhaps for the correlation of the uppermost part of the succession (see the later description of the Ārina Formation).

CENTRAL ESTONIA (subsurface) (3)

Central Estonia as a separate region (3) represents the transitional belt between the North Estonian Confacies Belt and the Livonian Tongue of the Central Baltoscandian Confacies Belt (see Jaanusson, 1976). In this area the Ordovician strata overlie the Cambrian and are succeeded by Silurian rocks. The area is characterized by the greatest lithological diversity. The Ordovician sequence is similar to that of northern Estonia but generally more marly. The chart column offers a simplified picture of the unique formations of Central Estonia, which occupy an intermediate position between the formations of northern Estonian (1, 2), and those of western Latvian (4) and eastern Lithuanian (5). The correlation of formations is usually in accordance with Resheniya ..., 1987, with some differences introduced by Männil (1990), for instance, the Rokiškis Formation being treated as the full equivalent of the Napa and Segerstad Formations, the Bruddesta Formation being excluded, and the late Keila-age strata being referred to the Viluciai Formation.

SOUTH ESTONIA, WESTERN LATVIA, NORTH-WESTERN LITHUANIA, KALININGRAD REGION (subsurface) (4)

The area is known in literature as the Baltic Syncline (Alikhova, 1960), the Swedish-Latvian Facial Zone (Männil, 1966), the Western East Baltic Structural-facial Belt (Resheniya ..., 1978), or the Livonian Tongue of Central Baltoscandian Confacies (Jaanusson, 1976). The Ordovician strata overlie the Cambrian and underlie the Silurian. The thickness of the Ordovician rocks reaches about 250 m being maximal in south-western Latvia. Marly limestones prevail in the sequence, except for the lower terrigenous part. The Oeland and lowermost Viru Series, and the upper Harju Series are characterized by red-coloured strata. Specific lithological and palaeontological characteristics of the succession have caused a number of correlation problems. Only the lower half of the Ordovician can be satisfactorily correlated with the other sequence types (particularly with those in northern Estonia). In the upper half of the succession the correlations are more complicated, especially at the levels including the Mossen, Paroveja and Kuili Formations. Four rock units in the sequence have common characteristics with those in Sweden. These units maintain their essential characteristics across the East Baltic area and are considered to be of approximately the same age; they are referred to the Swedish Segerstad, Mossen, Fjäckå and Jonstorp Formations. The general stratigraphy of the area has been described by R. Ulst, L. Gailite and others (see Ulst *et al.*, 1982). Correlation of rock units in the column is the same as that compiled in Resheniya ..., 1987.

EASTERN LITHUANIA, SOUTH-EASTERN LATVIA (subsurface) (5)

The area has been considered by Jaanusson (1976) as a separate Lithuanian Confacies Belt. In the correlation chart of the East Baltic (Resheniya ..., 1978) it has been regarded together with northern Estonia as the Eastern East Baltic Structural-facial Belt. The facies pattern is analogous to that of central Estonia (column 3) but the nomenclature used is mainly of Lithuanian origin. Correlation of rock units in the column is mostly based on the correlation chart of the East Baltic (Resheniya ..., 1978) and corresponds to that in Resheniya ..., 1987. The Auleliai Formation within the Mežciems Group is of Keila age, and serves as the key level to improve the correlation (Resheniya ..., 1987). Also, *Cyathochitina reticulifera* has been identified from the middle part of the Voore Group, suggesting a Nabala-age for these beds. A number of other formations are recognized as belonging to the Pirgu Stage; and the Baltinava

Formation in particular is proposed as a key horizon because, according to Nõlvak (1986; Resheniya ..., 1987, p.38), it equates to the upper part of the Svedasai Formation of column 6, to the lower (Geidžiūnai) member of the Paroveja Formation of column 4, and to the Oostriku Formation of column 3.

NORTH-WESTERN BYELORUSSIA (subsurface) (6)

The separate column for this area was first distinguished in Resheniya ..., 1987. The Ordovician strata occurring here represent the shallow-water marginal equivalents to the south-eastern Lithuanian sequence (column 5). North-western Byelorussia differs in being a comparatively pure carbonate sequence, and in having a reduced thickness of the Ordovician strata and numerous depositional breaks, altogether confirming the tendency of the formations to thin out in a south-eastern direction. Some of the formations of south-eastern Lithuania (column 5) are applied in this area, as well as restricted Byelorussian units. Correlation of the formations is in general in accordance with that presented in Resheniya ..., 1987.

NORTH OF SANKT PETERBURG REGION (7)

The area is in effect a continuation of the northern Estonian Lower - Middle Ordovician outcrop belt to the east; it has a lithologically very similar rock sequence. The Ordovician strata overlie the Cambrian rocks, though the succession of beds is in general more complete than in northern Estonia. The stratotype of the Volkhov Stage is located within the area.

The terrigenous basal part of the Ordovician is overlain by a predominantly limestone sequence, which terminates with the limestones and dolomites of Oandu to ?Nabala age. Most of the Upper Ordovician is missing. The subdivision of the Ordovician into rock units was first proposed by L. Popov, K. Khazanovich, V. Gorjanski and others (see Popov & Khazanovich, 1985; and Gorjanski & Popov, in Resheniya ..., 1987). Only part of the older version of subdivisions established by Alikhova (1960), Selivanova (1971), Resheniya ..., 1965, etc., has been applied. The correlation in the present chart follows that presented in Resheniya ..., 1987, except for some differences in detail; namely, the top part of the Lomashka Formation being regarded as the base of the Ordovician (according to Kaljo *et al.*, 1986), and the upper part of the sequence being referred to the "Pljussa Group" (of Oandu-?Nabala age).

SOUTH OF SANKT PETERBURG REGION, NOVGOROD REGION (subsurface) (8)

This area is generally known as the western part of the Moscow Syncline. The Ordovician strata overlie the Cambrian, and are usually succeeded by Devonian rocks. The Ordovician succession ranges up to the Oandu-?Rakvere Stages, with the topmost part of the sequence being absent. As in the areas described above, the basal part of the Ordovician sequence is terrigenous, and in the Latorp Stage it grades into predominant limestones.

The Ordovician stratigraphy of the area is based on the studies of Alikhova (1960), Selivanova (1971), Dmitrovskaya (1980) and Nikanorova (1977). At some levels (upper Oeland and middle Viru) the rock units used are those from the northern part of the Sankt Peterburg region (column 7), but otherwise the units of the Moscow Syncline (column 9) are employed. Correlation of the rock units has been suggested by V. Gorjansky, J. Dmitrovskaya, M. Rybnikova with the assistance of L. Popov (in Resheniya ..., 1987). The present correlation corresponds to that adopted in Resheniya ..., 1987. Only the term "Pljussa Group" is used in preference for the beds earlier designated as the Varlygino Formation of this area, and also the north Sankt Peterburg region (column 7).

YAROSLAVL REGION (subsurface) (9)

The so-called Yaroslavl region (otherwise known as the Central Russian area and comprising the Yaroslavl, Kostroma and Vologda regions) exhibits an easterly continuation of the sequences developed in the Sankt Peterburg regions (columns 7 and 8). Earlier the area was referred to the Moscow Syncline (Alikhova, 1960, etc., Resheniya ..., 1965), but since the 1970s only to its eastern part (by several authors, in Resheniya ..., 1987), or to the Eastern Facial Zone of the Moscow Basin (Nikanorova, 1977). In Resheniya ..., 1987, according to the decision of the Interdepartmental Stratigraphic Committee of the former USSR, the column for this region was excluded from the general chart. It was considered to have its own independent preliminary scheme. However this does not seem to be acceptable given that much of the lower half of the chart column has nomenclature and correlation of rock units which are identical to those used in the Sankt Peterburg regions. On this basis the Yaroslavl column is reinserted in the present chart. The upper half of the Ordovician differs from that of other areas in having a more terrigenous nature - namely, through the succession of Kubena, Mitino, Varlygino and ?Poshekhonye Formations. Relations of these formations with the units of other areas are as yet unclear.

SOUTH-WESTERN BYELORUSSIA (subsurface) (10)

South-western Byelorussia is characterized by a dominantly limestone sequence of a restricted thickness and by the absence of Harju-age strata. Preliminary correlation of the rock units within the present area is based on the correlation chart of Byelorussia (see Ropot & Pushkin, 1987). The correlation of Resheniya ..., 1987 is adopted in this present contribution

WESTERN VOLYNY (subsurface) (11)

The stratigraphic column presented for this area should also be regarded as preliminary. It has been published in Resheniya ..., 1987 and makes use of a unique nomenclature of rock units although in principle the section is similar to that of south-western Byelorussia. In general the correlation shown in the present chart corresponds to the version of Resheniya ..., 1987.

PODOLIA, EASTERN VOLYNY, MOLDOVA (subsurface) (12)

This area is characterized by having a fragmentary Ordovician sequence of restricted thickness, and comprising three segments of different spatial distributions. The lower segment (the Bilychi Formation) is known in the Lvov Depression only, the middle segment is developed in southern Moldova (the Pleshany Formation), on the western slope of the Ukrainian Shield and in the Carpathian Foredeep (in Russian: Prikarpatiskij progib) (the Goraevka Formation), and the upper segment (the Suboch Formation) is represented in the Lvov Depression, on the western slope of the Ukrainian Shield and in the Carpathian Foredeep. The middle and upper segments together have traditionally been referred to the Molodovo Group.

ALPHABETICAL LIST OF ROCK UNITS

In this next section the groups and formations are described in outline, in alphabetical order. The characteristic features listed include the distribution, thickness, rock type(s), relationship to beds above and below, type section, and correlation. Selected fossils and other remarks have been added where necessary. Distribution of the units is given according to the basic regions and corresponding to the individual columns in the correlation chart. If a formation has been subdivided into widely accepted members or subformations, relevant features of these have been added to the description of the particular formation. Where the complete data set has not

been available (for instance, some material has not been published), or the primary information has been confused, the corresponding description of these subdivisions is much reduced.

In the following chapter the term "type area" is used in a number of instances. It has been introduced herein to designate the immediate surroundings of the type section, characterized by having a general stability of both litho- and biofacies. The type area relates to a small area, much smaller than that adopted as the basis for each chart column. Usage of the term "type area" coincides to that adopted by Põlma *et al.* (1988).

Adila Formation (1-3). A 10-15 m thick sequence of grey argillaceous thin- or medium-bedded calcarenitic limestones with numerous discontinuity surfaces in its type area near Kohila-Rapla, south of Tallinn (Jaanusson, 1956); it lies between the underlying Moe Formation and the overlying Rõa Member (lower part of the Ärina Formation). The unit has been distinguished as the upper, lithologically well characterized part of the Pirgu Stage in the type area and elsewhere (Rõõmusoks, 1960). At the base and the top of the formation hiatuses are suggested in this area (Resheniya ..., 1978). The Adila Formation has been accepted as the type formation of the upper substage of the Pirgu Stage (Männil, 1966; Resheniya ..., 1987). It is highly fossiliferous, containing a rich fauna of corals, brachiopods, cephalopods, ostracodes, etc. The characteristic association includes *Maclurites neritoides*, *Paleofavosites alveolaris*, *Paleofavosites schmidtii*, *Proheliolites dubius*, *Catenipora tapaensis* and *Luhaia vardi*.

Adze Formation (4). Grey alternating calcarenitic limestones and marls, with thin intercalations of bentonite, from 5-14 m thick, rests on the Dreimana Formation, and is overlain by the Blidene Formation. Type section is in Adze boring (or well) No. 6, depth 888-898 m (Ulst & Gailite, 1976; Ulst *et al.*, 1982). The unit yields *Cyathochitina* aff. *reticulifera* and "*Eremochitina*" *dalbyensis* at the base indicating an Idavere age, and in the middle part, the first occurrence of *Amplexograptus* cf. *fallax*, which may suggest a Jõhvi age. Also in some sections, in the upper part of the succession, the main bentonite bed (the base of Keila Stage) can be recognized. Consequently this formation spans an interval through the Idavere, Jõhvi and lower Keila Stages.

Äiamaa Formation (3). of Interbedded nodular calcilutitic limestones and marls, up to 5 m thick, are separated by a gap from the underlying Adila Formation and also separated by a gap from the overlying Saldus (?) Formation. Reference section is in the Äiamaa boring (Männil & Rõõmusoks, 1984). This is an ill-defined unit which has yielded *Climacograptus supernus* and *Conochitina taugordeaui*, and probably corresponds to a part of the Taučionys Formation (column 5) which, according to the lately accepted correlation chart (Resheniya ..., 1987), is accorded an early Porkuni age.

Ärina Formation (1, 2). This succession of mainly grey calcarenitic and arenaceous limestones and dolomites with small bioherms is from 3-10 m thick. The unit rests on the Adila Formation and is overlain by the Varbola Formation (lower Llandover). Type section: Ärina outcrop near Rakvere, 90 km east of Tallinn (Schmidt, 1858; Rõõmusoks, 1983; Männil & Rõõmusoks, 1984). The unit is subdivided into five members mainly on the basis of lithological data. The lowermost Rõa Member (0.5-3.7 m) consists of grey thin-bedded dolomites with few determinable fossils. The succeeding Vohilaid Member (up to 3.7 m) is characterized by medium- to coarse-grained calcarenites with a well-known assemblage of macrofossils. It is overlain by the Siuge Member (up to 2.6 m) consisting of brownish-grey argillaceous bituminous calcarenitic limestones. The succeeding Tõrevere Member (up to 4.1 m) consists mainly of a massive calcilutitic bioherm limestone with intercalations of bedded arenaceous limestones. The topmost Kamariku Member (up to 2.7 m) rests upon different older members (Vohilaid, Siuge, but most commonly, the Tõrevere Member) and consists of grey bedded arenaceous limestones or light grey quartzose sandstones. The age relations of the above-mentioned members have not yet been established precisely. The base of the Vohilaid Member seems to represent a hiatus level but other boundaries between the members may be

considered, in many cases, diachronous. The status of the Rõa Member is still problematic: in recent correlation charts (Resheniya ..., 1978; Resheniya ..., 1987) it has been attributed to the Porkuni Stage, as the basal part of the formation, but macrofossil evidence exists suggesting a late Pirgu age (Rõõmusoks, 1983; 1991). The characteristic faunal assemblage of the Ärina Formation proper includes *Mesofavosites dualis*, *Rhabdotetradium frutex*, *Clathrodictyon gregale*, *Streptis undifera*, *Aphanomena luna*, *Streptopora estonica*, etc. (Nestor, 1990).

Aseri Formation (1, 2). The grey oolitic calcarenites of this unit are up to 4 m thick, and thin out in a northwestern direction. Type section: Aseri quarry, 120 km east of Tallinn (Orviku, 1940). The formation rests upon different units of the Kunda Stage, and is overlain by basal oolitic beds of the Vao Formation (Lasnamägi Stage). It is subdivided into the Malla (lower) and Ojaküla (upper) Members. According to Orviku (1927; 1940; 1960), the Malla Member (0-3.5 m) consists of lower Sõtke ("Asaphid") and upper ("Echinospaerites") limestones; the Ojaküla Member (0-1.7 m) corresponds to the former Cephalopod Limestone. The sequence represents the type section of the Aseri Stage. The characteristic fossils are *Asaphus* (*Neoasaphus*) *platyurus*, *Asaphus* (*Neoasaphus*) *cornutus*, *Asaphus* (*Neoasaphus*) *latus*, *Asaphus* (*Neoasaphus*) *kowalewskii*, *Iliaenus excellens*, *Echinospaerites aurantium*, *Leptestia humboldti*, etc.

Auleliai Formation (5). This 6-25 m thick succession of greenish-grey calcareous marls with few intercalations of calcarenitic limestones rests upon the Šventupys Formation. Thin bentonite beds occur at the base. It belongs to the middle third of the Mežciems Group, resting on the Šventupys Formation and being overlain by the Vilučiai Formation. Type section: Svėdasai boring, depth 633.0-651.3 m (Laškov *et al.*, 1984). The formation has yielded a rich fauna of the so called "Skagen association" of ostracodes, including *Henningsmoenia gunnari*, *Platylolbina rima*, *Vittella vittensis*, etc. (Sidaravičiene & Saulenene, 1980) and indicating an early Keila age (Resheniya ..., 1987).

Baldone Formation (4). Reddish-brown and mottled greenish-grey limestones and marls, up to 20 m thick, rest on the Šakyna Formation and are overlain by the Segerstad Formation. Type section: Baldone boring No. 80, 897.0-913.5 m (Brangulis *et al.*, 1989). Previously (Gailite & Ulst, 1975; Ulst *et al.*, 1982; 1984) the unit was used in a wider sense including rocks of Aseri age (including the Segerstad Formation). The formation has been subdivided into the Šiupyliai (lower) and Ziemeļi (upper) Members, represented by grey mottled reddish-brown argillaceous limestones and mudstones, and grey mottled reddish-brown limestones, respectively. The upper part of the formation has yielded *Megistaspis gigas*, *Megistaspis* aff. *obtusicauda*, *Pinnatulites procera*, indicating a late Kunda age.

Baltinava Formation (5). Brownish-grey nodular calcilutitic limestones comprise a 6-11 m thick unit which rests upon the Halliku and Moe Formations, and is overlain by rocks classified as the Ludza, Ukmergē or Parovēja Formations. Type section: Baltinava boring, depth 593-601.5 m (Ulst & Gailite, 1976; Ulst *et al.*, 1982). The unit has yielded *Tvaerenella expedita*, *Steusloffina cuneata*, *Neoprimitiella plavinensis* and other Pirgu ostracodes (Ulst *et al.*, 1982). It is assumed to be the stratigraphical equivalent of the lowermost Parovēja and Oostriku Formations (Resheniya ..., 1987).

Biciflūai Formation (5). Up to 2.8 m of mainly grey limestones and marls, overlie the Draseļķiai Formation. Type section: Butkunai boring, depth 737.9-739.35 m (Laškov *et al.*, 1976; 1984). It comprises three members: the lower Gindviliai Member is represented by up to 1 m of grey dolomitic limestones and marls with glauconitic grains, the Mikonys Member, by up to 2.6 m of mottled limestones and marls, and the Obeliai Member, by up to 2.5 m of grey limestones and marls. The lower subdivision has yielded *Glyptograptus austordentatus*, indicating an early Kunda age. The other two members contain *Asaphus "raniceps"*, *Pinnatulites procera*, *Uhakiella cicatriosa*, *Paracyclendoceras cancellatum*, etc., of middle Kunda age.

Bilychi Formation (12). This 7 m thick unit of grey limestones is restricted to the subsurface Lvov Depression area (Drygant, 1976; 1979). It rests upon Cambrian rocks, and is separated by a gap from the overlying Suboch Formation. It has yielded *Prioniodus variabilis* and is presumably of Kukruse to Idavere in age.

Blidene Formation (4). The greenish-grey calcareous and argillaceous marls are from 0.5-4 m thick, they rest on the Adze Formation, and are overlain by black shales of the Mossen Formation. Type section: Blidene boring, 892-895 m (Männil, 1963; Ulst *et al.*, 1982). Neostatotype: Saldus 5RM boring, depth 1061-1063 m (Brangulis *et al.*, 1989). The unit is highly fossiliferous containing brachiopods, trilobites, ostracodes, conodonts and chitinozoans but the exact relationship with other formations is still obscure. It is usually considered as an equivalent of the Vilučiai Formation of late Keila age, but the common occurrence of *Estoniops* cf. *alifrons* suggests a correlation with the lower Mossen Formation of Västergötland, Sweden, which is considered to be of Oandu age.

Bugino Formation (8, 9). It consists of grey quartzose siltstones and sandstones in its lowermost part, and of dark brownish-grey silty argillites and clays with thin intercalations of siltstones and sandstones in the main upper part. Thickness increases from 22 m in western areas to 85 m in the east. Type section: Udromo boring No. 1, depth 2060-2145 m (Rybnikova & Strikovskaya, 1984). It has yielded *Obolus apollinis*, *Rhabdinopora flabelliforme*, *Rhabdinopora graptolithinum*, *Parabolina jaroslavica*, etc. The unit is of Pakerort age. It is separated by a hiatus from underlying Cambrian rocks, and is overlain by the Ukhra Formation.

Daugavpils Group (5). The 15-30 m thick sequence of mainly grey monotonous calcarenitic limestones, rests upon different formations of Aseri age, and is overlain by the Mežciems Group. According to the current use (Resheniya ..., 1987) it is subdivided into three units, the Vyžūnai, Kraštai and Kriaunos Formations; the Sartai Formation, previously included in this group (Ulst & Gailite, 1970; Resheniya ..., 1978; Ulst *et al.*, 1982; Laškov *et al.*, 1984), is now regarded as the lowermost subdivision of the overlying Mežciems Group. Reference section: Sartai boring, depth 672-694.4 m (Laškov *et al.*, 1984).

Dolbnevo Formation (10). Grey homogeneous calcarenitic limestones, 3-10.5 m thick, overlie the Zhabinka Formation. Type section: Novoselkovo boring, depth 920-925 m. The unit is fossiliferous, but has not yielded any good index forms. Assumed age is from Aseri (?) to early Uhaku (Pushkin, 1981; Ropot & Pushkin, 1987).

Draseikiai Formation (5). This unit of mostly reddish-brown limestones and marls is up to 9.5 m thick, and separated by a hiatus from the underlying Leetse Formation. Type section: Butkunai boring, depth 739.35-745.6 m (Laškov *et al.*, 1976; 1984). It is subdivided into three parts: the lower, Armonys Member of dolomitic limestones (up to 1.3 m thick), the Medeikiai Member of mottled argillites, marls and dolomitic limestones (up to 5 m) and upper, Spalviškiai Member of mottled dolomitic limestones and marls (up to 4.4 m). The lower member contains *Protopanderodus rectus* and other *lanceolatus* Zone conodonts indicating a late Latorp age. The middle and upper members are of Volkhov age.

Dreimana Formation (3, 4). Grey calcarenites with dark pyritized organic detritus and nodular intercalations of argillaceous marls comprise a unit 7-18 m thick. They rest on the Taurupe (also in part the Kõrgekallas) Formations, and are overlain by the Adze (also in part the Tatruse) Formations. Type section: Dreimana boring No. 11, depth 1015.5-1027.5 m (Springis, 1974; Ulst & Gailite, 1976). Neostatotype: Saldus 5RM boring, depth 1073-1080.4 m (Brangulis *et al.*, 1989). It corresponds to the lower part of the Dalby Formation in the Swedish succession. It is highly fossiliferous and contains *Asaphus* (*Neosaphus*)

ludibundus, *Ogmasaphus praetextus*, *Steusloffia costata*, *Euprimites locknensis*, *Orthograptus uplandicus*, *Nemagraptus gracilis* and other fossils of Kukruse age.

Druya Formation (6). The up to 11.5 m thick, greenish-grey mottled argillaceous limestone sequence rests on the Svedasai Formation. Type section: Vangishki boring No. 205, depth 332-343.5 m (Ropot & Pushkin, 1987). The unit is thought to be a lateral equivalent of the Ukmerge Formation.

Duboviki Formation (7). These grey argillaceous dolomitic limestones, with marly intercalations are up to 9 m thick. The unit rests upon the Obukhovo Formation and is overlain by the Porogi Formation (Resheniya ..., 1987). Type section is in a mine by the Volkhov River, 110 km east of Sankt Peterburg. It is highly fossiliferous, containing numerous index fossils of the Aseri Stage such as *Asaphus* (*Neoasaphus*) *cornutus*, *Asaphus* (*Neoasaphus*) *kowalewskii*, *Suecoceras barrandei*, etc.

Dzerbene Formation (4). A sequence of light grey calcilutites with *Cyathochitina reticulifera*, up to 16 m thick, overlies the Priekule Member of the Mossen Formation. Type section according to R. Männil (unpublished): Dzerbene boring, depth 824-840 m (for comparison, see Ulst *et al.*, 1982). Distribution is restricted to north-central Latvia. It is stratigraphically equivalent to the Skruna Formation. The formation corresponds to the lower part of the Nabala Stage. Previously the Dzerbene Formation was considered as a unit of very restricted thickness corresponding only to the lower part of the Skruna Formation (Ulst *et al.*, 1982, fig. 12, p. 35-36).

Fjäckå Formation (4). 0.7-6 m of dark brown or black shales and mudstones resting on calcilutites of the Saunja Formation (in some cases on the Mõntu or Dzerbene clayey limestones), and mainly overlain by green or reddish-brown mudstones of the Jonstorp Formation. Originally this formation was distinguished in Sweden as the "Black *Tretaspis* Shale"; the current name was introduced by Jaanusson (1963). Type section is in an exposure at the Fjäckå Rivulet, Siljan District, Sweden. In the East Baltic mainly graptoloids such as *Climacograptus angustus*, *Climacograptus styloideus*, *Diplograptus vulgaris*, *Rectograptus pauperatus*, etc., (Ulst, 1975) occur; other groups are poorly known. It is correlated with the Vormsi Stage.

Goraevka Formation (12). Up to 3 m of grey calcareous quartzose sandstones with limestone pebbles characterize this unit. It is separated by breaks from the underlying Cambrian, and also apparently, from the overlying Suboch Formation. Type section: left bank of the Dnestr River, near Goraevka village, 35 km south-west of Kitaigorod, Podolia (Tsegelnyuk, 1972). The unit is developed in the Podolian outcrop area, and in the depression west of it. It has yielded a rich fauna of trilobites, brachiopods, etc., among them *Howellites wesenbergensis*, *Howellites vilniusensis*, *Platystrophia lutkevichi*, indicating an Oandu-Rakvere age. It belongs to the lower part of the Molodovo Group.

Gryazno Formation (7, 8). The name was introduced by Gorjansky & Popov (in Resheniya ..., 1987) to designate the rocks of early Idavere age in the area east of Lake Peipsi. Previously it was distinguished under the name "Itfer beds" (Asatkin, 1931; Alikhova, 1953; Selivanova, 1971). The unit consists of 8-30 m of grey more-or-less dolomitic marls, argillaceous limestones and calcarenitic limestones, and (or) dolomites, with thin intercalations of kukersite. The characteristic fossils are *Scopelochasmops wrangeli*, *Cyrtonotella concava*, *Platystrophia chama*, *Cyathochitina* aff. *reticulifera*, "*Eremochitina*" *dalbyensis*, etc.

Halliku Formation (3, 5). Greenish-grey, sometimes violet or red mottled marls and highly argillaceous limestones, with a thickness of 0.5-37 m. The type section is indefinite, but informally the Kose boring in eastern-central Estonia has been mentioned. In this section the formation overlies the limestones of the Moe Formation and is presumably succeeded by the

Adila Formation. It has been regarded as the lateral equivalent of a part of the Moe and/or the Adila Formations (Rõõmusoks, 1960; 1967; 1983; Nõlvak, 1984; 1986). The relationship between the Halliku and Moe Formations is still obscure and the correlation accepted in the present chart is tentative. Grey marls from 1.9-34.6 m thick in southern Estonia overlying the Jonstorp Formation (Oraspõld, 1975) have also been included in the Halliku Formation; but in the present chart these are considered to belong to the Jelgava, and in part, the Parovéja and Kuili, Formations (column 4). Macrofauna of the Halliku Formation is poorly known, though *Polygonograptus sokolovi*, *Rectograptus gracilis*, *Eospirigerina* cf. *sulevi* have been mentioned. Numerous ostracodes, among them *Tvaerenella expedita*, *Steusloffina cuneata*, *Rectella romboformis*, *Airina cornuta*, *Tetradella trilocolata*, and chitinozoans, also occur.

Hirmuse Formation (2). Up to 4.2 m of greenish-grey argillaceous marls and limestones with intercalations of light grey calcilitic limestones, are separated by a hiatus from the underlying Keila Formation and overlain by the Rägavere Formation. Type section: Hirmuse Rivulet, 120 km east of Tallinn (Männil & Rõõmusoks, 1984). The unit is a typical northern Estonian formation which thins out to the south (Rõõmusoks, 1983). Previously the rocks have been known as Oandu beds and they compose the main part of the type sequence of the Oandu Stage (Männil, 1960; Põlma *et al.*, 1988). Characteristic fossils are *Toxochasmops extensus*, *Howellites wesenbergensis*, *Sowerbyella* (*Sowerbyella*) *tenera*, *Klimphores minimus*, etc.

Ishev Formation (11). This unit of grey dolomitic glauconitic limestones is up to 1 m thick, and rests on the Podgorodny Formation. It has yielded *Orthis callactis*, *Microzarcodina flabellum*, etc., indicating a late Volkhov to early Kunda age.

Jelgava Formation (3, 4). The greenish-grey marls with reddish-brown bands and lenses of this unit are from 4-14 m thick. It overlies the Jonstorp Formation, and is succeeded by the Paroveja Formation. Type section: Dobeles boring No. 92, depth 1234-1242 m (Ulst *et al.*, 1982; Brangulis *et al.*, 1989). It is stratigraphical equivalent to the Halliku Formation of Central Estonia (3).

Jelizavetino Formation (7, 8). These mainly light grey dolomites with, in some places, the lower part containing greenish-grey dolomitic argillaceous limestones and, in part, skeletal limestones with intercalations of thin kukersite beds are up to 40 m thick. The formation was named informally by Gorjansky & Popov (see Resheniya ..., 1987) to designate the beds of Keila age. The characteristic fossils are *Clinambon anomalus*, *Strophomena* sp., *Leptaena rugosoides*, *Platystrophia crassoplicata*, *Conolichas aequilobus*. It is equivalent to the Keila Formation.

Jõhvi Formation (1-3). Grey argillaceous calcarenitic limestones, from 0.5-12 m thick, directly overlies the Vasavere Formation. It forms the lower part of the Kahula Group and represents the type formation of the Jõhvi Stage. Type section: Kambemäe quarry near Jõhvi, 58 km east of Rakvere (see Schmidt, 1858; Rõõmusoks, 1970; Põlma *et al.*, 1988). It has been subdivided into three poorly distinguishable members (from bottom to top, the Aluverve, Pagari and Madise Members). The Pagari Member is characterized by a higher content of terrigenous material and the presence of a distinct bentonite layer "c". The formation is highly fossiliferous, with typical faunal elements including *Rollmops wenjukowi*, *Conolichas pahleni*, *Clinambon anomalus*, *Clitambonites schmidtii epigonus*, *Hemicosmites extraneus*, *Tetrada memorabilis*, *Amphorichnus papillatus*, etc.

Jonstorp Formation (3, 4). This formation of up to 17 m of mudstones, marls and argillaceous limestones (Männil *et al.*, 1968; Oraspõld, 1975; Ulst *et al.*, 1982) in most districts overlie the Fjäckå Formation, and underlie the Jelgava Formation. The unit was first been distinguished in Sweden (Jaanusson, 1963). In the East Baltic it has yielded *Nankinolithus granulatus*, *Panderia megalophtalma*, *Rugosowerbyella rosettana*, *Eospirigerina sulevi*. The formation is of early Pirgu age.

Juodupé Formation (5). Up to 8.8 m of mottled limestones and marls overlie the Bičiūnai Formation. Type section: Butkunai boring, depth 734.5-737.0 m (Laškov *et al.*, 1976; 1984). It has yielded *Megistaspis gigas* indicating a late Kunda age.

Kahula Group (2, 3, 7, 8). A 20-50 m thick sequence of grey argillaceous limestones, which in the eastern districts is often dolomitic. Type section at Kahula, 55 km east of Rakvere. The name has been introduced in emended form (Resheniya ..., 1978; Männil & Rõõmusoks, 1984) to designate the undivided Jõhvi and Keila (2, 3), or Khrevitsa and Jelizavetino (7, 8), Formations. The unit seems to be useful for core sections in which the Jõhvi/Keila stadial boundary cannot be drawn with certainty.

Kallavere Formation (1-6, 10). This unit was previously informally called the "*Obolus* Sandstone"; the present name was introduced lately (Resheniya ..., 1978; Rõõmusoks, 1983; Männil & Rõõmusoks, 1984). Type section: Ülgase outcrop, 18-20 km east of Tallinn (Heinsalu, 1990). In northern Estonia (1, 2) the formation consists of up to 11 m of light coloured, weakly cemented quartz sandstones and siltstones with more or less frequent thin intercalations of dark, sometimes graptolitic, shales. In some districts 0.1-1.5 m thick bands of phosphate-bearing detritus and coquina of inarticulate brachiopods are also developed. South of the outcrop belt, in central Estonia, the total thickness of the Kallavere Formation (together with the Cambrian part) may locally exceed 20 m (Heinsalu, 1987). In a large area of central and southern East Baltic the unit is represented by the Salantai Member, with a thickness of about 0.1-0.5 m (Korkutis, 1971; Resheniya ..., 1978). In its revised and emended form (Heinsalu, 1987; see also Figure 2), within the outcrop area of the formation, it is subdivided into five different members, forming in the west a succession from the Maardu Member at the base to the Suurjõgi Member at the top, in the central area a succession comprising the Maardu Member, the Suurjõgi Member and the Katela Member, and in the east, a laterally equivalent succession consisting of the Rannu Member and the Orasoja Member. In the type area the basal beds of the formation have yielded *Proconodontus*, *Eoconodontus*, *Phakelodus*, *Westergaardodina*, indicating a late Cambrian age. Higher in the sequence, conodonts of the *Cordylodus andresi* to *Cordylodus rotundatus*-*Cordylodus angulatus* Zones occur, thus indicating an early Pakerort (early Tremadocian) age (Kaljo *et al.*, 1986). The unit is separated by a small break from underlying Cambrian rocks (Ülgase Formation; see Figure 2). In northern Estonia the Kallavere Formation is overlain by the Türisalu Formation, the boundary between them being diachronous (Kaljo & Kivimägi, 1976). In other districts the Kallavere Formation is separated by a hiatus from overlying Varangu-early Latorp rocks. Besides the conodonts, *Obolus apollinis*, *Ungula ingraca*, *Schmidtites celatus*, *Rhabdinopora flabelliforme* also occur in the Kallavere Formation.

Keila Formation (1, 2, 3). Greenish-grey argillaceous calcarenitic and light grey, in part, calcilitic limestones, 2-25 m thick, rest conformably on the monotonous rocks of the Jõhvi Formation. The overlying rocks include several different formations (the Hirmuse, Vasalemma, Lukstai and Viluciai Formations), some lying in continuity and some separated by breaks. The overlying Hirmuse Formation, for instance, is separated by a hiatus. The Keila Formation corresponds to the upper half of the Kahula Group and serves as the type formation for the Keila Stage. Type section: old Keila quarry (see Põlma *et al.*, 1988). The formation contains at least two K-bentonite layers. The lower is at the base of the formation and is referred to as the main bentonite bed, or bed "d"; it correlates with bed XXII of Oslo-Asker, Norway. The other, bed "e", is 1-7 m higher. The formation has its maximum thickness in north-western Estonia (20-25 m), decreasing eastwards to 11-15 m, and southwards rapidly to 2 m. In the type area the formation has been subdivided, from bottom to top, into the Kurtna, Pääsküla and Saue Members. The Pääsküla Member is characterized by light grey calcilitic limestones. The stratigraphical range of the formation is minimal in the area of development of the overlying Vasalemma Formation where it consists only of the two lower members. It has

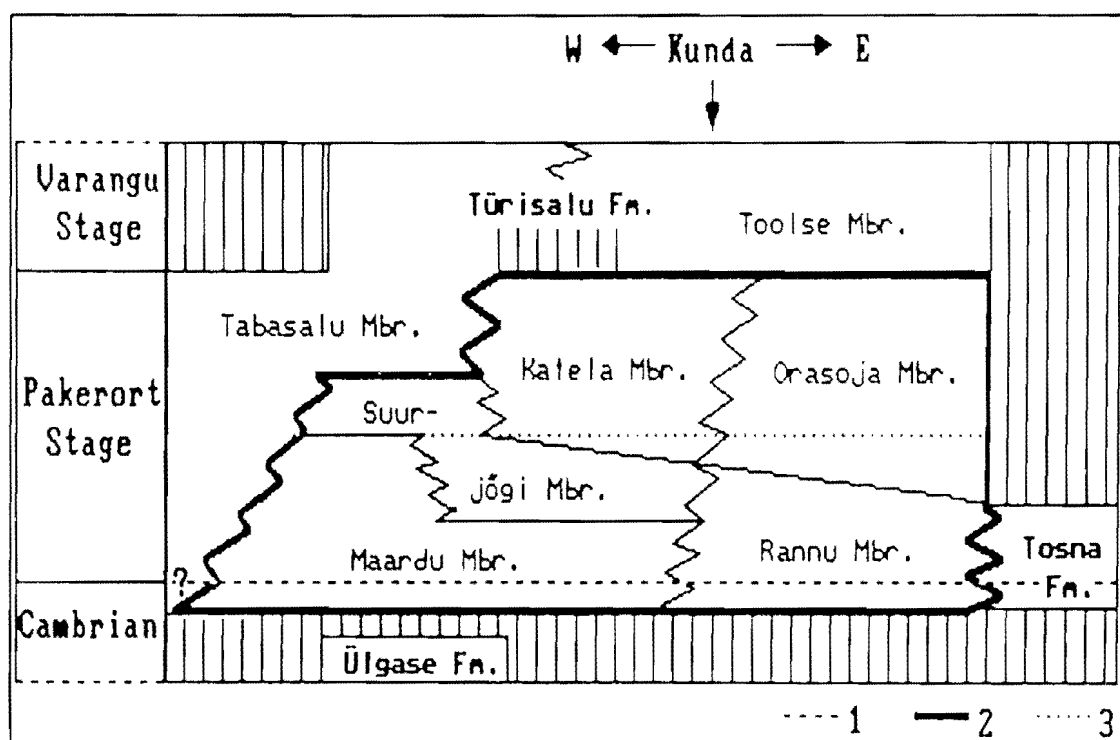


Figure 2. Subdivision of the Kallavere Formation (after Heinsalu, 1987). 1 - the Cambrian-Ordovician boundary; 2 - boundary of the Kallavere Fm.; 3 - base of *Cordylodus angulatus* - *C. rotundatus* Zone.

yielded a rich fauna of brachiopods, trilobites, ostracodes, bryozoans, etc. (Rõõmusoks, 1970; Põlma *et al.*, 1988).

Khrevitsa Formation (7, 8). This 17-21 m thick sequence of greenish-grey dolomitic argillaceous limestones overlies the Shundorovo Formation and is succeeded by the Jelizavetino Formation. The characteristic fossils are *Clinambon anomalus*, *Platystrophia lynx*, *Estlandia pyron silicificata*, *Sowerbyella* (*Sowerbyella*) *trivia*, *Toxochasmops maximus*. According to its definition (Alikhova, 1960), the formation exactly equates with the Jõhvi Formation (Jõhvi Stage).

Koporye Formation (7). Interbedded siltstones and sandstones, and dark argillites occur in the lower part (in the western districts), and homogeneous dark argillites with anthraconite is represented in the upper part of this, up to 5.4 m thick, unit. The formation overlies the Tosna Formation, and is separated by a hiatus from the overlying Leetse Formation, or in some areas, by the Naziya Formation. The type section is located 55 km north-east of Narva (Popov & Khazanovich, 1985). The unit is laterally equivalent to the Türisalu Formation of northern Estonia. Its lower part has yielded graptolites of the *Rhabdinopora flabelliforme anglicum* - *Rhabdinopora flabelliforme multithecatum* Zone (the uppermost Pakerort Stage), and the upper part elements of the *Clonograptus sarmentosus* Zone (lower part of the Varangu Stage).

Kõrgekallas Formation (1-3). Grey argillaceous calcarenitic limestones and marls, 1.5-14 m thick, overlie the Vão Formation and are succeeded by the Viivikonna (1, 2) or Dreimana (3) Formations. The thickness of the unit is greatest in north-eastern Estonia, and decreases in westerly and southerly directions, being only about 7 m in central Estonia. The type section is on the Purtse River, 130 km east of Tallinn. In the type area (north-eastern Estonia) the formation is subdivided into, from bottom to top, the Koljala, Pärtliorg and Ärra Members, each of about equal thicknesses. The lower member (Koljala) has been equated to the Uhaku Stage by Orviku (1940), and the upper member (Ärra), assigned to the upper, Ubja Substage of the Uhaku Stage by Rõõmusoks (1970). Based on current usage, the formation best correlates with the upper part (upper substage) of the Uhaku Stage. The lower part of the formation is highly fossiliferous having yielded *Chasmops odini*, *Iliaenus intermedius*, *Heliocrinites balticus*, *Leptelloidea leptelloides*, *Platystrophia biforata*, *Tallinnella angustata*, etc.

Kõrgessaare Formation (1, 2). The unit comprises 6-25.6 m of grey calcarenitic limestones which overlie calcilutites of the Saunja Formation, and are succeeded by the Moe Formation. Type section: old Kõrgessaare quarry in the north-western part of Hiiumaa Island (western Estonia). The formation is present everywhere in northern Estonia and partly in central Estonia, where it becomes more clayey and passes into the Tudulinna Formation. In the type area (north-western Estonia) the formation has been subdivided on the basis of lithological data into three members (in ascending order, the Hullo, Paopa and Saxby Members). The Paopa Member is the most argillaceous. The formation is highly fossiliferous with rugose and tabulate corals, stromatoporoids, brachiopods, bryozoans, gastropods, etc. (*Catenipora tapaensis*, *Esthonia asterisca*, *Wormsipora hirsuta*, *Protaraea schmidtii*, *Triplexia insularis*, etc. - Jaanusson, 1956; Rõõmusoks, 1962). It is the type formation of the Vormsi Stage (early Ashgillian).

Krastai Formation (5, 6). In north-eastern Latvia and north-eastern Lithuania, up to 14.4 m of greenish-grey marls and calcarenitic limestones overlie the Vyzunai Formation, and in north-western Byelorussia they succeed the Miory Formation (Ulst *et al.*, 1982; Laskov *et al.*, 1984; Ropot & Pushkin, 1987). It is lithologically and seemingly temporally equivalent to the Kõrgekallas Formation (columns 1-3). Type section: Svédasai boring No. 252, depth 678.5-687.6 m. It has yielded *Iliaenus intermedius*, *Platystrophia biforata*, *Echinospaerites aurantium*, *Glyptograptus cf. teretiusculus*, *Tallinnella angustata*, etc., indicating an Uhaku age.

Kriaunos Formation (5, 6). It comprises up to 12.5 m of grey calcarenitic limestones with intercalations of greenish-grey marls (Ulst *et al.*, 1982; Laškov *et al.*, 1984; Ropot & Pushkin, 1987), and overlies the Kraštai Formation. Type section: Svėdasai boring, No 252, depth 672.0-678.5 m. The formation has yielded *Asaphus* (*Neosaphus*) *ludibundus*, *Nileus* sp., *Panderia* sp., *Uhakiella granulifera*, *Steusloffia costata*, *Conochitina oelandica*, *Cyathochitina kuckersiana*, *Cyathochitina stentor*, etc., indicating a Kukruse age. It constitutes the uppermost subdivision of the Daugavpils Group.

Kriukai Formation (4). This, 12-32.5 m thick, unit of mainly reddish-brown marls with intercalations of limestones and mudstones succeeds the Zebre Formation and underlies the Šakyna Formation. Type section: Šakyna boring, depth 1362.4-1388 m (Ulst *et al.*, 1982; 1984). In some sections the unit contains a rich fauna of trilobites including *Megistaspis limbata*, "*Ptychopyge*" cf. *applanata*, "*Ptychopyge*" cf. *multicostata* and *Ptychopyge angustifrons*, indicating a Volkhov (middle Arenigian) age.

Kubena Formation (9). Up to 40 m of grey recrystallized, in part argillaceous or sandy, limestones and dolomites overlie the Soltsy Formation, and are separated from the overlying Mitino Formation by a probable hiatus. The unit was introduced by Dmitrovskaya (see Resheniya ..., 1987, p. 42) with the type section in the Lezha boring core No. 1, depth 2136-2172 m. The lower part of the formation contains an assemblage of brachiopods and ostracodes (*Multicostella*?, *Eorhipidomella*, *Platystrophia* sp. sp., *Vellamo* sp. sp., *Rafinesquina*?, *Tetrada krausei*, *Sigmoopsis cornuta*), suggesting a possible Idavere age.

Kuili Formation (4). The reddish-brown and greenish-grey marls with intercalations of grey calcilutitic limestones of this, 2-10 m thick, sequence overlies the Parovėja Formation and is separated by a hiatus from the overlying Kuldiga Formation. Neostratotype: Saldus 5RM boring, depth 994.7-999.5 m (Brangulis *et al.*, 1989). It contains *Tretaspis latilimbata*, *Tvaerenella expedita*, *Piretella acmaea*, *Kinnekullea waerni*, etc. It is presumed to correlate with the Adila Formation, and thus to be of late Pirgu age.

Kuldiga Formation (4, 5). This unit is up to 18 m thick, and composed of interbedded grey marls and calcarenitic limestones with coquina bands containing argillaceous, silty and sandy limestones. It is separated in most districts by a hiatus from the underlying Kuili Formation, and succeeded by the Saldus Formation. Type section: Mezmalis boring No. 16, depth 900-916 m (Ulst & Gailite, 1970; Ulst, 1972). In western Latvia the unit has been subdivided into the lower, Bernate Member, consisting of 2-8 m of argillaceous calcarenites, and the upper, Edole Member, composed of 3-15 m of interbedded marls and limestones (Ulst, 1972). The latter has yielded *Dalmanitina mucronata*, *Brongniartella platynota*, *Dalmanella testudinaria*, etc. In north-eastern Lithuania stratigraphically equivalent beds are distinguished as the Vaineikiai Member (Laskov *et al.*, 1976), containing *Dalmanella testudinaria*, *Eostropheodonta* cf. *hirsutensis*, *Leptaena* cf. *rugosa*; they are only up to 3.3 m thick and are overlain by the Taucionys Formation. The Vaineikiai Member was assigned to the Uzpaliai Formation (Laskov *et al.*, 1976), this latter now considered to be a synonym of the Kuldiga Formation (Resheniya ..., 1978; Resheniya ..., 1987). The Kuldiga Formation is of Porkuni age.

Leetse Formation (1-3, 5-7, 10). Up to 4 m of greyish-green glauconitic silts, sands, calcareous sandstones, are separated by hiatuses with various underlying upper or lower Pakerort strata, and are succeeded in outcrop areas by the Toila or Volkhov Formations (Männil & Rõõmusoks, 1984). Type section: North Estonian cliff, 35 km west of Tallinn. In northern Estonia the formation is subdivided into three members, from base to top: the Klooga Member (up to 2.9 m of glauconitic siltstones), the Joa Member (up to 1.2 m of glauconitic silts and sands), and the Mäeküla Member (up to 0.9 m of glauconitic sandstones). In some districts (3, 10) the term "Leetse Formation" has been used in a wider sense including glauconitic limestones of the Päite Member and its equivalents (see "Toila Formation"). In

northern Estonia, the formation has yielded *Thysanotos siluricus* (lower member), *Drepanoistodus inconstans* (middle member), *Oistodus lanceolatus* and *Oepikodus evae* (upper member), thus being of early to middle Latorp age (Resheniya ..., 1978; Resheniya ..., 1987).

Lomashka Formation (7). 2.2 m of fine-grained sandstones of restricted distribution, is separated by breaks from the Upper Cambrian Ladoga Formation below, and the Tosna Formation above. The type section is located at the Lomashka Rivulet, 55 km north-east of Narva. The basal part has yielded *Schmidtites celatus* and *Oepikites obtusus*, and the top part, *Cordylodus andresi* Zone conodonts, indicating an early Pakerort age (Kaljo *et al.*, 1986).

Loobu Formation (2, 3). Grey limestones, mostly with small glauconitic grains and nautiloid phragmocones, up to 7 m thick, rest upon the Sillaoru Formation and are overlain by the Aseri, Napa, or Rokiškis Formations. Type section is situated 62 km east of Tallinn (Rõõmusoks, 1983; Männil & Rõõmusoks, 1984). Four members are recognized in northern Estonia (Orviku, 1958; 1960) as follows: the western districts have a lower, Nõmmeveski Member (of up to 2 m of argillaceous limestones) and an upper, Ubari Member (up to 2 m of glauconitic limestones); and the eastern districts exhibit a lower, Utria Member (up to 3 m of dolomitized glauconitic limestones) and an upper, Valgejõe Member (up to 4.7 m of argillaceous limestones). The eastern Utria and Valgejõe Members are recognized also in the outcrop area of the Sankt Peterburg region. The upper Ubari and Valgejõe Members represent lateral equivalents of the Napa Formation. The unit has yielded *Asaphus "raniceps"*, *Asaphus sulevi*, *Megistaspis gigas* and is thus of middle to late Kunda age, and correlative to the upper half of the Obukhovo Formation of the Sankt Peterburg region (7).

Lyubokhin Formation (11). Up to 4.5 (to 6?) m of grey reddish mottled limestones with goethitic ooids, overlie the Ishev Formation, and are probably separated by a break from the succeeding Pishcha Formation. The unit has yielded *Asaphus*, *Megistaspis*, *Ladogiella transversa*, *Orthoceras regulare*, *Prioniodus prevariabilis*, indicating a Kunda to Lasnamägi (?) age.

Ludza Formation (5). Interbedded grey argillaceous calcarenitic limestones, with rich *Vermiporella* and marls, up to 23 m thick, overlie the Baltinava Formation, and are succeeded by the Ukmerge Formation. Revised type section: Ludza boring, depth 490-513 m (Ulst & Gailite, 1976; Ulst *et al.*, 1982). Given the stratigraphic position in the sequence and the correlation with neighbouring formations (Resheniya ..., 1987), the Ludza Formation is thought to have a latest early Pirgu age.

Lukštai Formation (3, 5). Up to 5 m of greenish-grey marls and limestones, succeed the Vilučiai Formation. Type section: Sartai boring, depth 619.4-622.3 m (Laškov *et al.*, 1984). It belongs to the top part of the Mežciems Group, and has yielded *Howellites wesenbergensis*, *Sampo* cf. *indentata*, *Bolbina rakverensis*, *Klimphores minimus*. The unit is of Oandu age.

Mednikovo Formation (8, 9). These grey dolomitized calcarenitic limestones and argillaceous limestones with intercalations of marls, in the basal part sometimes with goethitic ooids, are up to 60 m thick, though in the Yaroslavl region (9), they are only 12-27 m thick. The unit overlies the Obukhovo Formation, and is succeeded by the Soltsy Formation. The formation represents the southern subsurface equivalent of an early Viru sequence in the Volkhov River outcrop area (the Duboviki, Porogi, Valim and Velesy Formations, in Resheniya ..., 1987). The unit has been subdivided into two informal members, the lower which corresponds to the Duboviki and Porogi, and the upper, to the Valim and Velesy, "formations". *Asaphus (Neoasaphus) cornutus*, *Christiania oblonga*, *Clitambonites ascendens*, *Orthoceras regulare* have been recorded from the lower member and, *Xenasaphus devexus*, *Gymnograptus linnarssoni* and many others, from the upper member.

Meilunai Formation (5). Up to 29 m of interbedded grey marls and calcarenitic limestones comprise this formation, and it is separated by a break from the underlying Voore Group. Type section: Svédasai boring, depth 582.4-608.1 m (Laskov *et al.*, 1984; Ulst *et al.*, 1982). In the type area the formation is subdivided into three, from base to top, the Revuona Member (6 m of argillaceous marls, calcareous marls, limestones), the Kaimynai Member (up to 12.3 m of limestones and marls), and the Dobilyne Member (up to 15.1 m of homogeneous interbedded limestones and marls) (Laskov *et al.*, 1984). This upper member has yielded *Acanthochitina barbata*, indicating a late Vormsi age. The formation thus spans the Vormsi Stage.

Mežciems Group (5, 6). The sequence comprises 20-50 m of mainly greenish-grey calcareous marls, with argillaceous calcarenitic limestones at the base. It overlies the Daugavpils Group. Reference section: Svédasai boring, depth 619.4-672.0 m (Laskov *et al.*, 1984). Prior to 1984 (Laškov *et al.*, 1976; 1984; Ulst *et al.*, 1982; Resheniya ..., 1978) the group was comprised of four formations: the Šventupys, Auleliai, Vilučiai and Lukštai Formations. However in current usage (Resheniya ..., 1987) a fifth unit, the Sartai Formation has been added. This latter was formerly ascribed to the Daugavpils Group. The group presently includes rocks ranging from the base of the Idavere Stage to the top of the Oandu Stage.

Miory Formation (6). This unit is up to 5.5 m thick and comprises grey limestones and marls with occasional goethitic pseudo-ooids. It overlies the Tverečius Formation, and is succeeded by the Kraštai Formation. Type section: Tverečius boring core, depth 317.2-321.9 m (Laškov *et al.*, 1983). The unit has a wide stratigraphic range, from the Upper Kunda to Lasnamägi Stages.

Mitino Formation (9). The sequence consists unit of up to 100 m of part-coloured, and in part sulphatized, sandstones, siltstones and shales with intercalations of dolomites and anhydrites, and rare limestones. It is separated probably with hiatuses from the underlying Soltsy and/or Kubena Formations, and the overlying Varlygino Formation, though certain relationships are somewhat obscure. Dmitrovskaya (1989) suggested a relationship with the Middle Ordovician rocks of the Petchora region. The unit was first distinguished by Birina (1954) in the Ljubim boring No. 1, at a depth of 1829-1837 m. It has yielded *Tetrada krausei*, *Sigmoopsis cornuta*, *Estlandia* sp., *Rafinesquina* sp., *Horderleyella?* cf. *kegelensis* and some other rare fossils indicating a Jõhvi to Keila age.

Moe Formation (1-3, 5). Grey or brownish-grey calcarenitic and calcilutitic limestones, 10-25 m thick, rest on limestones of the underlying Kõrgessaare Formation, and marls of the overlying Tudulinna Formation. The formation contains beds with abundant dasycladacean algae and bioherms in north-west Estonia (at Huitberg, Nyby and Ruunavere). The formation was first distinguished (Rõõmusoks, 1960) as a lithologically distinct lower part of the Pirgu Stage in northern Estonia, and subsequently equated with the Nyby Substage of north-western Estonia (Männil, 1966; Resheniya ..., 1978). It is richly fossiliferous, including corals, stromatoporoids, brachiopods, bryozoans, gastropods, cephalopods, ostracodes and other forms. The most abundant and typical are *Catenipora rubraeformis*, *Stelliporella parvistella*, *Clathrodictyon microundulatum*, *Eospirigerina sulevi*, and *Dicoelosia* sp.

Molodovo Group (12). This unit is up to 5 m (in some districts up to 26 m) thick, and consists of sandstones and limestones. It overlies Vendian and Cambrian strata, and is succeeded by Silurian rocks. The name was introduced by Vaskautanu (1931), and the unit revised subsequently by Alikhova (1956), and Tsegelnyuk (1968; 1980). The type section is located 36 km south-east of Kitaigorod, Podolia. The group includes the Goraevka, Pleshany and Suboch Formations.

Mõntu Formation (3, 4). Grey calcarenitic limestones with glauconite grains, from 1.4-9 m thick, are represented as a lateral equivalent of the Paekna Formation in a narrow central-southern Estonian belt (see Männil, 1966, fig. 63). Type section: Ohesaare boring, depth

460.2-462.9 m. The name was also extended (Resheniya ..., 1987) to include glauconitic limestones and marls in Latvia earlier assigned to the Paekna Formation (Ulst, 1972; Ulst *et al.*, 1982; 1984). Occurrences of *Cyathochitina reticulifera* and *Uhakiella curta* have been reported from this unit.

Mossen Formation (4). It comprises black shales and grey argillaceous marls in the lower part (0.7-5 m thick), and greenish-grey argillaceous marls with thin intercalations of calcarenitic limestones in the upper part (1-6.5 m thick). The unit was first distinguished by Skoglund (1963) in Västergötland, Sweden. The lower and upper lithological subdivisions have been distinguished as separate members in the central East Baltic area (see Ulst *et al.*, 1982): an informal "shaly" lower member, and the Priekul Member at the top. The lower member contains *Climacograptus diplacanthus* and *Dicranograptus clingani*, and the upper also has *Dicranograptus clingani* at the top, suggesting a correlation with the Hirmuse-Rägavere succession of northern Estonia.

Myadel Formation (6). Grey dolomitic limestones with glauconite grains occur in a sequence 0.2-2.2 m thick, and is separated by a break from the underlying Leetse Formation, or early Cambrian rocks. Type section: Richany boring, depth 339.5-341.4 m (Ropot & Pushkin, 1987; Resheniya ..., 1987). A synonym is the Toila Formation of Laškov *et al.* (1983). The formation is of Volkhov age.

Napa Formation (2, 3). This unit consists of up to 4 m of grey oolitic limestones in eastern and central Estonia, succeeding the Loobu Formation. The type section is on the Purtse River, 120 km east of Tallinn (Orviku, 1958; 1960). The unit grades laterally into the upper part of the Loobu Formation (= the Valgejõe Member) to the west, into the uppermost part of the Obukhovo Formation (= the Simonkovo Member) to the east, and into the lower part of the Rokiškis Formation to the south. The Sinyavino Member of the upper Obukhovo Formation (7) probably also represents an extension of the Napa Formation. The unit has yielded *Megistaspis gigas*, *Lycophoria globosa* and *Pinnatulites procera*, indicating a late Kunda age.

Naroch Formation (6). Up to 30 m of grey argillaceous limestones with thin intercalations of greenish-grey marls, rest upon the Strusto Formation. Type section: Vangishki boring No. 205, depth 379.4-409.6 m (Ropot & Pushkin, 1987). The unit has yielded *Sampo hiiuensis*, *Boreadorthis reclusa*, *Esthonia tumutosa*, and is regarded as of Nabala - Vormsi age.

Naziya Formation (7). Greyish-green silty glauconitic clays, of restricted distribution and thickness (up to 0.4 m thick), are separated by hiatuses between the underlying Koporye and overlying Leetse Formations. Type section is located on the Naziya River, 50 km east of Sankt Peterburg. It has yielded a rich late Tremadocian conodont fauna (Borovko *et al.*, 1983).

Novoselki Formation (10). About 30 m of grey calcarenitic limestones and marls, rest on the Dolbnevo Formation, and are overlain by Silurian rocks. Type section: Novoselki boring No. 29, depth 891-920 m (Pushkin, 1981; Ropot & Pushkin, 1987). It is subdivided (from bottom to top) into the Lesovchitsy, Vidomlya and Lyshchitsy Members. The Lesovchitsy Member is represented by 4-18 m of limestones with intercalations of marls containing *Leptestia*, *Kullervo*, *Platystrophia bifurcata*, *Cyrtotrocha kuckersiana*, *Diplotrypa moniliformis*, etc. This member is of late Uhaku - Kukruse age. The Vidomlya Member consists of 1-14.5 m of interbedded limestones and marls with *Clitambonites schmidtii epigonus*, *Batostoma granulatum*, *Lioclemella clava*, etc. It is roughly of Idavere - Jõhvi age. The Lyshchitsy Member is developed as 2-8 m of interbedded marls and subordinated limestones with *Hesperorthis* cf. *pljussensis*, *Howellites* cf. *vilniusensis* and "*Leptaena*" *wesenbergensis*, and this unit is approximately of Keila to Oandu age.

Obukhovo Formation (7-9). In the type area it is represented by up to 12.5 m of grey argillaceous limestones, resting upon the Volkhov Formation. The type section is located on

the Volkhov River, 110 km east of Sankt Peterburg (7). Traditionally the formation is subdivided into three parts, corresponding to the three substages of the Kunda Stage. The lower "subformation" consists of up to 3.5 m of mostly highly argillaceous grey limestones, yielding *Asaphus expansus*, *Orthis callactis*, etc. The middle subdivision is represented at its base by 0.5 m of oolitic argillaceous limestones (=the Voka Member, see the Sillaoru Formation in columns 2-3), and higher by 2.5 m of grey dolomitic limestones with glauconite. The subdivision has yielded *Asaphus "raniceps"*, *Megistaspis lawrowi*, *Orthambonites calligramma*, etc. The upper "subformation" contains grey limestones with rich nautiloids at its base (the Valgejõe Member, 2 m), oolitic limestones in its middle part (the Sinyavino Member, 1.5 m), and grey limestones at its top (the Simonkovo Member, 5 m). The upper unit is up to 6 m thick. It has yielded *Asaphus sulevi*, *Megistaspis*, and *Iru concava*, indicating a late Kunda age. Previously a part of it, corresponding to the two upper members, was considered by several authors (e. g., Balashova & Balashov, 1959) as the lowermost Viru Series ("Tallinn Stage"). In the subsurface areas (8, 9) the Obukhovo Formation consists of up to 25-40 m of grey argillaceous limestones containing *Asaphus expansus*, *Asaphus "raniceps"*, *Asaphus major*, *Pliomera fischeri*, *Paracyclendoceras cancellatum*, *Ahtiella baltica*, *Didymograptus artus*, etc. (Dmitrovskaya, 1989).

Oostriku Formation (3). This unit is up to 14 m thick and is comprised of grey calcarenitic limestones. It overlies the Halliku marls and is restricted so far to a narrow belt in central Estonia. The formation is considered as the uppermost part of the lower substage of the Pirgu Stage (Männil & Rõõmusoks, 1984). It probably correlates with the Parovéja and Ludza Formations (4-5) and may correspond to the hiatus between the Moe and Adila Formations in northern Estonia (1-2). Macrofossils are very poorly known, but rich microfossil assemblages occur (Nõlvak, 1984).

Paekna Formation (1, 2). Up to 16 m of grey argillaceous calcarenitic limestones with intercalations of light grey calcilutites were distinguished by Jaanusson (1944) as a separate unit between the calcilutitic rocks of the underlying Rägavere Formation and calcilutites of the overlying Saunja Formation. Type section: Paekna quarry (Nõlvak & Meidla, 1990). Southwards the formation grades into the Mõntu Formation. The characteristic fossils include *Wysogorškiella litviensis*, "*Orthis*" *lyckholmiensis*, *Ilmarinia sinuata*, *Cyathochitina reticulifera*, *Hamarodus europaeus*, etc.

Pakri Formation (1). The sequence is up to 4.5 m thick and composed of yellowish-grey sandy limestones and calcareous sandstones. It is separated by a hiatus with the underlying Toila Formation. Type section: cliff on the Island of Väike Pakri, 45 km west of Tallinn (Öpik, 1927). In the western districts two members are distinguished, the lower, Suurupi Member (4 m thick), containing *Didymograptus pakrianus* and *Asaphus "raniceps"*, and the upper, Osmussaare Member (0.5 m thick), containing *Megistaspis gibba*. These members range from middle to late Kunda age (Männil & Rõõmusoks, 1984). In the eastern districts the unit is represented by the Kallaste Member, consisting of grey limestones with quartz and glauconite grains and coarse phosphatic material.

Parovéja Formation (4). This formation is up to 38 m thick, and consists of light grey calcilutitic limestones and greenish-grey marls (in the middle part of the succession). It rests upon the Jelgava Formation, and is overlain by the Kuili Formation. Type section: Parovéja boring, depth 775.6-795.6 m (Lapinskas, 1970). It has been subdivided on the basis of lithological data into three, in ascending order designated as the Geidžiūnai Member (up to 6 m of limestones), the Gulbinai Member (up to 7 m of marls) and the Smilgiai Member (up to 31 m of limestones) (Lapinskas, 1976; Resheniya ..., 1978; Ulst *et al.*, 1984). The formation has yielded a few ostracodes and chitinozoans, and is presumably of late early Pirgu age.

Pishcha Formation (11). The name was introduced by Pomyanovskaya & Khizhnyakov (1967). In its revised and emended form (Resheniya ..., 1987) the unit consists mostly of grey

calcarenitic limestones and marls, resting upon the Lyubokhin Formation and forming the youngest part of the incomplete Ordovician sequence of western Volyny. Three informal subdivisions have been recognized. The basal part is represented by 6.5-11.5 m of argillaceous limestones occasionally with chamosite oolites. It has yielded *Glossorthis tacens*, *Platystrophia veimarnensis*, *Porambonites kukersensis*, *Pygodus anserinus*, *Eoplacognathus lindstroemi*, etc., indicating an Uhaku to Kukruse age. The middle part consists of 8.5-29 m of calcarenitic limestones and marls, which have yielded *Amorphognathus tvaerensis*, *Cyrtototella concava*, *Clitambonites schmidtii epigonus*, *Platystrophia chama*, *Hordeleyella? kegelensis*, etc., indicating an Idavere-Keila age. The top part, consisting of up to 9 m of limestones and marls with *Howellites vilniusensis*, is apparently of Oandu age.

Pivorai Formation (6). The sequence is up to 10 m thick and is composed of grey limestones and marls with occasional goethitic oolites. The unit rests upon the Myadel Formation, and is overlain by the Tverečius Formation. Type section: Tverečius boring, depth 325-330 m (Laškov *et al.*, 1983). It has yielded *Asaphus "raniceps"*, *Eoplacognathus variabilis*, *Cyathochitina regnelli*, etc., and is assigned an early-middle Kunda age.

Pleshany Formation (12). This unit consists of light grey sandstones with a few intercalations of siltstones and argillites, up to 26 m thick, and developed in the subsurface of southern Moldova. Large hiatuses separate this unit from the underlying Cambrian, and the overlying Silurian. It has yielded "*Dalmanella*" *alichovae*. The unit belongs to the lower part of the Moldovo Group and it is thought to be stratigraphically a lateral equivalent of the Goraevka Formation (Krandievski & Bukatchuk, 1969). It is thus of Oandu to Rakvere age.

Pljussa Group (7, 8). The name was introduced by Alikhova (1960). It is used herein to designate an up to 46 m thick sequence of undifferentiated dolomitic limestones and dolomites of mainly Oandu to Nabala age, developed in the Sankt Peterburg and Novgorod regions. The unit rests upon the Jelizavetino Formation, and is overlain by the Devonian. Type sections are on the Pljussa River; the subsurface reference section is located in the Opochivalovo borehole (Selivanova, 1971). Gorjanski & Popov (in Resheniya ..., 1987) have assigned these rocks to the Varlygino Formation. The unit has produced only a few fossils such as *Sowerbyella*, *Platystrophia* and "*Rafinesquina*" cf. *inaequiclina*.

Podgorodny Formation (11). This 0.3-2.5 m thick unit of greenish-grey glauconitic sandstones, is calcareous at the top. It is separated by a hiatus from the underlying Vyzhivka Formation, and the Ishev Formation is in continuity above (Pomyanovskaya, 1972). The unit has yielded *Stolodus stola*, *Oistodus lanceolatus*, *Scolopodus rex*, *Microzarcodina flabellum*, etc., indicating a late Latorp to middle Volkhov age.

Porogi Formation (7). Up to 8.5 m thick, this formation of grey, mostly thick-bedded dolomitized limestones and dolomites, rests with no indication of hiatus upon the Duboviki Formation, and is overlain by the Valim Formation of similar lithological character (Resheniya ..., 1987). The Lasnamägi age of the unit is indicated by many index fossils, such as *Asaphus (Neasaphus) ornatus*, *Christiania oblonga*, *Orthoceras regulare*, *Dideroceras rectestrigatum* and *Cameroceras tallinnense*.

Poshekhonye Formation (lower part) (9). Up to 80 m of dolomites and dolomitized limestones with intercalations of fine-grained quartzose sandstones, rest on the Varlygino Formation and are succeeded by the upper part of the Poshekhonye Formation, of supposedly Devonian age. The revised type section is in the Poshekhonye boring, depth 1493-1572 m (that is, the Ordovician part of the formation - Prokofjev & Kuznetsov, 1982). The formation has yielded acritarchs *Baltisphaeridium*, *Veryhachium*, *Lophosphaeridium*, *Leiofusa* and *Leiosphaeridia*, suggesting a late Ordovician-early Silurian age (Aristova & Ivanova, 1977). According to other studies, however, the unit also contains "trilete" pollen indicating a probable Devonian age (Umnova, 1971).

Pribug Formation (10). This 1-3 m thick unit of greenish-grey dolomitic glauconite limestones, overlies the Leetse Formation. It has yielded *Ranorthis carinata*, conodonts etc., and is assigned a Volkhov age (Resheniya ..., 1987; Ropot & Pushkin, 1987).

Rägavere Formation (1-3). This is a sequence of mainly light grey, pure, calcilutitic limestones, up to 28 m thick, belonging to the lower part of the Voore Group. Type section: Rägavere quarry in Rakvere, 100 km east of Tallinn (Põlma *et al.*, 1988). In northern Estonia it overlies the Hirmuse Formation and is succeeded by the Paekna argillaceous limestones, while in Central Estonia, it rests upon the Lukstai marls, and underlies the Mõntu limestones. It is subdivided from bottom to top into the Tõrremägi, Piilse and Tudu Members. The Tõrremägi Member (0.5 m) yields "*Rafinesquina*" *poljensis* which is tentatively assigned to the Oandu Stage; the rest of the sequence contains *Toxochasmops wesenbergensis*, "*Rafinesquina*" *inaequiclina*, etc. (see Põlma *et al.*, 1988), and represents the type sequence of the Rakvere Stage. The Piilse Member consists of pure calcilutites, up to 24 m thick, and the Tudu Member is composed of microcrystalline limestones with some kukersite, up to 8 m thick.

Richany Formation (6). The 6 to 10 m thick sequence of interbedded greenish-grey marls and grey calcarenitic limestones of this unit has a rich fauna of echinoderms, bryozoans, brachiopods and ostracodes. It overlies the Kriaunos Formation. Type section: Vangishki boring No. 205, depth 434.5-444.5 m (Ropot & Pushkin, 1987; Resheniya ..., 1987). The formation is assigned an Idavere age, though in many sections (including the type section) it probably only spans the late Idavere interval.

Rokiškis Formation (3, 5). Up to 9 m of grey, reddish-brown and mottled limestones, occasionally with goethitic oolites, are represented in this unit. It rests upon the Bičiūnai, or the Loobu, Formations, and has as lateral equivalents the Juodup and Segerstad Formations (5), and the Napa and Segerstad Formations (3). Type section: Butkunai boring, depth 732.4-737.9 m (Laškov *et al.*, 1984; Resheniya ..., 1987).

Šakyna Formation (4). The mainly greenish-grey and grey argillaceous marls of this up to 25 m (typically 8-12 m) thick sequence lies between the Kriukai Formation (below) and the Baldone Formation (above). The unit has a more restricted regional distribution than the underlying Kriukai Formation. Type section: Šakyna boring, depth 1355.6-1362.4 m (Ulst *et al.*, 1982; 1984; Paškevičius, 1976). It is a highly fossiliferous unit with trilobites, ostracodes, graptoloids, brachiopods. The age is indicated by occurrences of *Aulograptus cucullus*, *Glyptograptus* cf. *austrorudentatus*, *Glyptograptus dentatus*, *Diplograptus ellesi*, *Asaphus* cf. *expansus*, *Asaphus* cf. "*raniceps*", *Tallinnellina primaria* and *Ogmoopsis bocki*, of early to middle Kunda age (Resheniya ..., 1987).

Saldus Formation (3-5). The grey marls and argillaceous, calcarenitic, clastic, sandy and oolitic limestones of this unit, up to 32 m (in most districts 1-5 m) thick, are separated mainly by hiatuses from the Kuldiga Formation below, and from the Silurian rocks above. Neostatotype: Saldus 5RM boring, depth 983.5-987.5 m (Brangulis *et al.*, 1989). The formation has been subdivided into the lower, Piltene Member, and the upper, Brocena Member (Ulst, 1972). The Piltene Member consists mainly of oolitic limestones (up to 13.5 m thick) with only the occurrence of *Rectella sturiensis*. The Brocena Member comprises silty and sandy marls and limestones with mud cracks and ripple marks (up to 8 m thick), and it has yielded *Dalmanitina mucronata*, *Bollia*? *rectangularis* and *Harpabollia harparum*. The formation is of late Porkuni age.

Sartai Formation (5). This unit is up to 6.5 m thick and composed of grey calcarenitic limestones with marly intercalations. It overlies the Kriaunos Formation. Type section: Svedasai boring, depth 667-672 m (Laškov *et al.*, 1984). It was previously classified with the Daugavpils Group, but according to the current usage (Resheniya ..., 1987) represents the

lowest subdivision of the Mežciems Group. The formation has yielded "*Eremochitina dalbyensis*", suggesting an early Idavere age.

Saunja Formation (1-4). This sequence of light grey calcilutites is up to 27.7 m thick, and in northern Estonia overlies the argillaceous limestones of the Paekna Formation. In southern districts it rests on other units, representing lateral equivalents of the Paekna Formation; these include the Mõntu, Skrunda, Dzerbene Formations. It is overlain by rocks of Vormsi age, again a number of different units, the Kõrgessaare, Tudulinna and Fjäcka Formations. Type section: Saunja quarry, 35 km south-west of Tallinn (Rõõmusoks, 1983). In the central East Baltic the formation is missing in many sections. The unit has yielded a rich but not diverse fauna in which corals and stromatoporoids are absent. Brachiopods, gastropods and different groups of microfossils are well represented: *Sampo mucronata*, *Iliaenus mascei*, *Boreadorthis recula*, *Rectograptus gracilis*, *Archeoretiolites regimontanus*, *Lagenochitina baltica*, etc. (Jaanusson, 1956; Männil, 1958c).

Segerstad Formation (3-5). The reddish-brown limestones of this formation are up to 4 m thick, and they rest on different late Kunda age units (the Baldone, Napa and Juodupė Formations) and are overlain by the Stirna or the Vyžūnai Formations. Type section is on the Island of Öland, Sweden (Jaanusson, 1960c). It was introduced as a formal stratigraphic unit in the central East Baltic area in 1984 (Resheniya ..., 1987). Previously these beds were referred to the uppermost part of the Baldone Formation *sensu lato* (Gailite & Ulst, 1975; Ulst *et al.*, 1982; 1984). The formation has a relatively wide distribution in the central East Baltic and grades into the Rokiskis Formation at its periphery (3 & 5). The unit contains *Asaphus* (*Neoasaphus*) *platyurus*, *Piretella tridactyla*, *Piretia geniculata*, *Chilobolbina lativelata* indicative of an Aseri age (earliest Viru).

Sementsovo Formation (8, 9). In the western districts (8) this formation of grey argillites, marls and limestones is up to 15 m thick, and in the eastern area (9) the mainly grey argillites, siltstones and marls are up to 80 m thick. The unit rests upon the Ukhra Formation and is overlain by the Volkhov Formation. Type section: Lezha boring No. 1, depth 2310-2340 m (Dmitrovskaya, 1989). Note, however, that according to Resheniya ..., 1987 the depth interval is 2302-2340 m. In the type area the sequence is subdivided mainly on the basis of lithological and faunal data into four parts, as follows (from base to top): (i) grey argillites and siltstones containing *Tetragraptus approximatus*, *Tetragraptus phyllograptoides*; (ii) mostly dark grey siltstones with *Didymograptus balticus*; (iii) greenish-grey calcareous clays, argillites and siltstones; and (iv) greenish-grey marls and argillites containing *Phyllograptus angustifolius*, *Phyllograptus* cf. *densus*. In the west, in more calcareous sections, the equivalent faunal units may be partly recognized, with the addition of *Megistaspis planilimbata*, *Megistaspis* aff. *limbata* and *Asaphus priscus*. The lowermost part of the formation is of early Latorp age, and the mainly upper part is of late Latorp age.

Shundorovo Formation (7, 8). The 14-25 m thick sequence of greenish-grey dolomitic argillaceous limestones and marls of this unit rest upon the Gryazno Formation, and are overlain by the Khrevitsa Formation without lithologically marked boundaries. In the outcrop area the unit is characterized by the presence of thin intercalations of kukersite, quartz (chalcedony) concretions and spicules of *Pyritonema*. These latter have been used as a basis for drawing the boundaries of the formation (Alikhova, 1953; 1960; Selivanova, 1971) but the occurrence of *Pyritonema* is in fact not restricted to this formation. The unit was first distinguished by Asatkin (1931) as a new unit C₄ (sponge beds) of stage category, subsequently designated as the Shundorovo beds (Alikhova, 1953). Characteristic fossils are *Oepikina dorsata assatkini*, *Endoceras gubkovense*, *Pyritonema subulare*, different species of *Carpospongia* and *Caryospongia*. The unit is of late Idavere age, equivalent to the Vasavere Formation.

Sillaoru Formation (2, 3). Up to 1.5 m of brownish-grey limestones and marls rest upon different members of the Toila Formation and are overlain by the Loobu Formation. Type section is located on the Purtse River, 125 km east of Tallinn (Männil & Rõõmusoks, 1984). Two members have been recognized, the lower one (Pada Member) of restricted distribution, and the upper (Voka Member), which can be distinguished over a wide area as a marker horizon. A hiatus may separate the two members (2). The lower member has yielded *Orthis callactis* (?) and *Ptychopyge angustifrons* (Mägi, 1990), and is of late Volkhov or early Kunda age. The Voka Member contains *Asaphus "raniceps"*, and is of early middle Kunda age.

Skrunda Formation (4). Interbedded grey argillaceous calcarenitic limestones and greenish-grey marls, 5-8 m thick, are developed in western Latvia. Neostatotype: Saldus 5RM boring, depth 1047.3-1053 m (Brangulis *et al.*, 1989). It contains *Cyathochitina reticulifera*, *Piretella acmaea* and *Grammolomatella vestrogothica*, indicating an early Nabala age.

Smorgon Formation (5, 6). This sequence of greenish-grey nodular calcarenitic limestones, in part developed as coquina beds with intercalations of calcareous to argillaceous marls, is from 2-8 m thick. It rests transgressively with a break upon Kukruse to Jõhvi age rocks, and partly upon the Cambrian. Type section: Vangishki boring No. 205, depth 417.4-425.5 m (Pushkin, 1981; Ropot & Pushkin, 1987). It is a highly fossiliferous unit containing *Howellites wesenbergensis*, "*Rafinesquina*" *poljensis*, *Bolbina rakverensis*, *Sigmoopsis granulata*, *Disulcina perita*, etc. In a north-western direction the formation grades into the Lukštai Formation. The unit is of Oandu age.

Soltsy Formation (7-9). The unit was introduced by Gorjanski & Popov (see Resheniya ..., 1987) to accommodate the rocks of Kukruse age which extend over a large subsurface area east of Lake Peipsi - the Moscow Syncline *sensu lato* - and first distinguished on the basis of macrofaunal data by Alikhova (1960; 1969). Type section is the Pirogovo boring in the vicinity of Soltsy, south-west of Novgorod. The Porkhov core (Alikhova, 1969) may serve as a reference section. The unit rests upon the Mednikovo Formation and is overlain by the Gryazno or the Kubena Formations. In the west the unit consists mainly of grey argillaceous, highly fossiliferous calcarenitic limestones with intercalations of marls and calcareous clays. Thickness of the unit is estimated between 15 and 35 m. Characteristic macrofossils are *Chasmops odini*, *Paraceraurus aculeatus*, *Kullervo panderi*, *Leptestia musculosa*, *Viruella liliifera*, *Michelinoceras kukersense* in the west, and *Clitambonites*, *Estlandia*, *Leptelloidea* and *Cyrtonotella* in the east. The formation is assigned to the Kukruse Stage.

Stirna Formation (3, 4). This unit of light grey mottled pale reddish-brown argillaceous limestones and (in the upper part) greenish-grey argillaceous limestones is 5-15 m thick, and rests mainly on the Segerstad Formation, and is overlain by the Taurupe Formation. Neostatotype: Saldus 5RM boring, depth 1096.8-1107.5 m (Brangulis *et al.*, 1989). The formation has yielded *Illaeus schroeteri*, *Pseudomegalaspis patagiata*, *Steusloffia linnarssoni*, *Prioniodus prevariabilis*, *Pseudoclimacograptus luperus* and *Pseudoclimacograptus eurystoma*, indicating a Lasnamägi (late Llanvirnian) age. The unit corresponds to the Vyzunai, Porogi and Vão (lower part) Formations in the East Baltic (1-2, 5, 7) and to the sequence of the Seby and Folkeslunda Formations in Sweden.

Strusto Formation (6). The grey calcareous or argillaceous marls and argillaceous calcilititic limestones of this unit are up to 25 m thick, and rest directly on the Smorgon Formation. Type section: Vangishki boring No. 205, depth 409.6-417.4 m (Ropot & Pushkin, 1987). In the type area the unit has yielded few fossils, suggesting possibly a Rakvere and/or early Nabala age. In other districts the formation may be highly fossiliferous with brachiopods, echinoderms, bryozoans, trilobites, ostracodes, including index fossils of the Rakvere (*Toxochasmops extensus*, *Erratencrinurus seebachi*, *Howellites wesenbergensis*, *Sowerbyella* (*Sowerbyella*) *raegaverensis*, *Sigmoopsis granulata*) and Nabala (*Eoplectodonta*, *Sampo*, *Cyathochitina reticulifera*) Stages (e. g., Berzini boring No. 33, depth 424.4-450.8 m: Põlma

et al., 1977). Stratigraphically it is equivalent to the Voore Group. It remains a relatively ill-defined unit.

Suboch Formation (12). This unit comprises up to 8.5 m of grey calcarenitic limestones; it is separated by hiatuses from the underlying Goraevka Formation or Precambrian rocks, and the overlying Silurian. Type section lies on the Dnestr River, in the neighbourhood of Kitaigorod (Tsegelnyuk, 1968). It belongs to the upper part of the Molodovo Group. The formation has yielded *Amorphognathus ordovicicus*, *Leurocycloceras foerstei*, "*Dalmanella*" *estona*, *Triplesia insularis*, *Porambonites gigas* and *Bekkeromena semipartita*, indicating a Vormsi age.

Svédasai Formation (5, 6). This sequence of grey limestones with brown shades, up to 35 m thick, rests upon the Meilunai and the Naroch Formations. Type section: Svédasai boring core, depth 558.9-582.4 m (Laškov *et al.*, 1984). It is subdivided in the type area into the lower, Rageliai Member and the upper, Salos Member, the lower consisting of up to 12 m thick limestones and marls, the upper, mainly calcilititic limestones with thin intercalations of marls. The formation has yielded *Eospirigerina sulevi*, indicating an early Pirgu age. In a northwesterly direction the formation is assumed to be intertongue with sequences representing four different units, in ascending order, the Moe, Halliku, Baltinava and Ludza Formations (5).

Sventupys Formation (5). These greenish-grey marls with intercalations of calcarenitic limestones are up to 19 m thick. They overlie the Sartai Formation. Type section: Svédasai boring, depth 651.3-667.0 m (Laškov *et al.*, 1984). The formation contains *Bichilina prima*, *Euprimites locknensis*, *Steusloffia costata*, *Uhakiella jaanussoni*, *Platystrophia chama*, etc., and is assigned a late Idavere-Jõhvi age.

Tatruse Formation (1-3). This unit is up to 10.6 m thick and is composed of grey marls and argillaceous calcarenitic limestones in the lower part, grey argillaceous calcarenites in the middle part, and light grey calcarenites in the upper part. It rests upon the Viivikonna Formation and is everywhere overlain by the Vasavere Formation. Type section: Tatruse, 90 km east of Tallinn (Männil & Rõõmusoks, 1984; Põlma *et al.*, 1988). In the outcrop belt in northern Estonia the unit is either missing (in the surroundings of Tallinn) or represented by its upper part only as in the type area, north of Rakvere. The sequence is stratigraphically complete in central Estonia. The unit may be regarded as the type formation for the lower substage of the Idavere Stage. The formation has produced *Scopelochasmops wrangeli*, "*Orthis*" *holmi*, "*Eremochitina*" *dalbyensis*, *Prioniodus gerdae* and many other characteristic fossils.

Taučionys Formation (5, 6). The sequence of light grey calcilititic limestones with thin intercalations of marls is up to 10.8 m thick. It is separated by breaks from the underlying Ukmergė Formation, and overlying Kuldiga Formation or Silurian. Revised type section: Svédasai boring, depth 540.6-550.2 m (Laškov *et al.*, 1984). In many sections the unit has yielded *Holorhynchus giganteus* and is currently tentatively regarded as the lowermost part of the Porkuni Stage (Resheniya ..., 1978; Resheniya ..., 1987).

Taurupe Formation (4). The light grey finely nodular limestones (mainly calcilitites) with intercalations of grey calcarenitic limestones and marls are 10-20 m thick; they rest on the Stirna Formation and are overlain by the Dreimana Formation. Type section: Taurupe boring, depth 828-848 m (Springis, 1974; Ulst & Gailite, 1976). The unit has yielded in its lower part *Gymnograptus linnarssoni* and *Pygodus serra*, and in the upper part, *Pygodus anserinus*, *Eoplacognathus lindstroemi*, *Illaenus intermedius*, etc., of Uhaku age. The unit is equivalent to the Furudal Formation of Sweden.

Toila Formation (1-3). The mainly grey glauconitic limestones of this formation, are up to 4 m thick, and overlie the Leetse Formation. A break separates the unit from the succeeding Pakri

or Sillaoru Formations. Type section: North Estonian cliff at Toila, 158 km east of Tallinn (Rõõmusoks, 1983; Männil & Rõõmusoks, 1984). The formation is subdivided into six members (Orviku, 1958; 1960). The lowermost two of them (Päite and Saka Members) are represented by hard, mostly dolomitized, glauconitic limestones. They are succeeded by two laterally equivalent units, in the west, the Telinõmme Member composed of interbedded greenish-grey limestones and marls, and in the east, the Künnapõhja Member consisting of mottled dolomitic limestones. The succeeding Kalvi Member consists of up to 1.7 m of grey argillaceous glauconitic limestones. The uppermost subdivisions represent presumed lateral equivalents: in the west, the Lahepera Member with up to 0.5 m of sandy, in part, conglomeratic glauconite limestones, and in the east, the Pada Member with oolitic limestones of similar thickness. The lowermost, Päite Member contains *Megistaspis estonica* and *Oistodus lanceolatus*, indicating a late Latorp age. The Saka Member has yielded *Megistaspis elongata*, *Megistaspis lata* and *Baltoniodus navis*, of early Volkhov age. The following two laterally equivalent members contain *Paroistodus originalis* and are of middle Volkhov age, and the three uppermost subdivisions, at least in part, are of late Volkhov (Langevoja) age. The Toila Formation is, consequently, nearly equivalent stratigraphically to the Volkhov Formation. However, it should be noted that, while the Päite Member is assigned to the bottom of the Toila Formation and directly overlies the Leetse Formation in Estonia (1-3), it is grouped in the top of the Leetse Formation, immediately beneath the Volkhov Formation in the St. Petersburg region (7).

Tootsi Formation (3). This is a 2.1-15.1 m thick sequence of grey and reddish-brown mottled calcarenitic limestones with glauconite grains. Oraspõld (1982) distinguished it as a lateral equivalent of the Moe Formation, at the transition between this latter and the Jonstorp Formation. The formation has yielded *Foramenella parkis*, *Tvaerenella expedita*, *Tetradella plicatula* and other ostracodes of lower Pirgu age.

Tosna Formation (7). This unit of weakly consolidated quartzose sandstones with brachiopod detritus is from 0.5 to 7.5 m thick. It is separated from underlying Cambrian rocks by an hiatus, and succeeded by the Koporye Formation. Type section is on the Tosna River, south of Sankt Peterburg (Popov & Khazanovich, 1985). Stratigraphically it is approximately equivalent to the Kallavere Formation. It has yielded inarticulates (*Obolus apollinis*, *Helmersenella ladogensis*, *Aulonotreta antiquissima*), and conodonts of the *Cordylodus proavus* through *Cordylodus rotundatus* - *C. angulatus* Zones (Kaljo *et al.*, 1986).

Tudulinna Formation (3). These more-or-less highly argillaceous grey calcarenites and marls, 3.4-15.4 m thick, are considered as transitional deposits between the North Estonian Kõrgessaare Formation and the Fjäckå Formation of the Central Scandinavian Confacies Belt in the Baltic Basin. Type section: Kamariku boring, depth 72.9-80.4 m (Rõõmusoks, 1983). The formation has yielded *Porambonites gigas*, *Triplesia insularis*, *Acanthochitina barbata* and *Uhakiella curta* (Männil, 1958c; Nõlvak, 1984), and is of Vormsi age.

Türisalu Formation (1, 2). The unit is characterized by an up to 7.7 m thick sequence of brownish-grey graptolitic argillites, in eastern districts with thin intercalations of siltstone, anthraconite and pyrite nodules. Previously it was known as the "*Dictyonema* Shale". The unit rests upon the Kallavere Formation and is separated by an hiatus from the overlying Varangu Formation or, in other districts, the Leetse Formation. Type section: North Estonian cliff 25 km west of Tallinn (Müürisepp, 1958). Two members have been recognized. The Tabasalu Member represents the western lithofacies of the northern Estonian outcrop area (Heinsalu, 1987); it has yielded *Rhabdinopora graptolithinum*, *Rhabdinopora flabelliforme anglicum*, *Rhabdinopora flabelliforme sociale*, *Rhabdinopora flabelliforme multithecatum*, *Rhabdinopora flabelliforme flabelliforme* and *Rhabdinopora desmograptoides*, indicating a Pakerort (early Tremadocian) age. To the east, the Toolse Member is represented, and contains *Clonograptus sarmentosus*, *Clonograptus heres*, *Adelograptus cf. hunnebergensis*, *Bryograptus*,

"Didymograptus" cf. *primigenius*, etc., of Varangu (late Tremadocian) age (Kaljo & Kivimägi, 1970; 1976; Kaljo, 1974).

Tverečius Formation (6). These grey argillaceous marls with intercalations of limestones are 3.2-4.2 m thick, and rest upon the Pivorai Formation. Type section: Tverečius boring, depth 321.9-325.0 m (Laškov *et al.*, 1983). It has yielded *Megistaspis heros*, *Pinnatulites procera*, *Lycophoria nucella*, *Orthis callactis*, etc. The unit is of middle to late Kunda age.

Ukhra Formation (8, 9). The sequence of dark grey calcareous clays and argillites with glauconite grains and thin intercalations of grey siltstones is 10-35 m thick, in the eastern districts, probably up to 78 m thick. In these eastern districts the lower part of the unit consists of 6-29 m of dark or greenish-grey glauconitic quartzose silty sandstones. The formation rests on the Bugino Formation. Type section: Daniloovo boring No. 8, depth 2032-2058 m (Dmitrovskaya, 1989). The lower part has yielded *Bryograptus ramosus*, *Rhabdinopora uralense*, and the upper, *Rhabdinopora "murayi"*, *Kiaerograptus* sp., indicating a Varangu (late Tremadocian) age. The same beds have been treated as the lower part of the Yelnik Formation (Rybnikova & Strikovskaya, 1984).

Ukmergė Formation (5). Up to 8.7 m of grey fine-grained calcarenitic limestones and marls, rest upon the Svėdasai and, in northern districts, the Ludza and ?Baltinava Formations. Revised type section: Svėdasai boring, depth 548.0-558.9 m (Laškov *et al.*, 1984). Two members have been distinguished: the lower, Alksniai Member is represented by up to 5.9 m of limestones and marls, and the upper, Margenai Member is composed of up to 10.7 m of dolomitic marls with intercalations of limestones (Laškov *et al.*, 1976). *Rafinesquina semipartita*, *Mjoesina pseudoalternata*, *Duplexibollia duplex*, *Tetradella plicatula*, *Foramenella parkis*, *Esthonia asterisca* and *Catenipora wrighti* have been reported. The formation is stratigraphically equivalent to the Adila Formation, and thus of late Pirgu age.

Valim Formation (7). Thick-bedded, grey dolomitized limestones, up to 5.3 m thick, rest upon the Porogi Formation and are overlain by more argillaceous rocks of the Velesy Formation (Resheniya ..., 1987). The unit is characterized by the presence of *Xenasaphus devexus*, *Porambonites laticaudatus*, *Lophocystis aranea* and *Camerocheras planum*, indicating an early Uhaku age. It seems to represent an equivalent of the northern Estonian Kostivere Member of the Vao Formation.

Vangishki Formation (6). This sequence of greenish-grey marls and argillaceous calcarenitic limestones is up to 9 m thick, and overlies the Richany Formation. Type section: Vangishki boring, depth 425.5-434.5 m (Ropot & Pushkin, 1987; Resheniya ..., 1987). The formation has yielded *Bichilina prima*, *Tetrada memorabilis*, *Polyceratella spinosa*, *Neotsitrella longata*, *Braderupia asymmetrica* etc., indicating a Jõhvi to Keila age. The stadial boundary lies in the type section at a depth of 429 m.

Vao Formation (1-3). These, 4.2-9.3 m thick, grey calcarenites are widely known as a "building limestone" (Baukalkstein). The thickness decreases southward and to the west of the type section (in Tallinn). It rests on the Aseri Formation, and is overlain by the Kõrgekallas Formation. The formation is subdivided into three units, which according to modern usage (Männil & Rõõmusoks, 1984; Resheniya ..., 1987) comprise, in ascending order, the Rebala Member (1.7-2.7 m), Pae Member (0.6-1.6 m), and Kostivere Member (1.9-5.7 m). The first two belong to the Lasnamägi Stage, the third, to the Uhaku Stage. The Rebala Member consists of thin- to medium-bedded limestones, at the base (in an 0.2-0.5 m thick interval) with phosphate and brown goethite oolites, and the Pae Member is represented mostly by thick-bedded limestones with dolomitic beds (0.2-0.4 m thick) at the base. The lower two members contain *Illaenus schroeteri*, *Asaphus (Neoasaphus) ornatus*, *Lituities* sp., *Orthoceras regulare*, *Christiania oblonga*, and the Kostivere Member has elements including *Xenasaphus devexus*, *Estlandia marginata*, *Lophocystis aranea*, *Ancistroceras* sp. and *Gymnograptus linnarssoni*.

In central Estonia (3) the formation is represented by a tongue corresponding only to the upper, Kostivere Member.

Varangu Formation (1, 2, 5). The mostly greenish-grey silty clays with intercalations of glauconitic quartzose siltstones, up to 3 m thick, are separated by hiatuses from the underlying Türisalu Formation and the overlying Leetse Formation. Type section is at Varangu, 90 km east of Tallinn (Loog & Kivimägi, 1968; Kaljo *et al.*, 1986; Heinsalu, 1987). The formation has yielded *Clonograptus* cf. *tenellus*, *Bryograptus* cf. *broeggeri*, *Adelograptus* sp., *Drepanoistodus deltifer pristinus*, *Paroistodus numarcuatus*, and *Acodus tetrahedron* (Kaljo & Kivimägi, 1976; Viira *et al.*, 1970). It serves as the type formation for the Varangu Stage.

Varlygino Formation (9). Up to 145 m of yellowish-grey dolomites and dolomitized limestones with intercalations of sandstones and siltstones rest on the Mitino Formation and are overlain by the Poshekhonye Formation. Type section: Ljubim boring No. 1, depth 1756-1829 m (Birina, 1954; Dmitrovskaya, 1989). It contains rare brachiopods *Rafinesquina*, *Fardenia*, ostracodes *Bolbina rakverensis*, and chitinozoans *Conochitina wesenbergensis*, *Lagenochitina baltica*, suggesting an Oandu-Nabala age.

Vasalemma Formation (1). The sequence of light to dark grey pure, coarse, organodetrritic, medium- to thick-bedded limestones including numerous carbonate mounds ("bioherms"), is up to 15 m thick. It is restricted to a small area in north-west Estonia (west of Tallinn), where it rests upon the Pääsküla or Saue Members of the Keila Formation, and it is succeeded, probably with an intervening break, by the Tõrremägi Member of the Rägavere Formation. Type section: Rummu quarry (Rõõmusoks, 1970); hypostratotype: the old Vasalemma quarry (Põlma *et al.*, 1988; Hints, 1990). The stratotype sequence of the formation has been subdivided into three informal members, the lower and middle seemingly either lateral equivalents of the Saue Member and/or they correspond in part to the suggested hiatus between the Keila and Hirmuse Formations (2). This part of the sequence contains *Clinambon anomalus*, *Estlandia pyron silicificata*, *Horderleyella? kegelensis*, *Asaphus* (*Neoasaphus*), etc., indicating a Keila age. The upper member is characterized by the presence of *Eofletcheria*, *Lyopora*, "*Receptaculites*", *Nekhorosheviella*, *Vasalemmoceras* etc., elements which are missing from the lower members and suggest an Oandu age. Beside these informal members, the Vasalemma Formation includes also in its upper part, the 7 m thick, Saku Member, a distinct local unit with a rich Oandu-age assemblage containing *Stromatocerium*, *Thyplasma*, *Toxochasmops extensus*, *Ilmarinia dimorpha*, *Dactylogonia luhai*, *Pseudocryptaenia*, *Rostricellula*, *Zygospira*, *Achradocystites* etc.

Vasavere Formation (1-3). The grey argillaceous calcarenitic limestones with intercalations of marls and some thin beds of K-bentonites of this sequence is from 0.5 to 5 m thick. It is underlain by the Tatruse Formation, and overlain by the Jõhvhi Formation. Type section: Vasavere quarry, 150 km east of Tallinn (Männil & Rõõmusoks, 1984). The formation corresponds to the level of the upper substage of the Idavere Stage. Characteristic fossils are *Pyritonema subulare*, *Estoniops bekkeri*, *Paucicrura plana* and *Bichilina prima* (Põlma *et al.*, 1988).

Velesy Formation (7). This unit is up to 14.5 m thick, and comprises grey thin- to medium-bedded argillaceous dolomitized calcarenitic limestones in the lower part, and thick-bedded dolomitized limestones with argillaceous intercalations in the upper part. The formation rests upon the Valim Formation, and is overlain by the Soltsy Formation (Resheniya ..., 1987). It represents an eastern equivalent of the northern Estonian Kõrgekallas Formation and is of late Uhaku age. Characteristic macrofossils include *Leptelloidea leptelloides*, *Orthisocrania planissima*, *Bicuspina dorsata*, *Heliocrinites balticus* and *Dianulites fastigiatius*.

Viivikonna Formation (1, 2). The sequence of grey more-or-less argillaceous calcarenitic limestones with intercalations of kukersite (oil shale) and kukersitic marls is from 3 to 20 m

thick. Type section: Viivikonna quarry, 170 km east of Tallinn (Männil & Rõõmusoks, 1984). The boundaries of the unit coincide with the limits of the Kukruse Stage, the lower boundary being drawn at the base of the commercial oil shale seam A-F₂, the upper, at the level of the seam X (Männil, 1984; 1986). The thickness of the unit has its maximum in the area surrounding the northern part of Lake Peipsi; it decreases most typically in a westerly direction. Mainly on the basis of lithological data, the formation is subdivided into three members, designated as the Kiviõli (1-6.5 m thick, Maidla (4-7.5 m thick) and Peetri (up to 10 m thick) Members. Boundaries between the members are defined by lithological marker horizons. In the type area of the formation the upper, Peetri Member is missing because of non-deposition. The lowermost and top parts of the formation are highly fossiliferous and contain a well-documented and diversified fauna of brachiopods, bryozoans, trilobites, ostracodes, gastropods, pelecypods, etc. (about 400 species). Very common are *Viruella liliifera*, *Bilobia musca*, *Graptodictya bonnemai*, *Chasmops odini* and *Asaphus* (*Neoasaphus*) *nieszkowskii* (Rõõmusoks, 1970; Männil, 1986).

Vilučiai Formation (3, 5). Up to 20.4 m of greenish-grey argillaceous marls rest upon the Auleliai Formation in the type area (Laškov *et al.*, 1984). Type section: Svėdasai boring, depth 622.3-633.0 m. Characteristic ostracodes are *Neotsitrella longata*, *Polyceratella spinosa*, *Pyxion keilaensis*, indicating a late Keila age.

Volkhov Formation (7-9). In the type area up to 6.5 m of greenish-grey, in part yellow mottled, limestones and dolomites, rest upon the Leetse Formation (the upper, Päite Member), and are overlain by the Obukhovo Formation. The type section is on the Volkhov River, 100 km east of Sankt Peterburg. In the type area the unit is traditionally subdivided (Lamansky, 1905) into three parts ("subformations"), corresponding to the three substages of the Volkhov Stage. The lower part (the Päite limestone excluded) consists of up to 1.6 m of hard, thick-bedded grey dolomitized glauconitic limestones containing *Megistaspis lata*. The middle subdivision is represented by up to 2.2 m of yellowish mottled, grey glauconitic limestones, yielding *Asaphus broeggeri* and *Scandodus brevibasis*. The upper part consists of up to 2.7 m of grey argillaceous glauconitic limestones with intercalations of grey marls and contains *Asaphus lepidurus* and *Microzarcodina parva*. In the Ilmen area (8) the rocks are much more argillaceous, in the eastern part being mainly represented by 20-25 m interbedded argillaceous limestones and marls with trilobites, brachiopods and few graptolites. In the Moscow Basin (9) the unit is represented by a sequence of grey highly argillaceous limestones and marls, up to 35 m thick, and faunal elements including *Didymograptus hirundo*, *Tetragraptus quadribrachiatas*, *Productorthis*, *Paurorthis*, *Antigonambonites* and *Apomatella*.

Voore Group (1-5). These mainly calcilutitic limestones and secondary dolomites of Oandu, Rakvere and Nabala age (presumably of late *clingani* to early *linearis* age), are up to 50 m thick, and overlie the Vasalemma (1), Hirmuse (2) or Mossen Formations (4), or the Kahula or Mežciems Groups (3, 5). They are underlain everywhere by rocks of Vormsi age. The stratigraphic range of the group varies widely in different areas. In northern Estonia the group is subdivided into three: the lower (Rägavere Formation) and the upper (Saunja Formation) being represented by calcilutites, and the middle part (Paekna Formation) being composed mainly of argillaceous calcarenites.

Vyzhivka Formation (11). Up to 41 m (?) of quartzose sandstones with intercalations of dark argillites and clays, rest on the Cambrian and are separated by a hiatus from the overlying Podgorodny Formation. The top part of the sequence has yielded *Obolus apollinis* (Pomyanovskaya, 1972) and is probably of Pakerort age.

Vyžūnai Formation (5). This unit of grey, in part reddish, mottled calcarenitic limestones and marls is 3 to 8 m thick, and it rests on the Segerstad or Rokiškis Formations. Type section: Svėdasai boring No. 252, depth 687.6-694.4 m. Stratigraphically the formation is equivalent

to the Stirna Formation (3-4). It belongs to the lowermost part of the Daugavpils Group. The formation has produced a fauna including *Christiania oblonga*, *Orthoceras regulare*, *Lituities lituus*, *Paraceraurus exul*, *Pseudomegalaspis patagiata*, *Euprimites effusus* and *Steusloffia linnarssoni*. and is assigned a Lasnamägi age (Laškov *et al.*, 1976).

Zebre Formation (4). The sequence of greenish-grey and reddish-brown mudstones is up to 46 m thick, and separated by a hiatus from the underlying Kallavere Formation. It is overlain by the Kriukai Formation. Neostratotype: Dobeles boring No. 92, depth 1383.7-1426.5 m (Brangulis *et al.*, 1989). The unit has been subdivided into five members by Ulst & Gailite (1976). The two lowermost, Lutrini and Kumbri Members, have a thickness of up to 11 m, and contain *Clonograptus*, *Bryograptus*, *Triograptus*, *Adelograptus*, *Kiaerograptus* and conodonts of the *Drepanoistodus deltifer* Zone, establishing a Varangu (late Tremadocian) age. The middle, Zirni Member (0-16 m) has yielded *Megistaspis planilimbata*, *Tetragraptus phyllograptoides* and *Paroistodus proteus* of early Latorp age. The two upper, Kalvene and Zante Members, with a thickness of up to 20 m, are of late Latorp age.

Zhabinka Formation (10). This 2-8 m thick unit of mostly reddish-brown limestones, rests on the Pribug Formation. It has yielded *Orthis callactis*, *Orthambonites calligramma*, *Apomatella ingrlica*, *Orthoceras regulare*, *Echinospaerites* and *Drepanoistodus basiovalis*, indicating a Kunda to Aseri age (Ropot & Pushkin, 1987).

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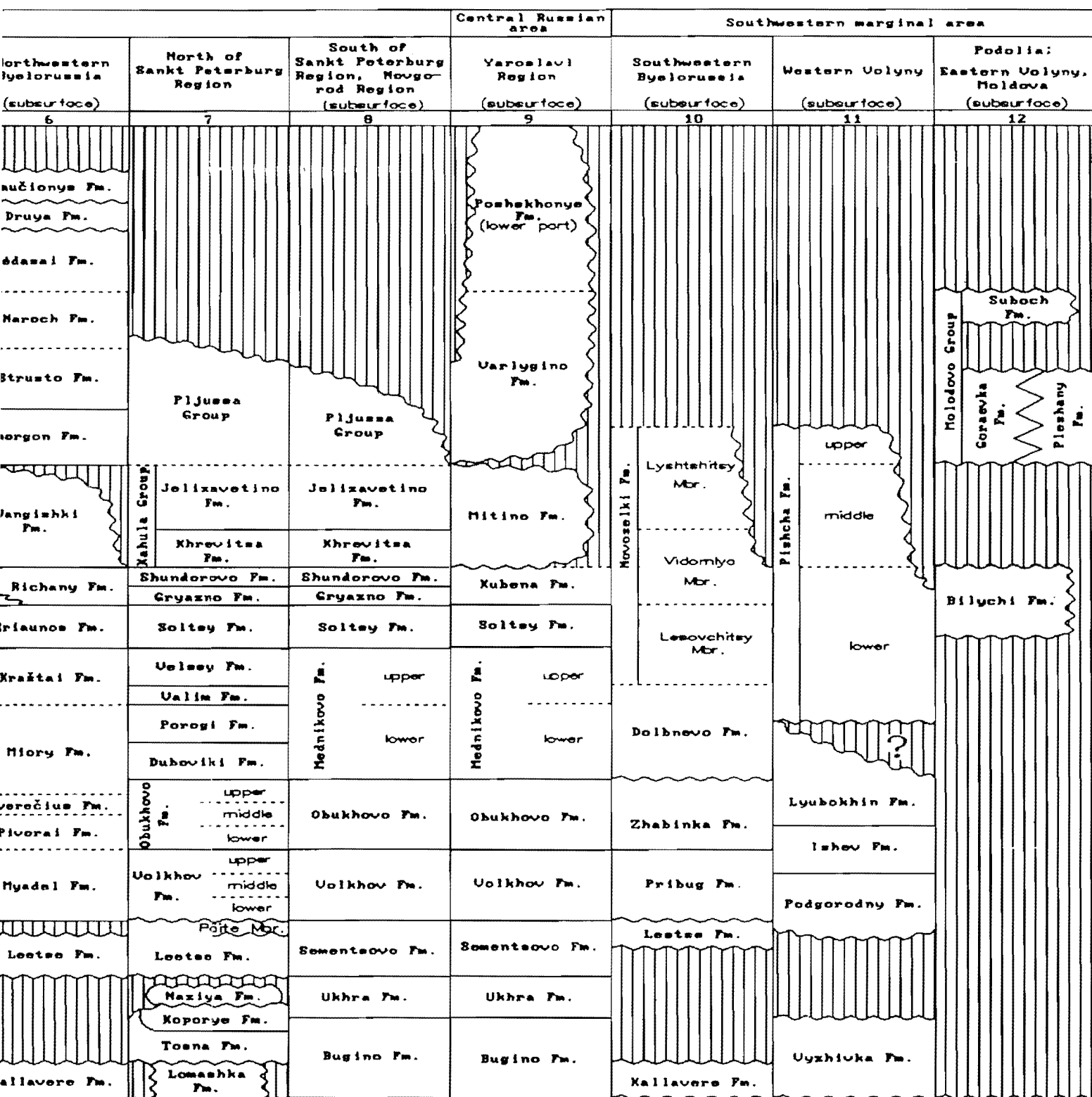
Chart 1

ORDOVICIAN SY

System	Subsystem	British series	Graptolite zonation	Regional standard			North-west Estonia	North Estonia	Central Estonia (subsurface)	Sommerberg Lithology	
				Series	Subseries	Stages Substages					
Ordovician	Upper Ordovician	Ashgill	<i>Clyptograptus persculptus</i>	Harju	unnamed	PORXUMI	1	2	3	5	
			<i>Chimaerograptus ? extraordinarius</i> <i>Dicellograptus anceps</i>				Ärina Fm.	Ärina Fm.	Saidus Fm.	Ku	
			<i>Dicellograptus complanatus</i>			PIRGU	U	Adila Fm.	Adila Fm.	Adila Fm.	1
							L	Moe Fm.	Moe Fm.	Oostriku Fm. Halliku Fm. Moe Tootsi Fm.	Pa Ja Joni
	Middle Ordovician	Caradoc	<i>Pleurograptus linearis</i>	Uru	Kohila	UORMSI	Kõrgessaare Fm.	Kõrgessaare Fm.	Tudulinna Fm.	FJ	
			NABALA			U	Saunja Fm.	Saunja Fm.	Saunja Fm.	Saun	
					L	Paskna Fm.	Paskna Fm.	Mõntu Fm.	Skrui Fm.		
			<i>Doranograptus olingani</i>		unnamed	RAKVERE	Rägavere Fm.	Rägavere Fm.	Rägavere Fm.	Moss Fm.	
						OANDU	Tõrrenõel Mbr. Daku Mbr.	Tõrrenõel Mbr.	Lukštal Fm.		
			<i>Diplograptus multidentatus</i>		Kure	KEILA	Uasa-Icuma Fm. upper middle lower	Hirmuse Fm.	Uiluõial Fm.	Bl	
							Keila Fm.	Keila Fm.	Keila Fm.		
			<i>Nemagraptus gracilis</i> <i>Clyptograptus teretiusculus</i>		Purtse	JÕHVI	Jõhvi Fm.	Jõhvi Fm.	Jõhvi Fm.		
						IDAVERE	U	Uasavere Fm.	Uasavere Fm.	Uasavere Fm.	
							L	Tatruse Fm.	Tatruse Fm.	Tatruse Fm.	
						KUKRUSE	Uilvikonna Fm.	Uilvikonna Fm.	Dreimana Fm.	Dre	
	Lower Ordovician	Llanvirn	<i>Didymograptus murchisoni</i>		Purtse	UHAKU	U	Kõrgekallas Fm.	Kõrgekallas Fm.	Kõrgekallas Fm.	Ta
						L	Koostivere Mbr.	Koostivere Mbr.	Uko Fm. (upper p.)		
			LASNAMICI			Uko Fm.	Uko Fm.	Stirna Fm.	St		
			ASERI				Aseri Fm.	Rokiškis Fm.	Soge		
		Arenig	Ontika	<i>Didymograptus artus</i>	KUNDA	U	Pakri Fm.	Loobu Fm. Hapa Fm.	Loobu Fm. Hapa Fm.	Ba	
						M		Billegu Fm. (upper)	Billegu Fm. (upper)	Ša	
	<i>Didymograptus hirundo</i> <i>Didymograptus extensus</i> <i>Tetragraptus approximatus</i>			UOLXHOV	U	Toila Fm.	Toila Fm.	Toila Fm.	Kr		
					L	Põite Mbr.	Põite Mbr.	Põite Mbr.			
Tremadoc		<i>Rhabdinopora flabelliforme</i>	LATORP	U	Leetse Fm.	Leetse Fm.	Leetse Fm.	Zeb			
				L							
	iru	Oeland	UARANGU		Uarangu Fm.	Uarangu Fm.					
PAKERORT			Türisalu Fm. Kallavere Fm.	Türisalu Fm. Kallavere Fm.	Kallavere Fm.	Kal					

ORDOVICIAN SYSTEM OF THE EAST EUROPEAN PLATFORM

Midwestern area							
East ia	North Estonia	Central Estonia (subsurface)	South Estonia, western Latvia, northwestern Lithuania, Kalin- ingrad Region (subsurface)	Eastern Lithuania, southeastern Latvia (subsurface)	Northwestern Byelorussia (subsurface)	North of Sankt Petersburg Region	South of Sankt Peter- burg Region, Mo- rod Region (subsurface)
	2	3	4	5	6	7	8
Fm.	Ärina Fm.	Saidus Fm.	Saidus Fm.	Saidus Fm.			
Fm.	Adila Fm.	Adila Fm.	Kuldiga Fm.	Kuldiga Fm.	Taučionys Fm.		
Fm.	Adila Fm.	Adila Fm.	Kuili Fm.	Ukmergė Fm.	Drūva Fm.		
Fm.	Moe Fm.	Oostriku Fm.	Parovėja Fm.	Ludza Fm.			
Fm.		Halliku Fm.	Jelgava Fm.	Baltinava Fm.	Suðasai Fm.		
Fm.		Moe Tõptai Fm.	Jonstorp Fm.	Halliku Fm.			
Fm.	Kõrgessaare Fm.	Tudulinna Fm.	Fjäska Fm.	Meilūnai Fm.	Haroch Fm.		
Fm.	Saunja Fm.	Saunja Fm.	Saunja Fm.	Upper part			
Fm.	Paekna Fm.	Mõntu Fm.	Skrunda Dzorbene Fm.	Middle part	Strusto Fm.		
Fm.	Rägavere Fm.	Rägavere Fm.	Priekule Mbr.	Lower part			
Fm.	Tõnnemägi Mbr.		Mossan Fm.		Smorgon Fm.	Pijussa Group	Pijussa Group
Fm.	Hirmuse Fm.	Lukātai Fm.		Lukātai Fm.			
Fm.	Kella Fm.	Uilučiai Fm.	Blidene Fm.	Uilučiai Fm.	Uangishki Fm.	Jelizavetino Fm.	Jelizavetino Fm.
Fm.	Jõhvi Fm.	Kella Fm.		Auleliai Fm.		Khrevitsa Fm.	Khrevitsa Fm.
Fm.	Uasavere Fm.	Jõhvi Fm.	Adze Fm.	Šventupys Fm.	Richany Fm.	Shundorovo Fm.	Shundorovo Fm.
Fm.	Tatruse Fm.	Uasavere Fm.		Sartai Fm.		Gryazno Fm.	Gryazno Fm.
Fm.	Uilvikonna Fm.	Tatruse Fm.	Dreimana Fm.	Kriaunos Fm.	Kriaunos Fm.	Soltay Fm.	Soltay Fm.
Fm.	Kõrgokallas Fm.	Dreimana Fm.	Dreimana Fm.	Kraštai Fm.	Kraštai Fm.	Uelasy Fm.	Uelasy Fm.
Fm.	Kostivere Mbr.	Taurupe Fm.	Taurupe Fm.	Uyžūnai Fm.		Ualim Fm.	Ualim Fm.
Fm.	Uõ Fm.	Stirna Fm.	Stirna Fm.			Porogi Fm.	Porogi Fm.
Fm.	Asori Fm.	Rokiškis Fm.	Sogerstad Fm.	Rokiškis Fm.	Miory Fm.	Duboviki Fm.	Duboviki Fm.
Fm.	Loobu Fm.	Loobu Fm.	Baldone Fm.	Jyodupė Fm.	Tverečius Fm.	Obukhovo Fm.	Obukhovo Fm.
Fm.	Šakyna Fm.	Šakyna Fm.	Šakyna Fm.	Bičiūnai Fm.	Pivorai Fm.	Obukhovo Fm.	Obukhovo Fm.
Fm.	Toila Fm.	Toila Fm.	Kriukai Fm.	Draseikiai Fm.	Myadel Fm.	Uolkhov Fm.	Uolkhov Fm.
Fm.	Leetse Fm.	Leetse Fm.	Zebre Fm.	Leetse Fm.	Leetse Fm.	Leetse Fm.	Sementsovo Fm.
Fm.	Varangu Fm.	Varangu Fm.	Kumbri Mbr.	Varangu Fm.		Naziya Fm.	Ukhra Fm.
Fm.	Türisalu Fm.	Türisalu Fm.	Lutrinini Mbr.			Koporye Fm.	Koporye Fm.
Fm.	Kallavere Fm.	Kallavere Fm.	Kallavere Fm.	Kallavere Fm.	Kallavere Fm.	Toena Fm.	Bugino Fm.
Fm.						Lomashka Fm.	



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Correlation chart for the Ordovician System
of the East European Platform

A. The Ordovician System of the East European