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WATERLAIN GLACIAL DIAMICTON ALONG THE PALIVERE ICE-MARGINAL ZONE ON THE WEST ESTONIAN ARCHIPELAGO, EASTERN BALTIC SEA

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Abstract. On both the distal and proximal sides of the Palivere end-moraine zone on the West Estonian Archipelago, a sporadic distribution of up to 25 m thick subaqueous waterlain glacial diamicton (WGD) was observed. The WGD lies at an altitude between −15 and +10 m relative to contemporary sea level. During the Palivere stadial the distribution area of the WGD was at least 50–60 m below the water table of the Baltic Ice Lake. The WGD was deposited at the grounding zone of the glacier by continuous subaqueous basal meltout from floating ice with minor involvement of sediment flows, dumping, and grounding. In texture, the WGD resembles glaciolacustrine clay with increased amounts of gravel and clay fractions. Compared to the basal tills of the area, the WGD contains less gravel (21.5% and 6.8%, respectively) but is rich in silt and clay fractions. Petrographic, mineralogical, and chemical analyses show a similar source for the Palivere basal till and the WGD.

Key words: Late Weichselian, glacial diamicton, sedimentology, Estonia.

INTRODUCTION

The final Late Weichselian glacial advance in Estonia deposited the Palivere Till and ice-marginal formations – end-moraines and deltas – in northwestern Estonia and on the West Estonian islands (Fig. 1). The Palivere stadial was proposed by Raukas (1963) and is dated to 11 600 BP (Raukas 1992a, 1992b). It is correlated to the ice recession line of 11 965 BP in Sweden (Eriksson 1992) or dated back to about 11 800 varve years BP (Hang & Sandgren 1996).

The accumulation of tills in the Pandivere stadial was affected by southerly or southwesterly ice flows, while ice flow during the Palivere stadial was towards

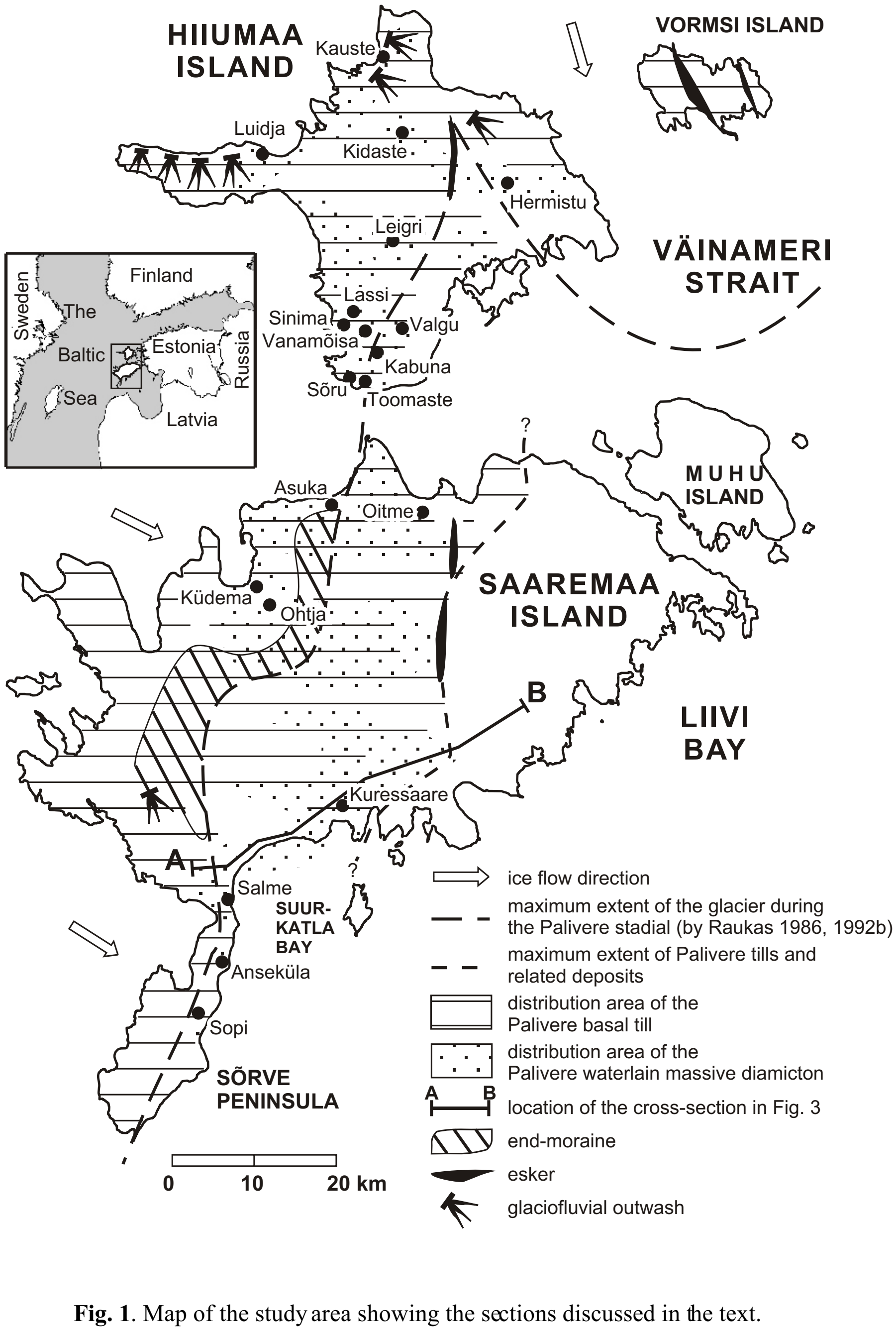

Fig. 1. Map of the study area showing the sections discussed in the text.

the southeast or even east near Saaremaa (Raukas et al. 1971; Raukas & Karukäpp 1978; Raukas 1986, 1992b, 1995). Large glaciolacustrine basins formed in the Palivere zone in northern Estonia, where the thickness of the varved clays is up to 26 m, e.g. near Loksa (Raukas 1994). Raukas (1978) first mentioned a theoretically possible distribution of waterlain diamicton on Estonian territory. However, in earlier investigations the waterlain glacial diamicton (WGD) unit described below was either not genetically or stratigraphically defined (e.g. Raukas 1969, 1978, 1995; Raukas et al. 1971), or it was classified as glaciolacustrine clay (Kiipli et al. 1993). Basal meltout, flow till, waterlain or glaciomarine deposits described at the shores of the Late Glacial Baltic (e.g. Bouchard et al. 1990; Stevens et al. 1991; Salonen & Glückert 1992; Hirvas et al. 1995; Lunkka & Alhonen 1996) or at the peripheries of floating or surging glaciers (e.g. Thomas & Connell 1985; McCabe 1986; Andersson 1997; Lønne 1997; Szabo & Bruno 1997) could suggest that this type of deposition in the area of the West Estonian Archipelago might be more common than previously thought. Eltermann (1993) drew the first preliminary conclusion on subaqueous conditions of till deposition in western Estonia.

The objective of this paper is to summarize the characteristics of subaqueous glacial sediment accumulations on West Estonian islands during the Palivere stadial of Weichselian glaciation. Petrographic and mineralogical analyses provide information on WGD sourcing; particle-size distribution shows the relative homogeneity of the deposit and allows its discrimination from the lodgement tills and glaciolacustrine clay. The distribution and sedimentary structures together with grain-size data provide information on WGD depositional conditions. Interpretation on the formation of this massive fine-grained diamicton outside the glacier grounding line and below floating ice is proposed.

MATERIAL AND METHODS

Most of the data presented here were obtained through geological mapping of Quaternary deposits at a scale of 1 : 50 000. Late Glacial and Holocene glaciolacustrine, lacustrine, or marine deposits generally cover till on the islands, and most of samples were taken from drill cores. A total of 1136 samples were subjected to compositional analysis, and about 2500 core sections, taken on the islands, were described (textures, structures, and colour) and used for elaboration of the depositional model of the WGD. Due to lack of outcrop data, the WGD structural analysis is based on drill core descriptions. The Kidaste section (Fig. 2) was excavated and mapped in 1990, but is no longer accessible.

Conventional grain-size, mineralogical, petrographical, chemical, and X-ray diffraction analysis, outlined in Lewis & McConchie (1994), or in the earlier publications of the authors (Kalm et al. 1992; Kadastik 1994, 1995), were applied to describe and define the main glacigenic depositional units. The colour of moist sediment was estimated using standard colour charts (Munsell Color 1998).

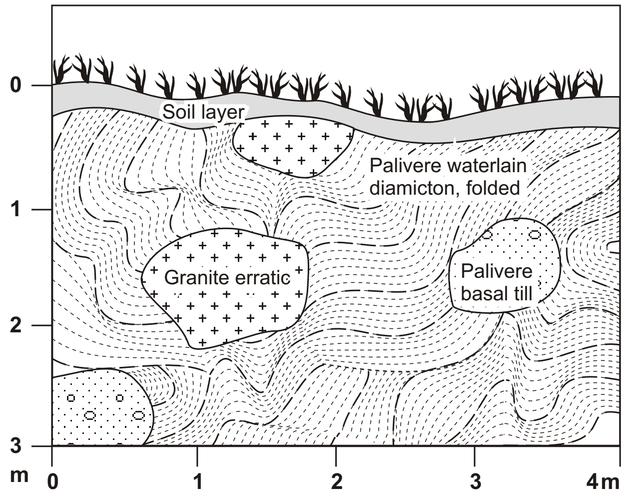

Fig. 2. Sketch of folded deformation structures in the slightly laminated waterlain glacial diamicton with coarse-clastic Palivere basal till inclusions and granite erratics at Kidaste, Hiiumaa Island (drawn by K. Suuroja, Geological Survey of Estonia). For location see Fig. 1.

RESULTS AND DISCUSSION

General lithostratigraphy and superposition of diamicton units

Earlier research and the results of lithofacies analysis show that the glacial stratigraphy of the West Estonian islands includes three principally different widespread diamicton units, named the Palivere WGD, the Palivere Till, and the Pandivere Till (Eltermann 1993; Kadastik 1994, 1995). All three diamicton units are part of the Võrtsjärve Subformation according to Estonian Pleistocene stratigraphy (Raukas & Kajak 1995) and are correlated to the Pandivere and Palivere stadials of the last (Late Weichselian) glaciation. The two lower diamicton units are interpreted as basal tills, deposited by grounded ice (Raukas et al. 1971; Raukas 1978, 1995; Eltermann 1993; Kadastik 1994, 1995). The ice sheet, which deposited the Pandivere Till, left glacial striae on the bedrock surfaces (Männil 1962) and formed a number of subsequently buried end-moraine ridges (Kadastik 1994), particularly on Hiiumaa Island. The Pandivere Till is light grey (10YR, 7/1–6/1), carbonate- and coarse-clast-rich, matrix supported massive diamicton (Photo 1A,C), mostly of subglacial lodgement till resting unconformably on the carbonaceous bedrock (Fig. 3). This grey till is tentatively assigned to the Pandivere stadial (Plink et al. 1992; Eltermann 1993; Kadastik 1994, 1995; Raukas 1978; Raukas et al. 1971) of the last glaciation, dated back to 12 500 BP (Raukas 1992a). The Pandivere Till occurs on most of Saaremaa, Hiiumaa, and smaller islands, but only in the eastern parts of the islands is it not overlain by

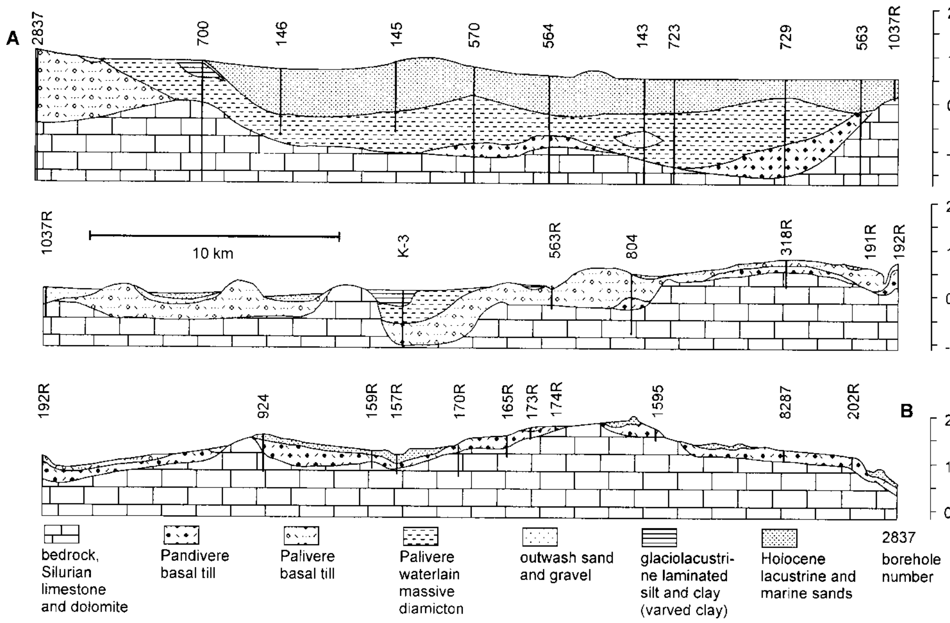

Fig. 3. Geological cross-section (A–B) with main diamicton units discussed in the paper. For location see Fig. 1.

younger till (Fig. 1). This diamicton is 30–40 m thick in end-moraine ridges and 5–10 m on plains.

The Palivere Till, the second diamicton from the bedrock, is greyish-brown to olive brown (2.5Y, 4/2–4/3), clast-supported (Photo 1B), with massive or, in places, deformation structures. It lies unconformably on the Pandivere Till or, in some places, on the bedrock (Kadastik 1994, 1995). Dislocated structures (Plink et al. 1992) and glacial erratics from the Pandivere Till on top of lacustrine interstadial deposits (Raukas 1978; Eltermann 1993) are found between the Pandivere and Palivere till units. The basal erosional unconformity and deformation of the underlying till indicate the overriding of active ice. The Palivere Till was mapped only on central and western parts of Saaremaa Island and on Hiiumaa Island (Fig. 1). Its thickness varies between 2 and 15 m on Saaremaa and between 2 and 8 m on Hiiumaa Island. This greyish-brown to olive till unit is assigned to the Palivere stadial of glaciation (Raukas et al. 1971; Raukas 1978; Eltermann 1993; Kadastik 1994, 1995) during which the glacier reached the studied area for the last time.

The uppermost diamicton in the Pleistocene section on West Estonian islands (Fig. 1) comprises a brown (7.5YR, 4/2) to dark greyish-brown (2.5Y, 4/2), fine-grained, clay-rich massive deposit with few gravel- or pebble-size clasts (Photo 1D). Laminated clayey deposits (Photo 1E) or brecciated varved clay inclusions and coarse-clastic diamicton lenses are found in this depositional unit. This unit has generally lenticular bedding between the underlying greyish Palivere lodgement till and overlying varved clay, occasionally between lodgement till and overlying Holocene marine deposits (Fig. 3). This up to 25 m thick diamicton unit is interpreted as subaqueous waterlain diamicton (WGD) associated with the lodgement till of the Palivere stadial (Eltermann 1993; Kadastik 1995). The rhythmically bedded, dark grey (10YR, 4/2) glaciolacustrine sandy silt overlying the WGD is in turn sporadically covered by marine and lacustrine beach sands. Accordingly, glacigenic Palivere stadial deposits show an upward gradational transition of sediments: lodgement till, massive clayey diamicton (WGD), and glaciolacustrine varved sediments.

Composition of the WGD and comparison with the lodgement tills

A summary of laboratory analyses of major lithological properties is shown in Table 1. Grain-size analysis shows that the texture of the WGD is significantly different from those of other diamictons in the area. According to texture, the WGD resembles glaciolacustrine deposits of the region with increased amounts of gravel and clay fractions (6.8% and 32.3%, respectively; see Table 1). The WGD has the highest clay content, even some 8–9% higher than that of glaciolacustrine deposits, and is also better sorted than the two lodgement tills (Table 1). The grain-size ternary diagram shows different plot fields for the three diamicton units with only partial overlap between the WGD and the tills (Fig. 4). Compared to the two lodgement tills, the WGD has the least amount of variation in the gravel + pebbles fraction and a more variable sand + silt and clay content (Fig. 4, Table 1).

The coarse-clastic petrographic composition indicates a similar source material for the WGD and Palivere Till. The WGD and Palivere Till have a lower clast

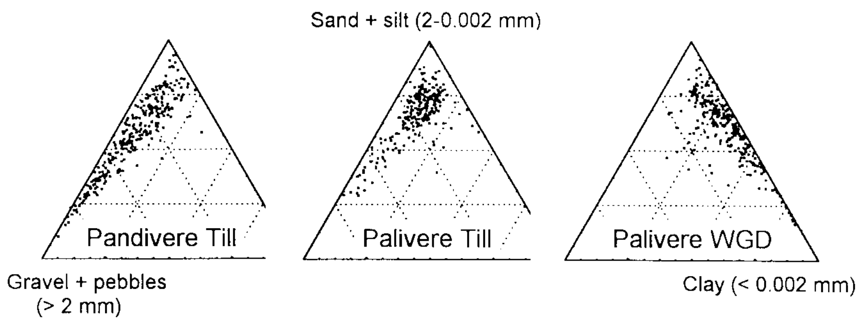

Fig. 4. Ternary diagram showing the grain-size composition of diamictons: Pandivere Till (n = 284), Palivere Till (n = 248), Palivere WGD (n = 265).

Table 1. Main compositional data on the diamictons discussed in the paper

Till unit	Gravel + pebbles, >2 mm, %	Sand + silt, 2–0.002 mm, %	Clay, <0.002 mm, %	Mean grain size, mm	Sorting	Carbonate clastics, 5–10 mm, %	Crystalline clastics, 5–10 mm, %	(Cal+Dol)/(Q+Fp), 0.25–0.1 mm fraction	Ilm+Magn, 0.25–0.1 mm fraction, %	Lim+Hem, 0.25–0.1 mm fraction, %	Fe_2O_3, <1 mm fraction, %
Pandivere basal till											
n	284	284	284	284	284	7	7	63	63	63	57
M	36.3	55.5	8.2	0.78	1.39	96.6	3.3	3.46	3.45	4.04	2.29
SD	20.3	12.5	5.0	1.28	0.21	5.11	5.13	4.20	1.92	5.16	0.80
Palivere basal till											
n	248	248	248	248	248	32	32	35	35	35	39
M	21.5	66.6	11.9	0.22	1.30	76.5	22.8	0.40	6.21	4.36	2.83
SD	13.9	12.2	5.8	0.42	0.19	19.9	19.9	0.20	4.17	5.74	1.11
Palivere WGD											
n	265	265	265	265	265	19	19	27	27	27	9
M	6.8	60.9	32.3	0.02	1.12	66.8	29.0	0.14	6.83	5.37	6.13
SD	6.1	14.6	16.2	0.03	0.20	22.9	20.7	0.14	4.78	4.74	1.94
Palivere glacio-lacustrine varved sediments											
n	34	34	34	34	34	–	–	6	6	6	–
M	0.23	76.3	23.8	0.019	0.69	–	–	0.27	1.42	2.15	–
SD	0.89	24.8	24.6	0.02	0.11	–	–	0.18	0.82	1.62	–

Abbreviations: *n*, number of samples; M, mean; SD, standard deviation; Cal, calcite; Dol, dolomite; Q, quartz; Fp, feldspars; Ilm, ilmenite; Magn, magnetite; Lim, limonite; Hem, hematite; WGD, waterlain glacial diamicton.

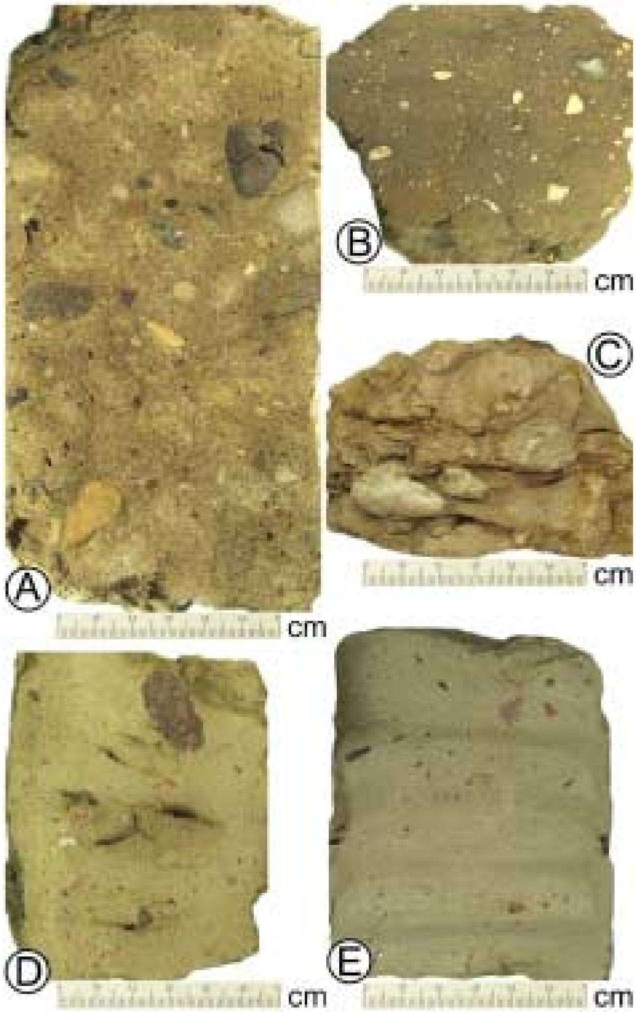

Photo 1. (A) Pandivere Till from a depth of 21 m, core No. 617 near Sopi on the Sõrve Peninsula, Saaremaa Island. (B) Palivere Till from a depth of 11.6 m, core No. 614 at Sopi, Sõrve Peninsula. Note the clearly smaller size of clast compared to the Pandivere Till. (C) Typical lodgement till of the Pandivere stadial with subrounded clasts from local limestone bedrock, eastern Saaremaa. (D) Subvertical orientation of granitic clast in the WGD at Kidaste, Hiiumaa Island, depth 1.2 m. (E) Transition beds between the massive Palivere WGD and glaciolacustrine clay, core section from Põhja-Uhtju Islet, depth 29.4 m.

content from local carbonaceous bedrock and significantly higher amounts of crystalline fabrics than the older Pandivere Till (Table 1). Similarly to clasts petrography, primary mineralogy of the WGD shows, compared to lodgement tills and glaciolacustrine silts, lesser amounts of local minerals (calcite and dolomite) and an increase in minerals (quartz, feldspars, ilmenite, and magnetite) from the Baltic Shield area. The carbonate mineral (calcite + dolomite) ratio to sum of quartz and feldspar (Q + Fp) in the fine sand fraction is about one order of magnitude lower in the WGD and Palivere Till relative to the Pandivere Till (Table 1) and the variation in carbonates, quartz and feldspar content in the WGD is least of all analysed diamicton units. The WGD has the highest Fe-mineral content and is the most Fe_2O_3-rich in the <1 mm fraction (Table 1), which is reflected in its brown colour, compared to the greyish-beige Palivere Till, light grey Pandivere Till, and dark grey glaciolacustrine deposits. Kalm et al. (1992) estimated that the WGD, Palivere Till, and glaciolacustrine deposits on Saaremaa Island have 5–10% more kaolinite and equivalently less illite than the Pandivere Till. The WGD reflects more the composition of englacial long-transported material, in contrast to lodgement tills in which the debris from glaciers basal layer is mixed with local material.

Distribution and structure of the WGD

The WGD overlies the greyish-beige Palivere Till and, in east-central Saaremaa and southern Hiiumaa, the older, light grey Pandivere Till. Palaeogeographically, the WGD is distributed on both sides, proximal and distal, relative to the Palivere stadial ice-limit (Raukas 1992b; Fig. 1) and lies at an altitude between –15 and +5 m on Saaremaa Island and between –15 and +10 m on Hiiumaa Island, relative to contemporary sea level. The areal distribution of the WGD together with the Palivere Till suggests that the maximum ice limit during the Palivere stadial recognized up to now (Raukas 1992b) should be shifted 20–30 km eastwards (Fig. 1). In the area of the Väinameri Strait, east of the Saaremaa and Hiiumaa islands (Fig. 1), no WGD was found and the Pandivere Till is unconformably overlain by Late Glacial varved clay (Lutt 1985). At the bottom of Liivi Bay no facies similar to the WGD was mapped (Striebinš & Väling 1996), except its northeasternmost shallow areas like Suur-Katla Bay (Kiipli et al. 1993). Core sections show that the contact between the WGD and the underlying Palivere Till is usually gradational but in places the WGD rests unconformably on the Pandivere Till (east-central Saaremaa, southern Hiiumaa). A distinct contact between the Pandivere Till and the WGD was described also in core sections from Suur-Katla Bay, south of Saaremaa Island (Kiipli et al. 1993). On Saaremaa Island the WGD has a gradational boundary with the overlying varved clay. In elevated areas, where the varved clay was not deposited or was abraded away, a sharp contact marked by a lag of cobbles occurs between the upper surface of the WGD and marine sands of the Baltic Ice Lake.

In the majority of borehole sections, the WGD was identified as massive diamicton with dispersed clasts – Dmm after Eyles et al. (1983) and Miall (1990). The WGD facies is uniform in colour, clasts petrography, and clay mineral composition, while the structure and clasts distribution are less homogeneous. Texturally, the diamicton has a poorly to medium-sorted silty clay matrix (Fig. 4). Typical clast sizes are granules and pebbles, rarely cobbles. Coarse-grained, angular- to subrounded debris, distributed irregularly and as isolated clasts (lonestones) within sediments of much smaller grain size (Photo 1D,E), are very distinctive throughout the WGD unit. Occasionally are found pebble-sized clasts in a subvertical position (Photo 1D). According to Gilbert (1990), Bennett et al. (1996), and Martin (1999), these clasts are interpreted as ice-rafted dropstones. Only few core sections on the islands (Lassi) and from Suur-Katla Bay (Kiipli et al. 1993) show normally graded texture within the generally massive ungraded WGD unit. Primary depositional stratification of the WGD, usually unidentifiable in natural moisture conditions but recognizable as 30–120 cm thick laminae after the drying of core sections, occurs in the central parts of both, Hiiumaa (Kidaste and Leigri) and Saaremaa (Oitme, Kuressaare, and Anseküla) islands. Bed contacts of this stratification are generally diffuse and hardly recognizable. Individual layers consist of ungraded fine-grained clayey silt to sandy silt. Rarely (Põhja-Uhtju Islet) rhythmical lamination is observed in the WGD unit (Photo 1E). In these cases the unit consists of 1.5–2 cm thick couplets of parallel laminated silt and clay. The couplets always consist of a thicker (1.2–1.5 cm) greyish-brown (2.5Y, 5/2) sandy silt layer and a thinner (0.3–0.4 cm) dark grey (2.5Y, 4/1) clay layer. Within coarser and thicker silty layers also a clear bimodal particle-size distribution occurs, where dispersed grains of several millimetres in diameter are distributed in silt matrix (Photo 1E). Due to a dense net of core sections a lens-like inclusion of laminated clayey deposit (Kidaste and Toomaste), pebbly gravel to coarse sand (Lassi, Asuka, Küdema, and Salme), or coarse-clastic diamicton (Vanamõisa, Kabuna, Sõru, and Ohtja) are mapped within the WGD unit. Laminated clay and WGD contacts are gradational and rarely sharp, while the WGD contacts with coarse-grained gravel and diamicton interbeds are often erosional and sharp. The estimated maximum thickness of till lenses is 10 m, laminated clay lenses reach 2–3 m, and gravel deposits 0.5 m in cross-section. Stratification, dump-, grounding-, and flow structures often identified in waterlain till (Dreimanis 1979; Thomas & Connell 1985; McCabe 1986) are not abundant but occur in some places in the WGD of the studied area. Folds and overturned folds containing load structures with crystalline erratics and undeformed enclosures of the Palivere Till are described in the upper portion of the WGD sequence in the Kidaste section (Fig. 2). Folded deformation structures are recorded also in few core sections on Hiiumaa Island (Kauste, Luidja, and Sinima). Brecciated varved clay blocks on top of the WGD sequence are described only in two core sections, at Valgu and Lassi on Hiiumaa Island.

Depositional conditions of the WGD

Before and after the Palivere stadial 11 600–11 800 BP successive marginal basins in western Estonia were controlled by positions of ice-tongue fronts and high Baltic Ice Lake levels. The estimated distribution area of the WGD (Fig. 1) was at least 50–65 m below the water table during the Palivere stadial (Saarse & Königsson 1992). A similar petrographic-mineralogical composition of the Palivere Till and WGD indicates that they originate from the same debris. Increased amounts of long-transported material (crystalline clastics, quartz, feldspars, magnetite, ilmenite, and kaolinite) and a decrease in local components (carbonates and illite), together with a finer texture in the WGD compared to the underlying Palivere Till, suggest that the proportion of englacial material is higher in the WGD than in lodgement till. The generally massive ungraded structure of the WGD indicates continuous and possibly quick deposition. As concluded by Drewry (1986), if layers of sediment a few metres in thickness were present in the basal portion of an iceberg, all debris would be melted out within a few years at the most. Only a few borehole sections (Lassi, Asuka, Küdema, and Salme) indicate coarse-grained gravelly deposits of surge-type turbidity flows, suggesting a generally steady deposition load across the basin floor. In addition, the subaqueous coarse-grained facies interlayers concentrate in the proximal zone of WGD distribution, that is in the area that was more influenced by glacigenic debris flow. A lack of seasonal lamination and the presence of ice-rain deposits with dropstones suggest that the WGD was mostly deposited by subaquatic basal meltout and the massive fine-grained sediment settled as suspension fall-out (Fig. 5). Rapid sediment fall-out was accompanied with turbidity flows on slopes and proglacial lake floor. In more distal areas floating icebergs may have dropped coarse debris into already reworked fine-grained deposits of turbidity flows. Contrary to distinctly laminated glaciolacustrine deposits, the WGD sedimentation was generally not affected by seasonal (or annual) variations in water and sediment discharge. Most probably the continuous floating ice cover in the proximal zone of the glacial lake provided good protection from katabatic winds and consequently from the effect of their possible diurnal currents. Locally recorded upward fining throughout the WGD unit (south-central Saaremaa) indicates a decrease in debris input when the basal melting reached a debris-poor englacial zone. Weakly developed and transitional massive bedding in the WGD does not necessarily refer to seasonal freeze–thaw cycles but may represent sediment-saturated low-viscosity interflows and surge currents (Miall 1990). The lens-like interlayers of varved clay in massive WGD as well as the transition of the WGD to overlying varved clay represent a considerable change in the depositional environment, where the generally continuous deposition below glacier ice was replaced by cyclic input of less clayey suspension load, possibly in conditions of mostly glacier-ice-free proglacial lake with increasingly developed water stratification.

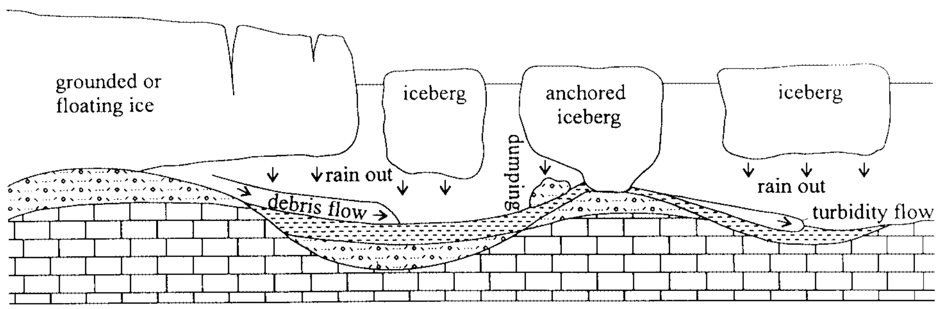

Fig. 5. Depositional model illustrating sediment transport processes in the Palivere ice-marginal zone during the formation of the WGD. For legend see Fig. 3.

Blocks of brecciated varved clay and till inclusions refer to grounded or anchored ice deformations and deposition. Brecciated varved clay might be also a result of postdepositional (postglacial) compaction of dewatered soft clayey deposits. The folded structures recorded in core sections of the WGD indicate subaqueous sediment gravity flow processes (and presence of subsequent till varieties), whereas the question of time, i.e. syn- or postdepositional flow, remains open. The folded upper part of the WGD section with incorporated till and clastic erratics at Kidaste in central Hiiumaa Island refers to grounded ice deformations and dumping (Fig. 5). The few coarse-clastic till lenses inside the WGD are interpreted as evidence of slumping and dumping from glacier margins. Deposition from anchored icebergs was also highly possible due to the undulating topography of the basin bottom. Similarly to coarse clastic turbidity flow facies, the diamicton inclusions (Vanamõisa, Kabuna, Sõru, and Ohtja; see Fig. 1) are located in the proximal zone of the WGD distribution area. The facies distribution and the deglaciation history of the Baltic Sea (Björck 1995) suggest that the WGD was deposited along the rapidly melting ice front.

CONCLUSIONS

The massive fine-grained diamicton, sporadically but extensively distributed along the Palivere stadial ice-marginal zone on the islands of the West Estonian Archipelago, was interpreted as waterlain glacial diamicton (WGD). Lithological analysis shows a similarity of source material for the Palivere basal till and the WGD. Therefore the latter is interpreted just as a different genetic variety but still deposited during the Palivere stadial. The composition, structure, and distribution of the WGD indicate that its deposition was generally as continuous subaqueous basal melt-out from floating glacier ice. During this process, englacial fine-grained deposits became increasingly dominant in the suspension fall-out as the ice melted and recession continued. Subaqueous debris flows, dumping and grounding of icebergs, as well as low-viscosity flows of fine-grained sediment, had minor and sporadic influence on the formation of the WGD unit as a whole.

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BASSEINIMOREEN PALIVERE STAADIUMI SERVAMOODUSTISTE VÖÖNDIS LÄÄNE-EESTI SAARESTIKUS

Volli KALM ja Ene KADASTIK

Lääne-Eesti saartel, nii distaalsel kui ka proksimaalsel pool Palivere staadiumi servamoodustiste vööndit, on kaardistatud savika basseinimoreeni sporaadiline levik. Basseinimoreen lasub kõrgusvahemikus –15 kuni +10 m praegusest meretasemest, kuid Palivere staadiumi ajal oli vastav piirkond vähemalt 50–60 m allpool Balti jääpaisjärve veetaset. Basseinimoreen ladestus liustiku servavööndis, kus jää ei olnud enam aluspinnaga kontaktis ning liustiku pideva basaalse sulamise tulemusel vabanenud purdmaterjal settis läbi veekihi. Samaaegselt toimusid turbitiidilaadsed veealused settevoolud, moreeniplokkide vabanemine jääst, nende varingud ja lihked ning setete deformatsioon, mida põhjustas ujuvate jäämägede ankurdumine. Struktuurilt sarnaneb basseinimoreen glatsiolimnilisele settele, kuid sisaldab sellest rohkem kruusa- ning savifraktsiooni. Kivimiline, mineraalne ja keemiline koostis viitavad basseinimoreeni ja Palivere põhimoreeni sarnasele lähtematerjalile.

БАССЕЙНОВАЯ МОРЕНА В ЗОНЕ КРАЕВЫХ ОБРАЗОВАНИЙ ПАЛИВЕРЕСКОЙ СТАДИИ НА ОСТРОВАХ ЗАПАДНО-ЭСТОНСКОГО АРХИПЕЛАГА

Волли КАЛМ и Эне КАДАСТИК

На Западно-Эстонских островах, как в дистальной, так и в проксимальной зоне Паливереских краевых образований, установлено распространение бассейновой морены. Бассейновая морена залегает на отметках от –15 до +10 м относительно современного уровня моря. Во время Паливереской стадии эта зона была как минимум на 50–60 м ниже уровня Балтийского ледникового озера. Бассейновая морена отлагалась по мере донного вытаивания утончающегося по краям плавающего ледника, где его дно уже не контактировало с основанием. Донное вытаивание ледника вызывало обвалы и оползни склонов, потоки наносов, осыпание льда с моренных блоков, деформирование поверхностных слоев отложений в результате зацепления айсбергов за вершины подводного рельефа. Петрологический и минеральный составы бассейновой и основной морен Паливереской стадии сходны, что указывает на однородность исходного материала.