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Vorträge | Lectures

Reconstructing the Pre-Late Weichselian history of the Southwestern Baltic Basin based on Sediment cores from Kriegers Flak

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The southwestern Baltic Basin was repeatedly affected by ice advances during the Middle Weichselian. Between 55 and 50 cal. kyr BP the Baltic Ristinge advance moved over the Baltic Basin and into Denmark. At around 29 cal. kyr BP the Kattegat advance expanded from the mountains in Norway and led to a damming of the Kattegat and Baltic Sea (LARSEN et al. 2009). A third advance, the Klintholm advance, might have expanded through the Baltic Basin at 32±4 cal. kyr BP (HOUMARK-NIELSEN 2010). Little is known about the ice free intervals in-between the glacial advances. In this study we present an interstadial sequence with marine and terrestrial/lacustrine sediments which have been identified between two diamict successions at Kriegers Flak in the southwestern Baltic Sea (Fig. 1). In this project macrofossils and foraminifers in sediment cores from Kriegers Flak are used to reconstruct the palaeoenvironment between two glacial advances. A general stratigraphy of the interstadial sediments in the northeastern part of the area has previously been published (ANJAR ET AL. 2010). Since then further studies on the benthic foraminiferal fauna and the macrofossils have been made and new radiocarbon dates have been added. We have divided the interstadial sequence into three subunits (A-C).

- Subunit A consists mainly of clay. Benthic foraminfera have been identified in two zones separated by an interval without foraminifers. The lower foraminfera zone is dominated by Haynesina orbiculare and Elphidium excavatum while the upper is dominated by E. excavatum and E. albiumbilicatum. The latter can probably be correlated to a similar fauna described by Klingberg (1998). Foraminifera samples from the lower zone were radiocarbon dated, but gave non-finite ages.
- Subunit B consists of alternating beds of organic sediments and clay. Macrofossil analyses indicate sedimentation in one or more lakes surrounded by a tree-less arctic environment. Seven radiocarbon dates on macrofossils and bulk samples gave ages ranging from 36 to 42 cal. kyr BP.
- Subunit C is the uppermost part of the interstadial sediments and consists mainly of clay.

We suggest that subunit A was deposited in brackish water following deglaciation of the southern Baltic Sea. This could, e.g., have occurred after the deglaciation of the Baltic Ristinge advance at c. 50 cal. kyr BP, which would imply a marine influence in the Baltic Sea during the Middle Weichselian. An older age can, however, not be excluded. Between 36 and 42 cal. kyr BP Kriegers Flak was a tree-less terrestrial environment with lakes and wetlands where clay, peat and gyttja were deposited forming subunit B. This was followed by a new clay sequence (subunit C) indicating a transgression, probably connected to the Kattegat advance c. 29 cal. kyr BP.

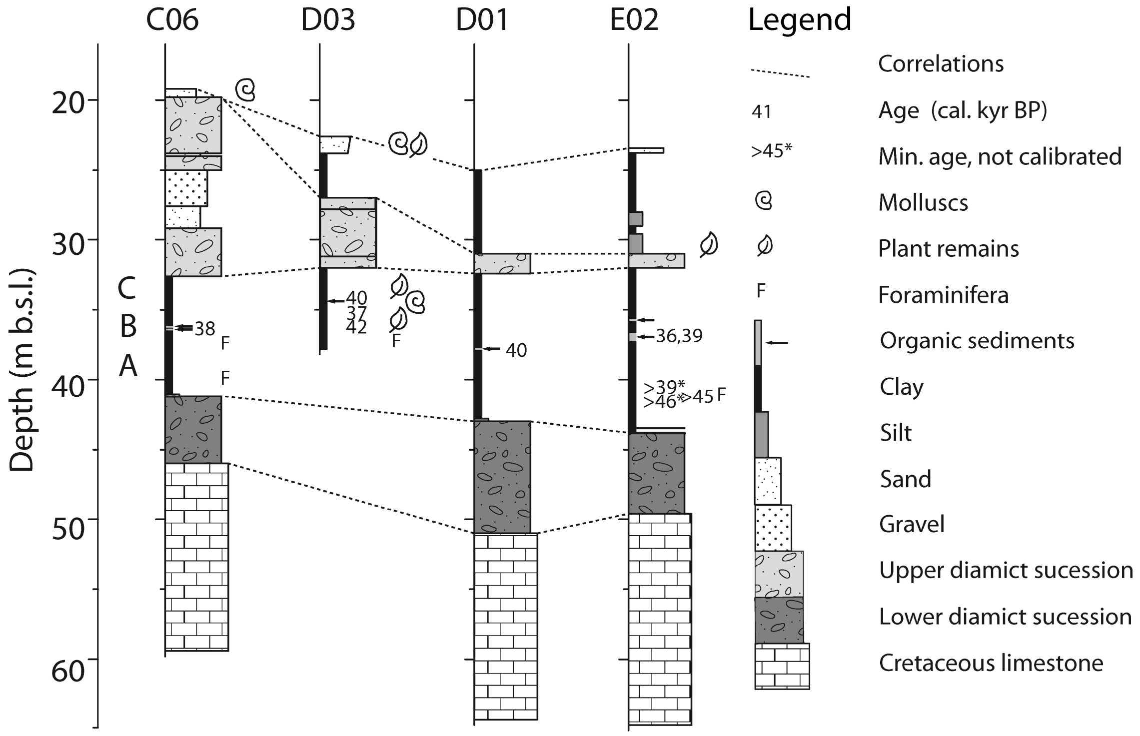

Fig. 1: Lithostratigraphic logs of the studied sediment cores from Kriegers Flak.

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Grain size composition and sedimentological environments in the Valley of Dnieper River during the Late Glacial and the Holocene

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The studies of alluvial sediments of the River Dnieper Valley were carried out by author during 2003-2009. The site of the valley had been researched between Dubrovno city and Mogilev city (Fig. 1). This site of Dnieper River is placed near the maximal border of the last ice sheet. The aim of researchers is to studying of grain size characteristics of terraces and flood plain of Dnieper River. Despite the similar depositional mechanism of sediments in the valley their sedimentological environments are different in respect to hydrodynamical conditions in the valley. Those conditions were changed due to recession of the last ice sheet and evolution of the climate in the Holocene. The grain size analysis contains of over 300 samples taken from two terraces and flood plain of Dnieper River as well describes over 500 samples taken from geological founds of Belarus.

Statistical grain size parameters of alluvium (Mz, σ1, SkI, KG) were calculated according to Folk AND WARD (1957). And their equations were used to describe grain size properties (BLOTT S.J., PYE K., 2001). Hydrodynamical conditions of the clastic material transport were analyzed on a based of the C/M diagram (PASSEGA, BYRAMJEE, 1969). The ancient water flow velocities were calculated according to Koster (KOSTER E.H., 1978). The researched site of the valley is narrow (from 300 m to 2000 m and more). It was taken to minimize the influence of the lateral migration of the river at the grain size interpreting. The average thickness of alluvium was from 2,0 m to 3,5 m and more. From 4 to 8 samples were taken from outcrops of terraces and flood plain for grain size analysis. All samples had been processed by sieve method.

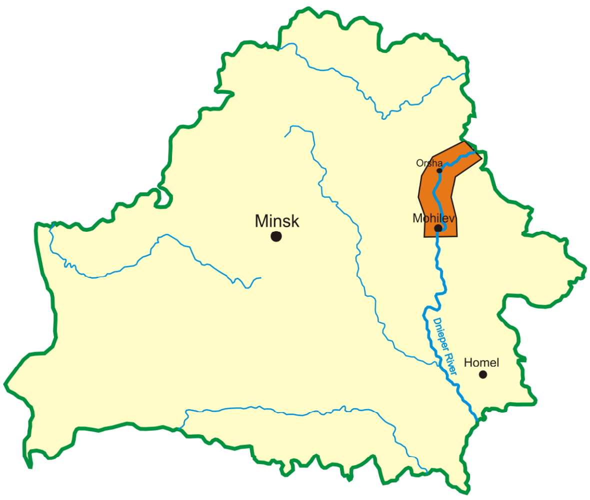

Fig. 1: Location of the study area.

RESULTS OF RESEARCHES

The samples from the second terrace have mean size (Mz) from 5,8 phi to 0,5 phi (Tab. 1). Standard deviation (σ_1) values ranged from 2,5 phi to 0,7 phi. Average skewness (Sk_I) values was closely to symmetric (0,04). Kurtosis (K_G) values ranged from 0,4 to 2,4. The water flow velocities ranged from 4,5 m/s to 11,03 m/s (Table 2). According to diagram Sk_1 - K_G erosional processes have been dominated under accumulation. According to CM diagram transport by saltation and traction are predominate. Most of sediments are I-III types (about 85-90 %) (PASSEGA, BYRAMJEE, 1969). According to Passega and Byramjee these sediments (higher than 1 mm) contain rolled grains either deposited near their source or transported across environments where sedimentation of suspensions was scarce.

The samples from the first terrace have better sorted sediments than sediments of the second terrace and flood plain (about 46 % is moderate sorting). Standard deviation (σ_1) values ranged from 2,0 phi to 0,0 phi (table 1). Mean size values ranged from 3,8 phi to - 4,3 phi (until – 10 phi in section Pashino and others). Skewness values (Sk_I) are in equality (positive and negative values). Kurtosis values (K_G) ranged from 0,2 to 1,9. According to Sk_1 - K_G diagram the erosional and accumulating processes were in equality. The water flow velocities ranged widely from 7,5 m/s to 64 m/s (table 2). The high speeds values are corresponding to gravel layers in the base of

the first terrace (sections Pashino, Buroje and others) (KALICKI, 1999 and others). Classification of sediments according to CM diagram has features close like in sediments of the second terrace.
The samples from flood plain have bad sorting of sediments (bad and very bad sorting). Standard deviation (σ_1) values ranged from 2,5 phi to 0,6 phi. Mean size (Mz) values ranged from 4,8 phi to -0,3 phi. Skewness (Sk_I) has the predominated positive values. According to Sk_1 - K_G diagram the accumulating processes dominated under erosion processes (left part of diagram). Kurtosis values (K_G) ranged from 0,7 to 2,7. The water flow velocities ranged from 5,7 m/s to 22,1 m/s (Tab. 2). The sediments of the flood plain have I – III types (until 40 %) also have widely presented IV – VII types of CM diagram. According to Passega and Byramjee IV – VII types are suspension sediments that may contain rolled grains smaller than 1 mm. These rolled grains may have been transported long distance in suspension before being rolled.

Tab. 1: Statistical grain size parameters of river terraces.

	Value, phi	Mean size, M_z		Standard deviation , σ_1	Skewness , Sk_1	Kurtosis , K_G
		phi	mm			
Flood plain	Average	1,9	0,3	1,55	0,1	1,3
	Maximal	-0,3	1,2	0,6	-0,3	0,7
	Minimal	4,8	0,03	2,5	0,6	2,7
First terrace	Average	0,42	0,75	1,0	0,13	1,04
	Maximal	-4,3	20,0	0,0	-0,2	0,2
	Minimal	3,8	0,07	2,0	2,1	1,9
Second terrace	Average	2,3	0,2	1,6	0,04	1,1
	Maximal	0,5	0,7	0,7	-0,6	0,6
	Minimal	5,8	0,02	2,5	0,4	2,4

Tab. 2: Flow velocities [m/s] at river terraces.

	Maximal	Average	Minimal
Flood plain	22,1	13,9	5,7
First terrace	64,0	18,3	7,5
Second terrace	17,7	11,03	4,5

CONCLUSIONS

Sedimentological environments in the valley of Dnieper River have been closely caused by influence of the last ice sheet. During the maximal stage of the last glacier (about 18 000 BP) in result of nearness of the front of ice sheet the volume of water discharge in the valley increased due to melt waters. It increased erosional processes in the valley. But huge mass of clastic material do not redound to bottom erosion. Instead this in result of the lateral migration the alluvial valley was formed. It consists of weakly differential alluvium (13-m second terrace of the Dnieper River). This process was continued with the drainage of Orshanskoje dammed lake at the front of the ice sheet (about 14 000-15 000 BP). And Dnieper River begins multi channel (Kalicki, 1999). In this time alluvium of the first terrace of Dnieper River (10-m) was formed. Flood plain (flood plain sediments) almost does not development.
With beginning of the Holocene due to ceasing of melted water discharge from the ice sheet to the valley and evolution of the climate and vegetable the Dnieper River changed its multi channel to meandering channel. The meandering, floods and mean water appear. The flood plain sediments were beginning forming. All that caused the facial differentiation of alluvium.

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Late Weichselian landscape history of south-western Scania, Sweden

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The main aim of this study has been to acquire new data of the late Weichselian developments from the south-western part of Scania, southernmost Sweden. The study focuses on the uppermost units of the Quaternary succession in the area south of Malmö along the coast. Previous studies about the glacial history of the area come mainly from the Danish side of the Öresund and from the hummocky landscape north-east of the area investigated now.
Field work was mainly carried out on a section in Vellinge. This section was investigated with several different methods. The section was drawn, fine gravel analysis was carried out and directional features such as clast fabric and deformation structures have been measured.
These units, among others, could be distinguished, mainly based on their lithological composition:

- A lowermost diamict, probably of Baltic origin. It also contains substantial amounts of local bedrock.
- A diamict which contains 30% palaeozoic limestone but no local bedrock
- A gravel band which contains 30% palaeozoic limestone and very little local bedrock
- A unit of sorted sediments, mainly fine sand and silt. Some primary sedimentary structures are preserved in the upper part of this unit. It is unclear, if this unit was deposited in a proglacial setting or in subglacial cavities.
- A band of $CaCO_3$. At this point it is unclear how the $CaCO_3$ was precipitated.
- An uppermost diamict which contains substantial amounts of both local as well as long travelled lithologies.

Two different hypotheses for the genesis of the units are tested; all units could be deposited subglacially or the diamicts could reflect individual ice advances. By means of additional datasets of the lithological composition of the uppermost diamict from other terrestrial field sites in the area and from the proximal parts of the Baltic it is attempted to put the results from Vellinge in a more regional context.

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Early Holocene rapid climate changes recorded in fast-growing stalagmites of the Alps

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Katerloch Cave, located at the south-eastern fringe of the Alps (Styria, Austria), is known as one of Austria's most impressive dripstone caves. It contains abundant fast-growing candle-stick stalagmites (Figure 1), which were investigated in order to exploit a new high-resolution paleoclimate archive in the climate-sensitive alpine region. An extensive cave monitoring program, including cave air- and drip water stable isotopic and chemical parameters, modern calcite precipitates on glass substrates and soil gas above the cave, was conducted to understand the environmental signals of stable carbon and oxygen isotopes, petrography (lamination) as well as trace elements recorded in the stalagmites.
Two coeval stalagmites from Katerloch were precisely dated by state-of-the-art Uranium-Thorium technique and they show prominent intervals of low O isotope values in the early Holocene, i.e. around 8.2, 9.1, and 10.0 ka (cf. BOCH et al., 2009, QSR). The stalagmite isotope curves provide near-annual resolution. The 8.2 ka climate anomaly, first discovered in Greenland ice core records, lasted about one century in the Alps – from 8196 to 8100 a, with a maximum amplitude of 1.1 ‰ at 8175 a. The event is characterized by a rapid onset and a more gradual demise and U-Th data as well as lamina counting support a rapid climate change towards cooler conditions within 10 to 20 years. A distinct climate anomaly also occurred around 9.1 ka. The latter had a similar duration and amplitude as the (central) 8.2 ka event, but shows a more symmetrical progression. Onset and demise, however, still occurred within a few decades. The different progression might result from a fundamental difference in the trigger and/or response of the climate system. Based on a modern calibration between air temperature and the O isotope values of precipitation and cave monitoring data, a maximum cooling by ca. 3°C can be inferred at 8.2 and 9.1 ka. Together, the Katerloch O curves constitute the first high-resolution isotope record of the 8.2 ka event and the first explicit recognition of climate events around 9.1 and 10.0 ka in the Alps.
Apart from that, all studied stalagmites in Katerloch show a regular lamination consisting of white, porous laminae and typically thinner, translucent dense laminae. The binary lamination pattern results from changes in the calcite fabric and U-Th dating as well as cave monitoring support an annual origin. In essence, the relative development of the two lamina types reflects changes in the seasonality of external air temperature and meteoric precipitation, with a strong control of the winter air temperature (BOCH ET AL., 2010, Sedimentology). For example, relatively thick translucent, dense laminae are favored by long, cold and wet winters. Interestingly, the relative thickness of the seasonally controlled laminae remains rather constant across the intervals comprising the isotopic anomalies, i.e. the stalagmite petrography argues against major shifts in seasonality during the early Holocene climate anomalies that are discussed in the paleoclimate community.

Fig. 1: Fast-growing (mean: 0.2 to 1 mm/a) candle-stick stalagmites in Katerloch Cave. Two of the stalagmites provide a precisely dated early Holocene isotope record of near-annual resolution.

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Isotopic-geochemical studies of climate variations during warm periods and global warm/cold transitions of the Quaternary in Central- and Eastern Europe

TATJANA BOETTGER

The summarized research activities focus on climate and environmental changes during the Quaternary warm intervals Last Interglacial (Eemian, Mikulino) and Holocene including their transitional phases (Eemian/Early Weichselian, Mikulino/ Early Valdai; Late Glacial/Holocene) on the base of accented to isotope geochemistry multi-proxy data from lake sediments in Central and Eastern Europe and subfossil trees in Northern Europe.
For the Last Interglacial, isotopic data from several limnic sequences in Germany (Gröbern, Neumark-Nord, Klinge) and in Central Russia (Ples, Cheremoshnik) confirm similarities in climate and environmental course in the Eemian and the global warm/cold transition Eemian/Early Weichselian over the latitudinal belt. The main phases of climate and vegetation development appear similar, whereas palynological data show increasing range of environmental changes from west to east (VELICHKO et al. 2005). The results show fluctuated in its transitional phases (at the beginning and the end) relatively stable climate during the Eemian in Central and Eastern Europe (BOETTGER ET AL. 2000). The end of the Last Interglacial and the beginning of Early Weichselian is marked by at least two warming events and the increase of environmental instabilities as observed in geochemical and palynological data of investigated profiles in Central and in Eastern Europe (BOETTGER et al. 2009). The pronounced climate and environmental instability during the global warm/cold transition (Eemian/Early Weichselian) caused possibly predominantly through short warming phases seems to be a European indication and could be carefully interpreted as a natural phenomenon.
For the Late Glacial, during the global cold/warm transition, isotope studies of limnic profiles in Germany (Krumpa, Lake Aschersleben, Miesenheim) and in Russia (Pobochnoye) verified main climatic oscillations during the period since Pleniglacial to Holocene as reflected predominantly as changes in lake hydrology, water level and evaporation (Fig.1) controlled by instable hydrological situation of Late Glacial lakes while relative rapid Glaciers melting and melting water supply events (BOETTGER et al. 2004). The isotope studies of profiles (Krumpa, Lake Aschersleben, Miesenheim) in Germany confirm pronounced climate and environmental oscillations as changes from warm/humid (Bölling, Alleröd) to dry/cold (Older and Younger Dryas) periods (BOETTGER et al. 1998). The results show at least two warming events during first Interstadial Meiendorf (SCHARF et al. 2005) and confirm the dividing of Alleröd in two parts. The Late Glacial/Holocene profiles in Germany (Plinz) and in Russia (Pobochnoye) reflect the fast transition Late Glacial/Holocene as a rapid change from cold/dry to warm/wet conditions, and in overall continuous (with only some oscillations) climatic improvement, increasing of lake evaporation, decrease of its water level for the Preboreal, Boreal and the beginning of Atlanticum (KREMENETSKI et al., 1999; BOETTGER et al. 2009).
The studies of Middle and Late-Holocene climatic variations were carried out on the base of subfossil and living Scots pines on the Kola Peninsula (NW Russia). Stable isotope analyses of 14C-dated timbers sampled in small lakes beyond the current pine timberline suggest the mid-Holocene climate as warmer and drier than nowadays, pine expanding at least 60 km northern of the present line between 7000 and 3500 14C yr BP and decline of the northern pine timberline after c. 3500 14C yr BP as synchronous with other parts of northern Eurasia climatic deterioration (BOETTGER et al., 2003). First for the Kola region, the results show occurrence of the Medieval Warm Period. Isotope data and a shift of the pine timberline indicate a pronounced period of warmer and drier conditions than at present between c. AD 1000 and 1300. That means diminished influence of North Atlantic circulation on region Central Kola compared to the northern part of Peninsula (KREMENETSKI et al. 2004).

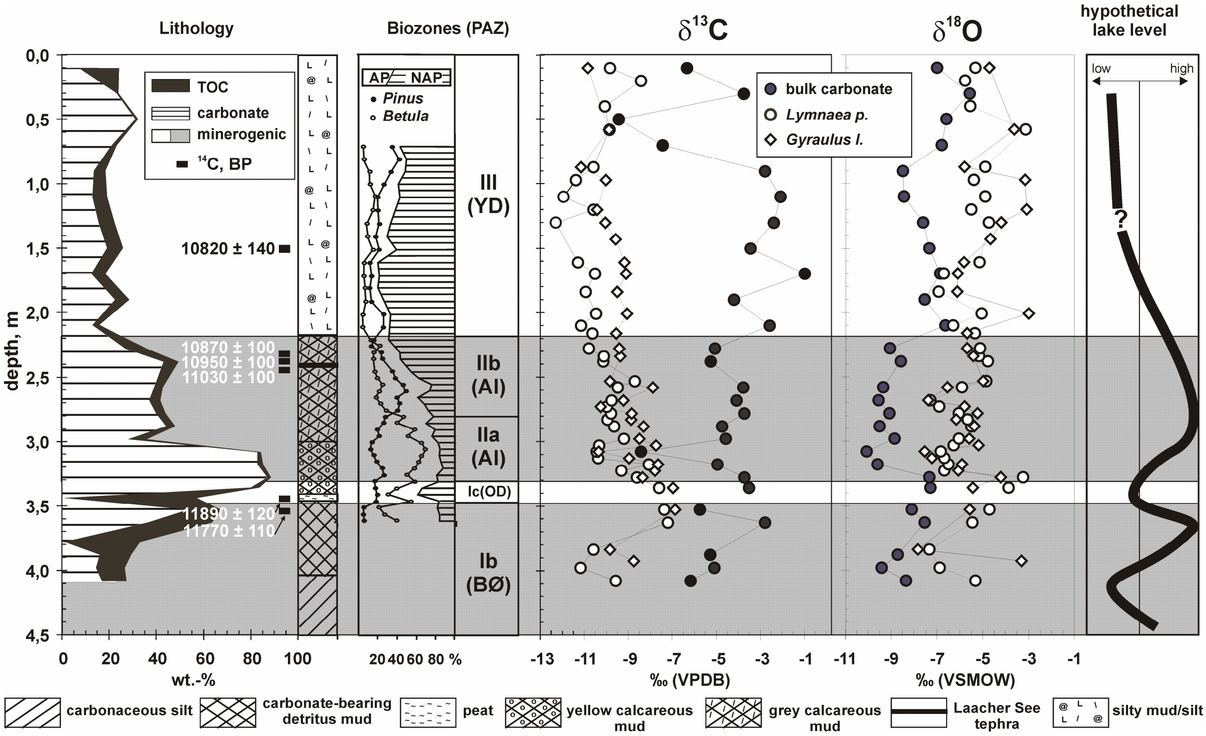

Fig. 1: Summary of stable carbon and oxygen isotope data from bulk carbonate and shells, including main features of lithology and sediment composition. Biozones, some important ^{14}C ages, and an evaluation of the hypothetical lake-level changes are also given.

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Report about detailed geological mapping at gaspipeline outcrop "OPAL" in eastern Mecklenburg-Western Pomerania (NE-Germany)

ANDREAS BÖRNER

The OPAL (**O**stsee-**P**ipeline-**A**nbindungs-**L**eitung – Baltic Sea Pipeline Link) will connect Germany and Europe to the major natural gas reserves in Siberia via the Baltic sea (Nord-Stream-Pipeline). With a capacity of 36 billion cubic meters of natural gas and a length of 470 kilometers, the OPAL pipeline is one of Germany's biggest energy infrastructure projects of recent years. The pipeline will connect the Nord Stream natural gas pipeline (Baltic Sea) with the European natural gas pipeline system and will run from Lubmin near Greifswald, through Mecklenburg-Western Pomerania, Brandenburg and Saxony, all the way to the Czech Republic. In Mecklenburg-Western Pomerania the OPAL will cross about 105 kilometers the eastern districts. The investments for the OPAL natural gas pipeline are around one billion euros and as many as 2,500 workers work on the pipeline construction until the pipeline's planned commissioning in October 2011 (WINGAS 2010).

The high groundwater level often represent strong hydrogeological constraints for an open digging project like this OPAL-pipeline-project. The local dewatering up to 5 m below ground surface are performed by several technologies like well point or horizontal drainage systems. The 3,5 - 6 m deep outcrop allowed geologists to have a good look to the uppermost Quaternary sediments. The excavation teams works in 300 up to 2,000 m long sections and excavated sections are open in average for three days and will be close after pipelaying. The Geological Survey Mecklenburg-Western Pomerania use this outcrop for check-up of lithological and genetical contents of geological maps in scale 1:25,000. The geoscientific observation complete as possible must carried out weekly on different excavation sections.

Entirely, the study area in northeast Germany is dominated by landforms and sediments formed during the Weichselian glaciation and Holocene (cf. Fig. 1). The straight-line OPAL outcrop is crossing till dominated morainic uplands of Pomeranian phase (qW2) and Mecklenburgian phase (qW3) and the terminal zone of the "Velgast" recession extend (qW3V). In last months the Geological Survey realized a detailed sampling of tills and will use a marginal modified pebble-counting method (4-10 mm, TGL 25 232, 1980) for lithostratigraphical classification.

Deep weathering profiles are developed in grey and brownish sandy tills that form several till plains. Where the depth of the till section is less than 2 m only in most cases sandy, strongly weathered and decalcified tills ("Geschiebelehm") are dominating. Weathering takes the form of oxidation followed by leaching of carbonates and is characterized by colour change and increasing content of rotten boulders. The tills contains also intraformational sands, gravels and laminated clays and rafts of eroded and incorporated Prequaternary deposits (Miocene sands and browncoals, Cretaceous marls).

After deglaciation of youngest Weichselian ice sheet (Mecklenburgian Phase, qW3) the lower region between Pasewalk and Ueckermünde was a part of the meltwater drainage system of an SE-NW extended, ice-dammed lake basin of so-called "Haffstausee" (in terms of KEILHACK 1899). In southern part of the "Haffstausee" basin we observed a large number of periglacial structures like simple frost cracks or frost wedge casts and deformation structures like "dropsoils" and "ball and pillow" structures were observed in silts, organic silts, glaciofluvial sands and gravely sands. These graviturbations resulting mainly by gravity-dominated processes of slumping and collapsing.

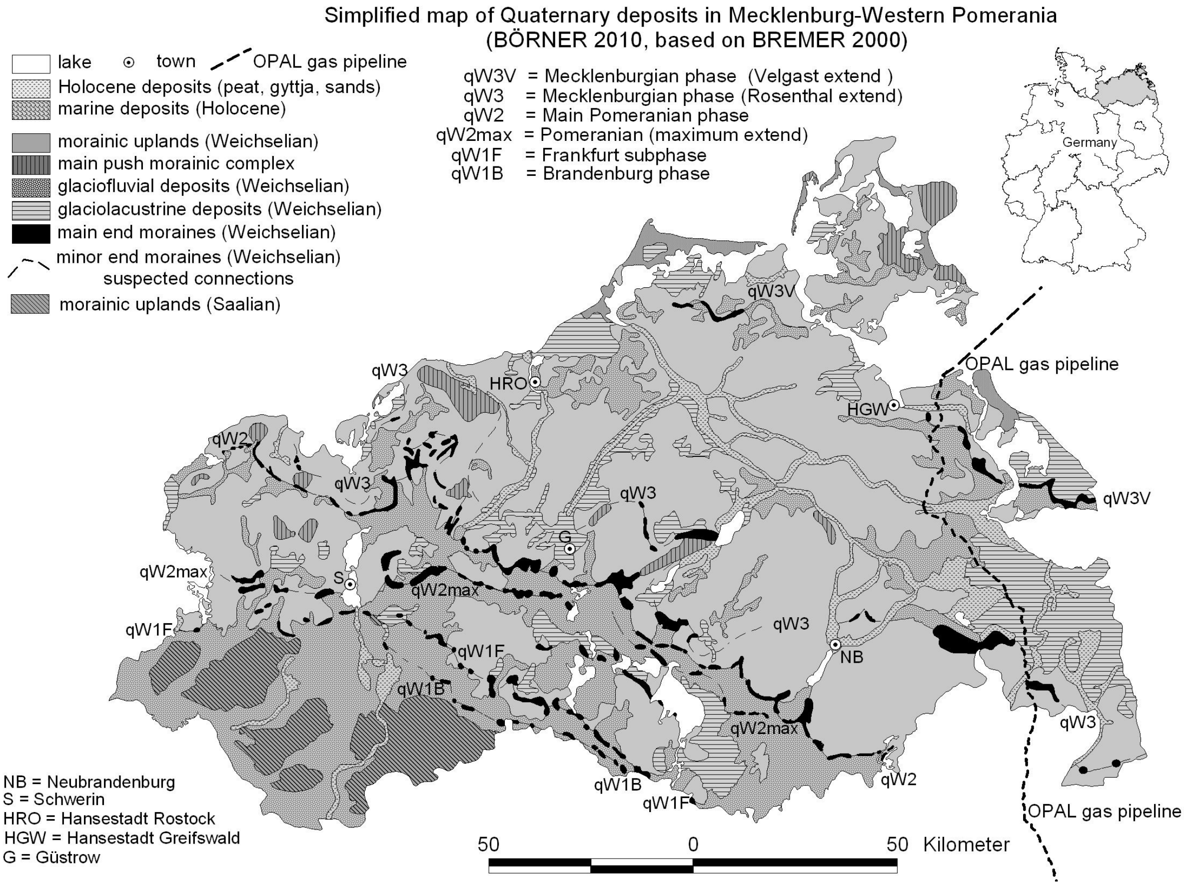

Fig. 1: Simplified map of Quaternary deposits in Mecklenburg-Western Pomerania and distribution of OPAL gas pipeline.

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On the ice marginal positions in north-eastern Germany between the Brandenburg Phase and the Gerswalde Subphase

MARGOT BÖSE & CHRISTOPHER LÜTHGENS

In general, three main ice marginal positions are differentiated in north-eastern Germany: The Brandenburg phase, the Frankfurt phase and the Pomeranian phase. This pattern of ice marginal positions and the herein included deglaciation pattern was named and thereby established by Woldstedt in 1925 already, shortly after the introduction of the concept of polyglaciation. The ice advance to the southernmost, relatively weakly developed ice marginal position of the Brandenburg phase has traditionally been ascribed to the LGM. The Frankfurt phase is usually interpreted as a long-lasting marginal position during the downmelting of the glacier. The most prominent ice marginal position in north-eastern Germany is that of the Pomeranian phase. The Gerswalde subphase marks a recessional ice marginal position north of the end moraines of the Pomeranian phase.

During the last 130 years, this classification of the Weichselian Pleniglacial in north-eastern Germany has mainly been based on morphostratigraphical interpretations. Due to the absence of recent geochronological data of the Weichselian ice advances in north-eastern Germany, the ages of ice marginal positions which are commonly used for that region, are only estimates or based on extrapolations from ^{14}C ages from underlying organic sediments. These ages are commonly based on the works of Kozarski (last 1995). However, throughout the last years a number of studies have been conducted in order to set up a chronology based on geochronometrical data. Lüthgens et al. (2010a/b) dated fluvioglacial sediments from outwash plains associated with the Brandenburg phase by means of Optically Stimulated Luminescence (OSL). Heine et al. (2009) and Rinterknecht et al. (2010) dated the exposure of erratic boulders using cosmogenic ^{10}Be. To be able to compare the results from these methodologically (and technically) different approaches the type and position of the sampled material within the glacial landscape system has to be considered. Consequently, different geomorphological processes are datable using either luminescence or surface exposure dating techniques.

New results from single grain OSL analyses from the Brandenburg and Pomeranian phases will be presented and discussed in comparison to the ^{10}Be ages in order to achieve a synthesis in terms of ice dynamics and ice retreat patterns during the MIS 2. Varying phases of ice decay and periglacial processes are taken into consideration.

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Pleistocene reactivation of basement faults, triggered by ice-sheet advance, glacial lake formation and sediment loading

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The interplay of faulting and Pleistocene glacial cycles was extensively studied in Scandinavia, but complementary studies are lacking for Central Europe. We present new data on the interplay of ice-sheet advance, water and sediment loading, and the reactivation of Mesozoic basement faults in Northern Germany. The study area is located at the southern margin of the Drenthe Ice Sheet. The blocking of the River Weser Valley led to the formation of a large and deep glacial lake, referred to as glacial Lake Weser. On the northern lake margin, the Emme Delta was deposited (Winsemann et al., 2010). Shallow shear wave seismic surveys allow a detailed assessment of the structural style of the delta body (Brandes et al., 2010), indicating two different fault systems developed within the delta, both showing syn-sedimentary activity. The seismic sections display the geometry of normal faults, related offsets and the lateral evolution of the deformation style. The faults have planar to slightly listric geometries and show vertical offsets in a range of 2 to 15 m. They form small graben and half-graben systems, which locally show roll-over structures. The fill of the half-grabens has a wedge-shaped geometry, with the greatest sediment thickness close to the fault. The fault system in the upper portion of the Emme delta is restricted to the delta body and probably gravity induced.

In the lower portion of the Emme delta several normal faults occur, which originated in the underlying Jurassic basement rocks propagating into the delta deposits. The grid of seismic sections shows that the normal faults are trending E-W. This fits to a late Triassic – early Jurassic deformation phase, which was described for the Central European Basin System (Lohr et al., 2007). It is very likely that the basement coupled deformation in the study area was caused by the advance of the Drenthe Saalian ice-sheet. The advancing ice-sheet caused far field extension, which might have reactivated pre-existing normal faults in the basement. The advance of the ice-sheet induced a transfer of the stress-front through the upper lithosphere. Pre-existing basement faults were probably reactivated due to the varying stress conditions. The growth of the Emme delta created a local load that might have enhanced the reactivation of normal faults in the basement. The water pressure could have reduced the friction along the faults and supported the slip process. Fault activity ceased when the glacial lake catastrophically drained. Though a reactivation of pre-existing basement faults due to loading and related effects is very likely, a neotectonic component along the Wiehengebirge flexure cannot be ruled out.

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The Hondsrug: geological setting of a geopark in Drenthe Province, the Netherlands

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The Hondsrug, Drenthe province, The Netherlands, reflects with a complex of linear ridges (NNW-SSE direction; 60 km lenghts) glacial features from the Saalian glaciations (MIS 6; stage 3 according to RAPPOL, 2001). Saalian till covers the ridges (s.l. raises from 6 to 28 m in the south) and thickens to the south from 40 cm to several meters, with a maximum of 7 meters. The main ridges crosses locally NE-SW ridges of an older glaciation stage (stage 2, according to RAPPOL, 2001) as is confirmed by shear stress measurements in tills (RAPPOL, 1983) and field observations. Subglacial features are indicative for subglacial conditions (periglacial versus non frozen conditions) and deforming processes of iceflows, which formed the Hondsrug. As so far the genesis of The Hondsrug, nearly perpendicular on the direction of the main Scandinavian ice flow and the linear feature, is still unknown. In 2008 a study started to get a good geological base for the HONDSRUG GEOPARK.

To start with, a newly reconstructed glaciation and deglaciation phasemodel, based on SRTM datasets (PIERIK, BREGMAN & COHEN, 2010), will be presented as a frame to understand the late Saalian ice streams in the NW European context.The "glacial footprint" shows local obstructions and flow direction. The Hondsrug is part of a wider, but not deep incised ice flow which (based on erratic counts) reached to the Münster Basin in Germany. Stagnant or cold based ice conserved elder glacial features at both sides of the Hondsrug – (Ems) ice stream.

In the northern part of the Hondsrug area Elsterian deposits are at surface level. We suppose for several reasons that erosion of meltwater must have had an important influence in that area; whereas in the central part of the area subglacial deformation and sedimentation processes played an important role in the genesis of the Hondsrug.

We conclude a reversed groundwater flow influenced by saltdomes – and ridges. The structure of the salt ridges declares a convergent groundwater flow with possible higher water pressure as indicated by subglacial and intratill channel sediments. Because of (i) a higher salt content of the groundwater (pressed up to the surface), (ii) higher temperatures caused by a better conductivity of soil energy in saltdomes and (iii) high internal friction energy as a result of dramatic change of velocity at the shear margin of the ice stream, we suppose more subglacial melt. As a result subglacial erosion eroded Saalian deposits. That is why Elsterian deposits are at the surface level now. It also declares lateral selection of deposits and formation of endogenous minerals in the SSE part of the Hondsrug area. The newly formed minerals, like syngenite, basinite and halite, are indicative for saltwater conditions and significant present in the lower tills of the southern part of the Hondsrug. Final conclusion: the Hondsrug is a unique geological feature.

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Geological investigation along the OPAL construction trench in Brandenburg – first findings

ROBERT BUSSERT & OLAF JUSCHUS

The OPAL (Ostsee-Pipeline-Anbindungs-Leitung – Baltic Sea Pipeline Link) which crosses the federal state of Brandenburg from North to South covering a length of 270 km is designed to transport natural gas coming from Siberia via the Nord Stream pipeline to Central Europe. Its construction trench will represent a more or less continuous outcrop 3-4 m deep that traverses all major Quaternary landscapes of Brandenburg. The opening of the trench has started in March 2010 and construction is scheduled to be finished in the first half of 2011.

First geological results of the ongoing investigation along the pipeline trench are related to the genesis of the Uckermark and Barnim till plains, the geographic extent and the mode of formation of sandur north of the Spree valley, the age and sedimentology of the Spree river, and the glacial conditions near to the southernmost ice margin during the Brandenburg phase of the Weichselian.

Whereas the flat to gentle rolling Weichselian till plains of the Uckermark and the Barnim are traditionally interpreted as landscapes shaped predominantly by the passive melt-out of stagnant glacier ice, a more dynamic genesis is envisaged. In these regions, the investigated tills reveal abundant deformation structures, both of ductile and brittle style that can be primarily related to simple shear deformation. Sediments thought to stem mainly from the passive melting of stagnant ice, such as melt-out tills, are rare to non-existent. Intensity and style of deformation of the tills considerably varies laterally. Differences between flat to gentle rolling and hilly till landscapes, generally thought to reflect origin of the till either dominantly by melt-out or by glaciotectonic processes, seem to mirror predominantly variations in the intensity of glaciogenic deformation. Hot spots of glaciogenic deformation form cupola hills, while less intensively deformed regions build up rolling to flat till landscapes.

Sandur sediments investigated north of the Berliner Urstomtal (ice-marginal valley) reveal the typical characteristics of braided channel sediments, with highly irregular vertical successions and very gradual proximal-distal changes in both lithofacies and mean grain size. Progradation of these outwash sediments into the Urstromtal evidently constitute one major reason for the uneven valley profile of the Urstromtal.

The large meandering palaeochannels of the river Spree east of Berlin have been interpreted as Late Glacial features that developed after a Late Pleniglacial braided river stage and that became inactive early during the Late Glacial/Early Holocene transition. However, large palaeomeander cut by the pipeline trench north of the recent river Spree yielded abundant large Alnus trunks within several generations of point bar deposits. This indicates Holocene river flow, channel avulsion and sedimentation in these large palaeomeanders. Furthermore, evidence of a Late Pleniglacial braided river stage is scarce.

Investigations close to the southernmost maximum position of the Weichselian glaciers, southeast of Berlin, reveals an impressing intensity of glaciogenic deformation, considering the presumed thickness of the marginal ice sheet. This suggests a very mobile ice margin and subglacial conditions that promoted glaciogenic deformation processes.

Fig. 1: The route of the OPAL in Brandenburg.

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Flood deposits on the Halligen Islands – Surface growth versus sea-level rise

MATTHIAS DEICKE, VOLKER KARIUS & HILMAR V. EYNATTEN

The „Halligen“ are a small archipelago in the North Sea west of Schleswig-Holstein. Its surface is only a few decimetre above mean high tide water (MTHW) and the shorelines of these islands are not protected by dykes. These 10 islands are frequently flooded during the winter season. The 300 inhabitants live on artificial hills, so called "Warften", 4-5 m above the island surfaces. Thus, this environment seems to be severely endangered by global warming and sea level rise. On the other hand, sedimentation of sandy-silty material occurs during each flooding which is responsible for the growing island topography.
Since 2005 the department of Sedimentology / Environmental Geology investigates the recent and historical sedimentation on selected Halligen. Within the research cooperation SAHALL I (**S**ediment-**A**kkumulation **Hall**igen) the age of sediments from drill cores were determined by ^{137}Cs, ^{210}Pb and OSL and the younger sedimentation history was reconstructed. During winter 2007/08 with its numerous storm floods an amount of 110 sediment traps were installed on the surface of four Halligen. The trapped sediment was detected concerning total amount of sediments, the grain size distribution, as well as C_{org}- und C_{karb} contents. Furthermore there were five permanent stations for the measurements of Sedimentation-Erosion-Bars installed. In the project SAHALL I it was observed for the bigger Halligen Hooge and Langeness that the recent sediment accumulations (2-3mm/a) is not high enough to compensate the recent increase of the MTHW (5,5mm/a at level Wyk/Föhr). In contrast, the recent sediment accumulation on the smaller Halligen Süderoog und Nordstrandischmoor compensates the regional increase of the mean high tide.
Another main focus in SAHALL I was the identification of the controlling parameters for the sedimentation process. Based on these findings in the current project SAHALL II measures to promote natural sedimentation are to be tested in test fields constructed on Hooge and Langeness. The test fields are equipped with sediment traps, sedimentation-erosion bars, sedimentation-erosion plates and suspension measuring instruments.
The investigations on the Halligen test fields will start in winter 2010/11.

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Das norddeutsche Quartär als Zeit-, Prozeß- und Klimaarchiv. Zustand und Aufgaben

LOTHAR EISSMANN

„Incommensurable !“ Reflexion des lehrbuchbekannten kanadischen Periglazialforschers H.M. French nach einer betont illustrierten Vorstellung des norddeutschen Quartärs auf der europäischen Permafrostkonferenz in Rom 2001. Dieses außergewöhnliche Adjektiv für „unvergleichbar“ bzw. „Sonderfall“ oder „absolute Ausnahme“ bezüglich einer Region, ihrer natürlichen geologisch-geographischen Ausstattung und ihres natürlichen oder anthropogenen Erschließungsgrades (Großaufschlüsse, Bohrungen) war bisher von der Zunge eines deutschen Großgelehrten oder Förderers der Erforschung des jüngsten Erdsystems noch nie zu hören, so sei es an vorderster Stelle dieser kurzen Übersicht positioniert.

Die Quartärgeschichte Norddeutschlands und der Hügelländer bis zu den Mittelgebirgen ist in dichten Maschen geknüpft; eines hängt über das Band des Klimas und seiner Prozesssteuerung am anderen. Lange Sedimentsukzessionen klimasignifikanter Faziesbereiche des Glaziärs, Periglaziärs, des marinen und limnischen Milieus vor allem seit Beginn der Elstereiszeit mit drei übereinanderliegenden vollständigen Warmzeit-Kaltzeit-Zyklen (Elster-, Saale-, Weichseleiszeit) machen die Region zu einem idealen Objekt der Klima- und Landschaftsforschung in der heute gemäßigten Klimazone der Erde mit dem Endziel der Erarbeitung eines entsprechenden komplexen Grundmodells oder Fallbeispiels auf der Erde und dem Bewusstsein, dass die im Interferrenzbereich von Inlandeis, periglazialem und marinem Milieu geprägten Regionen die eigentlichen Bühnen des Eiszeitklimas sind. Nicht hoch genug zu betonen sind die zahlreichen paläontologisch und archäologisch bedeutsamen Fundstätten (Untermaßfeld, Bilzingsleben, Schöningen, Neumark-Nord u.a.). Nach reichen „Transitfaunen“ vom Jungtertiär zum Quartär erscheinen im norddeutschen Raum zu Beginn der Elstereiszeit die ältesten modernen reinen Kaltzeit-Säugetierfaunen Eurasiens, in Verbindung mit der exzesshaften Zunahme der Permafrosterscheinungen die stärkste Akzentverschiebung der Klimaentwicklung mit Beginn der Elstereiszeit demonstrierend. Es beginnt das Eiszeitalter im engeren Sinne.

Bei optimaler Aufschlussdichte durch Bohrungen und Großaufschlüsse, sicherer Ortung bereits entdeckter künftiger Forschungsobjekte – es existieren beispielsweise ungezählte bisher nicht näher untersuchte Vorkommen oberflächennaher Warmzeitfolgen und von Typusprofilen glaziärer Sequenzen – erlaubt die Region aufgrund ihres hohen verkehrstechnischen Erschließungsgrades den unproblematischen Einsatz aller heute verfügbaren Untersuchungsverfahren bei minimalem technischen Aufwand, kurzen Wegen und hoher Verifizierbarkeit der Befunde und ihrer Interpretation. In einer derartigen Region mit dem wohl höchsten geologischen Erkundungsstand und einem festen stratigraphischen Verbund ist der Weg frei, um über die Anwendung modernster geochemischer Analysemethoden, der absoluten Altersdatierung und der Gewinnung relativer und absoluter Klimaparameter zu einer wirklichen Aussagequalität(!) für die jüngere globale Klimaentwicklung zu gelangen. Im sprichwörtlichen Sinne braucht das „Fahrrad“ in dieser Region im Gegensatz zu vielen anderen nicht neu erfunden zu werden.

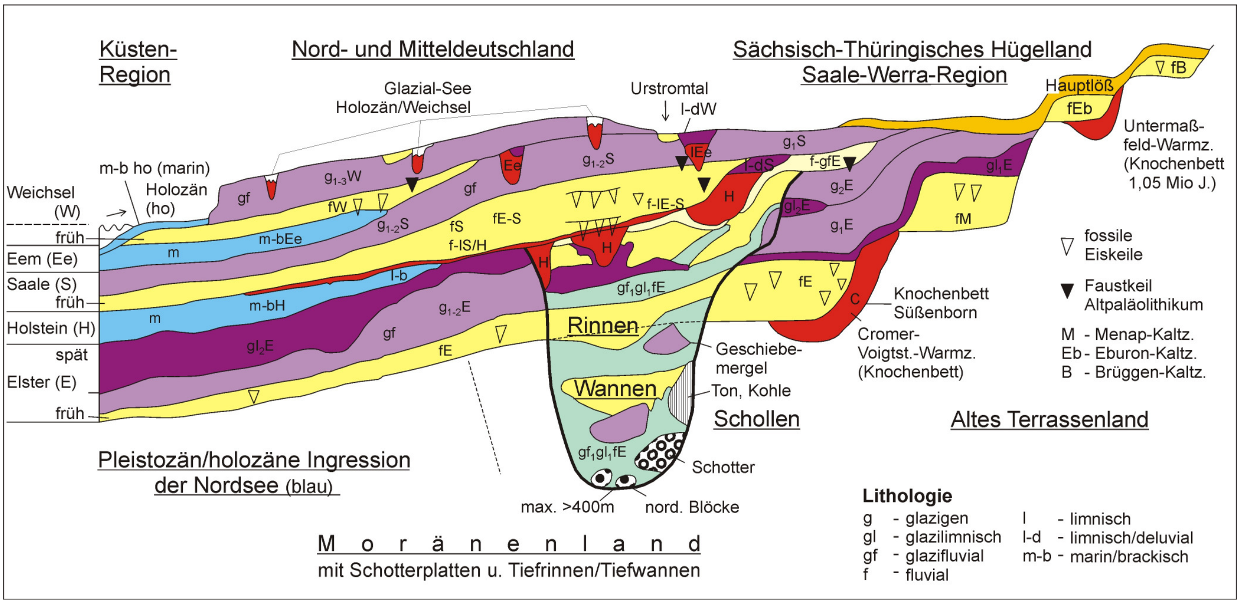

Abb. 1: Lithostratigraphische Grobgliederung ohne stratiforme äolische und deluviale Formationen vom Holozän bis Präelster:

- Postglaziale (holozäne) Deckformation aus vorwiegend fluviatilen-limnischen, deluvialen und marinen Sedimenten
- Jüngeres oder Oberes Glazialstockwerk (Weichsel/Würm-Eiszeit)
- Jüngeres oder Oberes Fluviatil inkl. marines/limnisches Eem (späte Saaleeiszeit bis frühe Weichseleiszeit inkl.)
- Mittleres Glaziärstockwerk (Saale/Riss-Eiszeit)
- Mittleres Fluviatil inkl. marines/limnisches Holstein (späte Elster/Mindel-Eiszeit bis frühe Saaleeiszeit)
- Älteres oder Unteres Glazialstockwerk (Elster/Mindel-Eiszeit)
- Älteres Fluviatil (Postpliozän bis frühe Elstereiszeit; mehrere Schotterterrassen; international bedeutende Säugetierfundstellen älterer Warmzeiten: Untermaßfeld, Voigtstedt u.a.)

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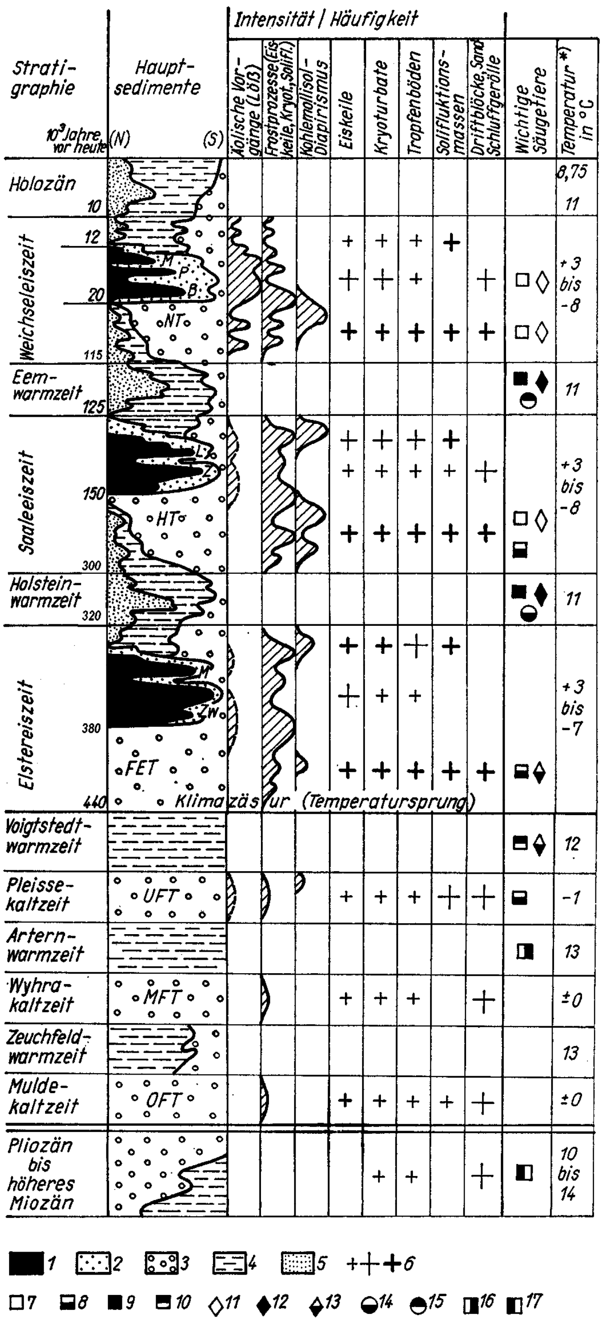

Abb. 2: Vereinfachte Gliederung des Quartärs im Norddeutschen Tiefland, Sachsen und Thüringen mit dem Versuch einer Intensitäts- und Häufigkeitseinschätzung periglazialer Prozesse und Erscheinungen sowie faunistischer Belege (Großsäuger, Mensch). Aus Eissmann & Hänsel (1991): 1 – Inlandeis bzw. Grundmoräne; 2 – vorwiegend Schmelzwassersedimente; 3 – Flusssedimente; 4 – Fluss- und Seesedimente; 5 – Meeressedimente; 6 – Intensitätsskala: selten bzw. häufig bzw. sehr häufig; 7 – Wollhaarmammut (*Mammonteus primigenius*); 8 – Steppenmammut (*Mammonteus trogontherii*); 9 – Europäischer Waldelefant (*Palaeoloxodon antiquus*); 10 – Südelefant (*Elephas meridionalis* oder *Archidiskodon meridionalis*); 11 – Wollnashorn (*Coelodonta antiquitatis*); 12 – Waldnashorn (*Dicerorhinus kirchbergenss*); 13 – Etruskisches Nashorn (*Dicerorhinus etruscus*); 14 – Alt-Mensch (*Homo erectus*); 15 – Neanderthaler (*Homo neanderthalensis ehringsdorfensis*); 16 – Flusspferd (*Hippopotamus*); 17 – Rüsseltier (*Mastodon*); Vereisungsstadien im Weichselglazial: M – Mecklenburger, P – Pommersches, B – Brandenburger; Vereisungsstadien im Saaleglazial: L – Leipziger, Z – Zeitzer; Vereisungsstadien im Elsterglazial: M – Markranstädter, Zw - Zwickauer; Flussterrassen: NT – Niederterrasse, HT – Hauptterrasse, FET – Frühelsterterrasse, UFT – Untere frühpleistozäne Terrasse, OFT – Obere frühpleistozäne Terrasse;
*) vermutete mittlere Jahrestemperatur. In den Kaltzeiten bezogen auf Hochglazial- bis Warmphasen, in den Warmzeiten auf das Klimaoptimum

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Multiproxy results of the climatic evolution of the Marmara Region during the past 15,000 years

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The Marmara region (Western Turkey) is expected to have been one of the principal key areas in the transcontinental dispersal of modern humans from the Near East to the Balkans. Lake Iznik is located in the east of the Marmara Sea, adjacent to the North Anatolian Fault and holds a continuous sediment record. We recovered several continuous sediment cores (max. 14 m) from Lake Iznik in 2005 and 2009. Now, we are able to reconstruct the environmental history and climate patterns during the reestablishment of human habitats after the last glacial maximum and the dispersal of Neolithic economy (15,000-7,000 a BP). First results of our sedimentological and geochemical analyses suggest a cyclic (±350 and 800 years) precipitation pattern with increased terrigenous input in contrary to in-lake carbonate production. Despite these results, records of biological indicators (Cladocera and Ostracoda) show little or no response to environmental changes during the last 5000 years. But intensive changes of land use in the northern farmlands of Lake Iznik, starting around 1950 are synchronously detected by sedimentological, geochemical and biological proxies in the sediment record. From 1950 to 1990, woodland was converted to farmland and a more intense farming began. Together with high sedimentation rates more weathered materials were eroded and transported into the lake (K/Na Ratios and Mn concentration; FRANZ et al. 2006). The ancient ostracode fauna (*Limnocythere*-association) was replaced by a *Candona*- association during this short period.

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Late–Weichselian ice-flow pattern and ice margins in the background of bedrock surface topography: The region southeast of the Baltic Sea

ALEKSANDR GORLACH & VOLLI KALM

In this study we correlate ice-flow pattern and the last glacial maximum (LGM) and subsequent ice marginal positions with the bedrock surface topography and thickness of the Quaternary sediments. 3D model of the bedrock surface topography was constructed from the data available in printed or digital format. 15 maps and sketches were draped over the map of the region and the information on the bedrock surface elevation was entered into a GIS (MapInfo 10.0™) in point values, which allows building a raster image of the bedrock surface. The 3D image of the bedrock surface (Fig. 1) clearly exhibits regions with detailed available data (Baltic States, particularly Lithuania) and the regions where the information about the bedrock surface is scarce. We aim to update the 3D model of the bedrock surface topography at any time if new information becomes available.

Comparison of the bedrock surface topography with the late Late-Weichselian ice-flow pattern and the ice-marginal positions, subsequent to the LGM (KALM 2010), show that the ice-flow pattern was strongly influenced by the major topographic features of the bedrock surface, which are well reflected in the current relief. Valdai, Tihvin and Vepsa Heights with their bedrock cores probably presented a considerable eastern obstacle for the Late-Weichselian glaciers, as the LGM extent covered just the highest elevations and the glacier was able to surpass the heights only in exceptional cases (e.g. Msta valley). Mentioned Valdai, Tihvin and Vepsa Heights bordered the Ladoga-Ilmen-Lovat' ice stream from the east almost throughout the deglaciation. Peipsi-Pskov, Riga and Neman ice-streams followed bedrock depressions as well.

Thickness of the Quaternary deposits was deduced as a result of subtraction of the bedrock surface elevations from the SRTM digital elevations of current topography. Obviously the result includes errors of both relief models, but nevertheless the obtained 3D thickness model of the Quaternary deposits highlights the location of earlier mapped ice marginal positions (KALM 2010) in many regions of the study area. Normally the thickness of the Quaternary deposits is highest in the zones where the ice marginal positions have bordered highlands. In general the thickness of the Quaternary strata tends to decrease from the LGM zone towards the centre of the glaciation in Scandinavia. However, not always the greatest thicknesses of the Quaternary deposits are in the zone close to the LGM. At the LGM margin of the ice flows that surpassed the Valdai and Tihvin Heights (for example Msta ice-stream and eastern branch of the Kunja ice-stream), thickness of the Quaternary deposits is rather small if compared to that at the proximal (western) zone of the same heights.

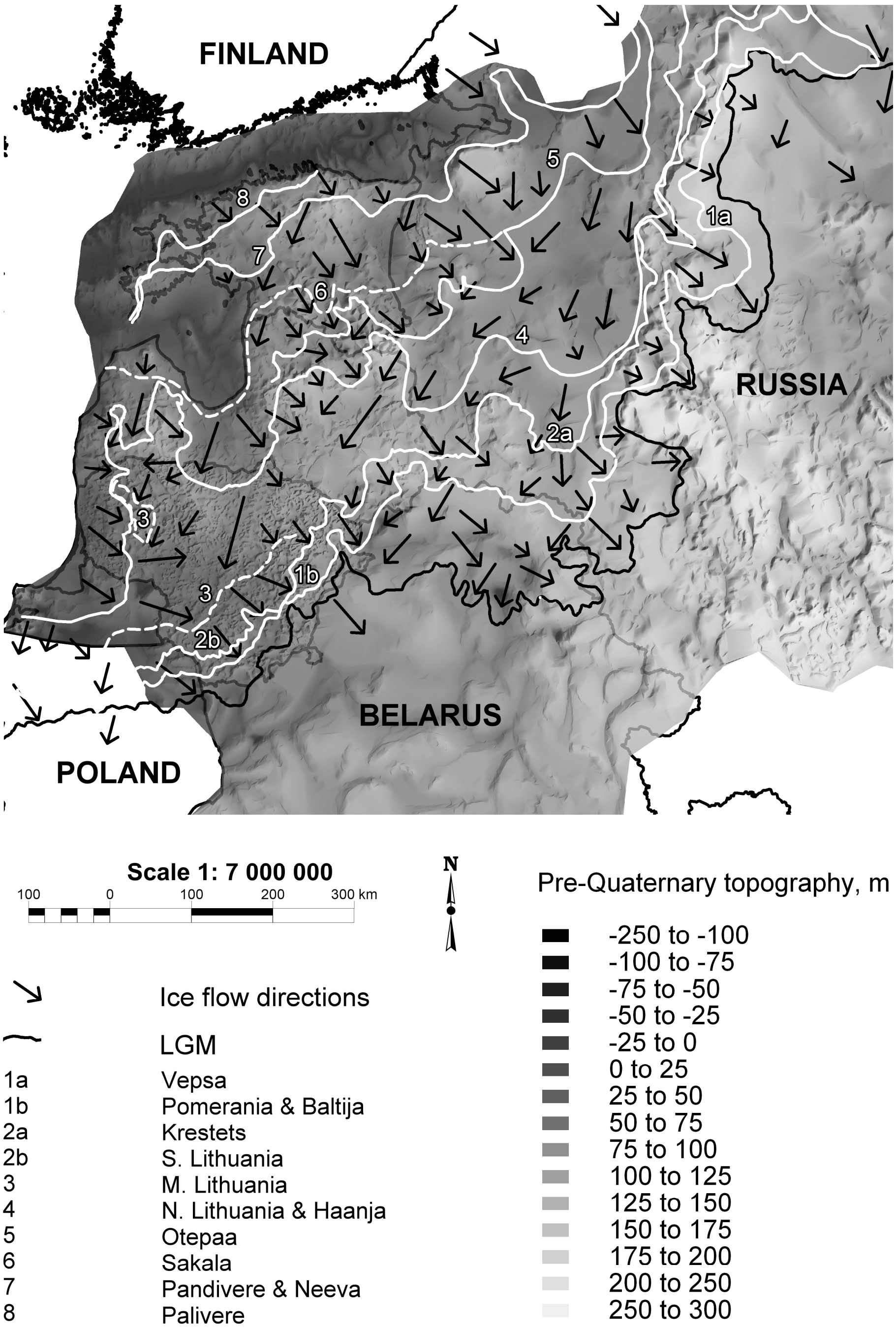

Fig. 1: 3D image of the bedrock surface.

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Aspects of eskers and kames in Schleswig-Holstein

ALF GRUBE

Eskers (Scandinavia: rullsten os; German: Wallberg) are elongated, often sinuous, ridges. They are built up of sand and gravel, often with a complicated internal structure. Locally, till intercalations are found. Eskers are formed in sub- or inglacial melt water tunnels which are often the continuation of supra- or inglacial tunnels. Esker originate in a decaying phase of a glacier. They are mainly found in tunnel valleys or other morphological depressions. Kames are geomorphological forms typical for areas of down melting glaciers. Kames can be morphologically differentiated into terraces, plateaus, ridges and hills. Kame hills were formed from sediment fillings in basins under, in or on the ice. After down melting of the surrounding ice inversening of the relief leads to the typical hill form. Often fine-grained melt water sediments (fine sand) dominate.

The different esker forms of Schleswig-Holstein are presented according to actual studies: typical eskers, “Aufpressungs-esker” with core of till, “Aufpressungs-esker” with core of basin sediments, “Perlenschnur-esker”, eskers with till cover, crossing overlaying eskers, eskers with and without accompanying erosional channels, etc. Partially a parallelism of several esker ridges appears. Eskers are often spatially associated respectively genetically linked with drumlins, drumlinoid forms, till diapir structures, ice marginal forms, subaerial crevasse fillings, kame structures and / or dead ice forms.

Among others an "esker kames system" is presented in detail that is situated on a large ice marginal ridge with a height of up to +85 mNN. Despite an intensive sand and gravel extraction in the area parts of the natural morphology are still detectable. The whole structure is morphologically recognizable as gravely sand back formed on a bulged, glaciofluvial area. The structure can be subdivided into three parts: (A) a large esker ridge with parallel structures, (B) a central, high sand ridge (esker / crevasse filling) and (C) hilltop-shaped kames at the southeast end of the structure. The esker structure "A" shows a central, big gravely sand ridge with 70-metre width, a height of approx. 8-10 metres and a length of approx. 220 metres (till covered esker) as well as two other smaller esker ridges which run to the south of the big one. The genesis of the esker-kames-structure in a morphological top position is discussed.

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Proglacial varves indicate the stagnation of ice terminus during the formation of Pandivere-Neva ice marginal formations in eastern Baltic

TIIT HANG, MARKO KOHV, KARIN PAI & TÕNN TUVIKENE

Interrupted chains of end moraines and glaciofluvial formations in Estonia mark marginal positions of the ice sheet in present topography. It is believed that they represent temporary stagnations (BOULTON ET AL. 2001) or even readvances (RAUKAS et al. 2004; KALM 2006) of the ice terminus when the glacier regime was close to equilibrium. This, in turn, was most likely reflected also in proglacial sedimentary environment in front of the ice margin. Currently the distribution of varved clays, local varve chronology and varve thickness changes are analysed across the Pandivere-Neva (13,500-13,300 ka yrs BP) belt of ice-recessional formations in western Estonia.

The study area includes the shallow water Pärnu Bay and adjoining coastal lowland in western Estonia. Pandivere-Neva belt of ice-recessional formations is crossing the area and is represented by push end-moraines, glaciofluvial deltas and marginal eskers (KARUKÄPP & RAUKAS 1997). Due to Holocene wave erosion, the forms have been levelled while the height of features ranges from few meters up to maximum of 20 m. Locally the levelled formations are buried under younger marine sediments. Over the entire study area, the hummocky upper surface of the Late Weichselian bluish-grey loamy till is covered by glaciolacustrine varved clay or silt. The reported maximum thickness of varved clay in the study area is 30 m, but an average between 5-9 m. The upper surface of clay dips towards the south.

Varved clays in western Estonia have been deposited in the Baltic Ice Lake. Glacial varved clays with their characteristic summer (silty) and winter (clayey) layers are interpreted to reflect seasonal variations in sedimentation environment in the proglacial lake (DE GEER 1940). Clays in the study area are characterised by very distinct lamination and easily distinguishable seasonal layers. Varves are usually thick and clayey with silty microlayers in some intervals (HANG et al. 2007). Current ripple marks and erosional features are quite rare as well as synsedimentary disturbances. In limited area at the distal slope of the Pandivere-Neva formations (in NW part of the Pärnu Bay and in the City of Pärnu) a massive silty clay unit (0.40 – 10 m in thickness) with dispersed sand grains has been described within the varved clay complex. Its composition responds to clayey waterlain glacial diamicton earlier described in western Estonia (KADASTIK & KALM 1998). According to varve correlation between the studied sequences an interval of 20 silty varves with dispersed sand and gravel grains and few dropstones stratigraphically corresponds to the massive clay unit.

Clay and silt fraction dominate in the grain-size composition of proglacial clays in the study area. With few exceptions a common clay texture exceeding 60% is diagnostic for the winter layers through the studied sections. Texture of the summer layers displays decreased clay content and increased silt content compared to the winter layers. Aforementioned massive clay unit has the coarsest grain–size of analysed samples. An increase of clay fraction and decrease in fine-silt fraction upwards are the main tendencies in vertical change of grain-size composition. Amplitude of changes is bigger in the summer layers. Within a singel varve the summer layer consists mainly of fine- and medium grained silt (up to 90%). Clay fraction usually starts to dominate already in the upper portion of the summer layer and constitutes at least 70-80% of the winter layer.

A 565 yrs long local varve chronology for the Pärnu area in western Estonia has been established through the correlation of 33 varved sequences. The correlation has been done through the straight comparison of sediment sequences being thus more convincing than classical varve graph correlation. All sequences at the distal and few at the proximal slope of the Pandivere-Neva marginal formations, contain easily recognizable marker interval of 20 silty varves and/or a colour change from light grey to reddish–brown on top of the interval which certainly strengthen the correlation. All investigated sequences display a normal varve series with decreasing varve thickness upwards. No drastic or very rapid changes in total varve thickness were reported. Correlation of proximal varves up to local year 150 of the chronology was easier compared to the distal varves.

According to the varve correlation two groups of varve graphs could be distinguished: those representing sequences from the distal side and those representing sequences from the proximal side of the Pandivere-Neva ice marginal formations. Accumulation of varved clays started ca 85-90 yrs earlier at the distal part. Massive clay unit with corresponding silty varve interval precedes the beginning of varve formation at the proximal part of the basin and could therefore correspond to the ice stagnation during the Pandivere-Neva stade. Description of ice recession in detail is complicated due to scattered distribution of investigated sites and only few sites which reached the bottom varve.

Studies into grain-size, internal structure and thickness changes of the varves demonstrate that the proximal sedimentary conditions at each point of the proglacial lake gradually changed to become more distal. It is expected that laterally these changes were in accordance with the ice recession. Surprisingly our varve correlations demonstrate simultaneous changes over the vast area (maximum distance between the investigated sites is ca 30 km) of proglacial basin and even across the ice marginal formations. Changes in relation of seasonal layer thicknesses within the varve serves as a good example. Silty summer layers dominate in the thick proximal varves up to the local year 120 in the chronology. Within following 10 to 20 years in all studied sequences the winter layers start to dominate in the varves which could be attributed to the changes in sediment supply. What is complicated to explain is the corresponding location of ice terminus as a sediment source. Due to rapid and simultaneous change in sedimentary environment, a rather similar distance of all studied sequences to the source is expected, which questions the local ice recession direction in the study area.

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The occurrence of Late Weichselian pingo remnants in Germany

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The occurrence of permafrost related phenomena, in combination with radiocarbon and OSL dates of these phenomena, indicate that permafrost was present during the Pleniglacial, Early Lateglacial and Younger Dryas in The Netherlands. The most typical phenomena that indicate the presence of permafrost are the numerous remnants of Pleniglacial pingo's that can be found in particularly the Northern Netherlands (DE GANS, 1982). They appear as circular depressions with or without a rampart, a diameter of 50-300 meters and depth of several meters at present partly or completely filled with organic deposits.
Pingo's are known from present day permafrost regions in Alaska, Canada and Siberia and occur under conditions with sufficient groundwater, leading to the formation of ice lenses. The presence of these pingo remnants with a depth varying between 5 meters in the southern Netherlands to 20 meters in the northern Netherlands indicates a minimum thickness of permafrost in the order of those values. The pingo's presumably originated as a result of hydrostatic pressure, under conditions of discontinuous permafrost during the Weichselian Pleniglacial. As temperature rose at the onset of the Lateglacial interstadial (GI-1, round ca. 12,500 ^{14}C BP or 14,700 cal BP), permafrost most likely started to disappear from that time onward. Melting of the permafrost layer that was several meters thick, presumably lasted several hundreds of years. Implications for the disappearance of permafrost during the Lateglacial in The Netherlands are given by the basal organic infilling of pingo remnants, dated to begin between 12,500 and 11,900 ^{14}C BP (HOEK & BOHNCKE 2002). Some of these depressions are filled with calcareous gyttja, implying that hydrostatic pressure and groundwater exfiltration continued after the decay of the ice-body.
Remarkably, only few pingo remnants have been described in German literature, which makes it seem that the distribution stops at the Netherlands-German border. In this presentation, characteristics and distribution of pingo remnants in the Netherlands and adjacent Germany are presented. We describe previously unknown pingo revealed by the detailed digital elevation maps (AHN) that are now available in the Netherlands in combination with detailed coring transects and core analyses. A comparison is made with circular depressions that are presents in Niedersachsen/Ost Friesland. Based on the characteristics and the position in the landscape it is concluded that, like in the Netherlands, numerous pingo's must have existed in this part of Germany during the Late Pleniglacial. During the Lateglacial and Early Holocene, hydrological conditions, however, were different from those in the Netherlands leading to a fill, which is only partly comparable to that of the pingo-remnants in the Netherlands.

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Evidence for neotectonic activity on the SW Baltic Sea coast (Germany)

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A 1460m long profile of a Late Glacial subglacial, glacio-fluvial, -limnic and -deltaic sequence exposed at a cliff section on Usedom Island (SW Baltic Sea coast) is analyzed. The sequence is up to 31m thick and shows sedimentary structures typical for a glacial setting. Soft sediment deformation is encountered and is associated with changes in lithology. These deformations include liquefaction, slumping and faulting. We regard earthquake induced shaking as the most plausible cause. The associated neotectonic activity is seen as a consequence of the postglacial isostatic crustal rebound. As the deglaciation earthquake ratio diminishes with time and as the rebound is phasing out no large earthquakes are anticipated for Northern Germany; although in conclusion the lithosphere of the North German Basin has to be regarded as weakened by repeated ice-loading and deloading.

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Natural hazards along the coastline of Oman (Arabian Peninsula)

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The coastline of the Sultanate of Oman is densely populated; more than half of the population is living at the coast. Due to economic improvements the country experiences substantial changes in land utilization, particularly in the coastal areas of Al Batinah and Muscat.
Coastal evolution is a function of several forcing factors e.g.: differential land movement which in turn is an effect of local variations in the tectonic stress field; climate and sediment availability. We quantify the various forcing factors by analysing Quaternary coastal sediments and geomorphologic features (e.g. terraces, notches) as archives and indicators. This research focuses on revealing long-term and short term changes within the coastal zone. Long-term changes can be described by the reconstruction and comparison of the relative sea-level development along the coastline. Short-term coastal changes are often related to natural hazards. Hurricanes as well as tsunamis are known to have affected Oman's coastline in the past. By analysing geological archives information regarding recurrence intervals and potential damages will be revealed which allows assessing the risk and estimating the vulnerability. This is done for different areas along the coast which have been identified as key-locations. Sediment cores and ground-penetrating radar (GPR) surveys are utilised to analyse Quaternary coastal sediments; terrestrial Light Detection and Radar (T-LIDAR) techniques are used to analyse geomorphologic features (e.g. terraces, notches).

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Herausforderungen bei der Planung der OPAL-Erdgastrasse – administrative, naturschutzfachliche und technische Erfordernisse

HOLGER ILLIAN

The OPAL (Ostsee-Pipeline-Anbindungs-Leitung – Baltic Sea Pipeline Link) will connect Germany and Europe to the major natural gas reserves in Siberia via the Nord-Stream-Pipeline. This will enhance supply security right in the heart of Europe.

The OPAL runs southward from Lubmin, passes Berlin in the east, and crosses the German-Czech border in the Erz Mountains. Over its full length, the OPAL pipeline overcomes a height difference of 700 meters and crosses the River Peene in Mecklenburg-Western Pomerania, the River Elbe in Saxony, the A12 highway east of Berlin and the A4 highway between Chemnitz and Dresden, among other feats. The 470-kilometer-long pipeline comprises many individual pipes, each of which is 18 meters long and weighs 15 tonnes. WINGAS is constructing OPAL together with E.ON Ruhrgas AG, which holds a 20-percent stake in OPAL. Network operation of the connecting pipelines will be realized by OPAL NEL TRANSPORT GmbH. This company is part of the WINGAS Group.

From fall 2011, natural gas from the Nord Stream pipeline will flow into the transfer station which is currently being built. There, it will first be purified and preheated to the right temperature. The quality, quantity and pressure of the natural gas will then be measured. In order to then transport it southward through the 470-kilometer-long Baltic Sea Pipeline Link (OPAL) via Mecklenburg-Western Pomerania, Brandenburg and Saxony to the Czech border near Olbernhau in the Erzgebirge mountains, it will be recompressed to as much as 100 bar after half of the total route south of Berlin.

With a capacity of 36 billion cubic meters, OPAL is one of the largest pipelines ever laid in Europe. As a comparison, the capacity corresponds to about a third of Germany’s annual natural gas consumption.

In order to complete OPAL on schedule, several sections are being constructed simultaneously. Since the beginning of construction work in September 2010, the topsoil has been removed from over 460 kilometers of the pipeline route, around 350 kilometers of piping have been welded and more than 240 kilometers of pipeline sections have already been laid.

In addition to OPAL, construction of the North European Gas Pipeline (NEL) is also planned. This is to run from the Nord Stream pipeline landing point, past Schwerin and Hamburg, to the Rehden gas storage facility in Lower Saxony, thus connecting the Nord Stream to the European pipeline network, just like OPAL.

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The deep drilling project at Lake El´gygytgyn/ NE Siberia - objectives, coring campaign and first results

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Lake El´gygytgyn (White Lake), located in central Chukotka, NE Siberia, is a 3.6 million year old impact crater lake with a diameter of 12 km and a water depth of 170 m. During the last decade the sedimentary record of the lake has become a major focus of multi-disciplinary multi-national paleoclimatic research. The principal investigators are from Germany, the USA, Russia and Austria. Recently, the International Continental Scientific Drilling Program (ICDP) has provided funding for a drilling operation on the lake and in its permafrost catchment in autumn/winter 2008/09. Additionally the project became funded by the German Ministry of Education and Research and the US-american National Science Foundation. A full-length sediment core from Lake El´gygytgyn would yield a complete record of Arctic climate evolution, back one million years prior to the first major glaciation of the Northern Hemisphere.

Fig 1: Location of Lake El´gygytgyn in North-eastern Siberia

Geomorphological evidence from the catchment suggests that the crater was never glaciated during the entire Late Cenozoic. Two, 12.9 m and 16.5 m long sediment cores retrieved from the deepest part of the lake in 1998 and 2003 revealed a basal age of 340 kyr, confirmed the lack of glacial erosion, and underlined the sensitivity of this lacustrine environment to reflect highresolution climatic change on Milankovitch and sub-Milankovitch time scales. Seismic investigation carried out during expedtions in 2000 and 2003 revealed a depth-velocity model of brecciated bedrock overlain by a suevite layer, in turn overlain by two lacustrine sedimentary units between 300 and 350 m thickness. The upper well-stratified sediment unit appears undisturbed apart from intercalation with the debris flows near the slopes. Based on extrapolation of sedimentation rates the entire Quaternary and possibly parts of the late Tertiary record are reflected by the app. 170 m thick unit one, whilst the earliest history of the lake is presumably represented with a considerable higher sedimentation rate by unit two. There is no evidence for glacial erosion or complete lake drying in the entire sedimentary record. Coring objectives included as a maximum duplicate cores of 630 m length to retrieve a continuous paleoclimate record from the deepest part of the lake and into the underlying impact breccias and bedrock. Studies of the impact rocks offers the planetary community with the opportunity to study a well preserved crater uniquely found in igneous rocks like those on Mars. One additional core to ca. 200 m into permafrost from the adjacent catchment will allow us to test ideas about arctic permafrost history and sediment supply to the lake since the time of impact.

The permafrost coring was conducted in November and December 2008. After some delay due to missed permissions the coring process proceeded to 141 m, the final depth of the permafrost core. Coarse grained sediments were recovered. The bottom temperature of the hole is -5°C.

The equipment for the lake based coring was carried by ship to Pevek, app. 250 km to the North of the lake. Main transportation from Pevek to the lake took place during winter 2008/2009 using trucks of a local mining company. Aditionally, the company provided the base-camp at the lake. The lake-sediment coring was conducted between January and early May 2009. The equipment, a modified drillrig on a platform, used the lake ice cover. To improve the ice strenght the lake ice was thickened artificially to 2 m.
The lake sediment succession was finally penetrated at about 315 m below lake floor. From the lake floor to app. 150 m depth the sediments predominantly consist of silts and clays. Between 150 and 275 m coring depth thick sand layers are intercalated while between 275 and 315 m the lake sediments are usually fine grained again. On site measurements of magnetic susceptibility indicate for the uppermost 120 m a succession of glacial and interglacial sediments as it was observed for the uppermost 16.5 m in 2003. The origin of the lower sediment succession remains speculative as yet. Nevertheless, the record will likely cover the whole Quaternary and the Upper Pliocene.
Below the lake sediments impact rocks were recovered. While the uppermost dozen metres of these rocks are interpreted as fallback-breccias with a high amount of glasses the lower part seem to represent the bedrock, which is partly brecciated as well. Alterations, probably caused by hydrothermal processes after the impact, are common and hampered the drilling progress. The coring stopped at a depth of 517 m blf.
After receiving all necessary permissions the cores arrived in Germany in autumn 2010. Following the measurements of whole core physical properties the core opening and sampling party started in October 2009. As yet about 120 m of fine grained lake sediments were described and sampled. Except some minor gaps due to mass movement events the uppermost 120 m contain the entire Quaternary history of the lake and its surroundings.

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Climate and environmental change on the Iberian Peninsula during the Middle to Upper Paleolithic transition

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Introduction

The new Cooperative Research Center (CRC) "Our Way to Europe – Culture-Environment Interaction and Human Mobility in the Late Quaternary" (www.sfb806.de) focuses on the dispersal of anatomically modern humans (*Homo sapiens sapiens*) on their way from East Africa towards Central Europe. The main objectives are to identify factors and processes of dispersal within two trajectories along the eastern and western coasts of the Mediterranean Sea. Within the regional research cluster C, the project C1 deals with cultural changes in relation to climatic and environmental forcing on the Iberian Peninsula (e.g., CORTÉS 2005; SANCHEZ-GOÑI & D'ERRICO 2005; ZILHÃO 2006).

Project C1: Continuity or Discontinuity? Patterns of Land Use and Climatic Changes in the Late Pleistocene of the Iberian Peninsula.

In the first phase (2009-2013) the temporal focus is on the transition from the Middle to the Upper Palaeolithics (45-25 ka), when Europe was colonized by anatomically modern humans (AMHs) and the Iberian Peninsula (IP) might have acted as a refuge for a prolonged survival of Neanderthals (ZILHÃO 2000; FINLAYSON et al. 2006). However, age controle for these cultural events is not unequivocal (cf. MAROTO et al. 2005, TZEDAKIS et al. 2007) and more information is needed on the cultural patterning of late Neanderthals and AMHs (e.g., VEGA 1999; CORTÉS 2005; ZILHÃO 2000, 2006) in their environmental settings.

Suborbital climatic changes known from the Northern Atlantic, such as Grönland Interstadials or Heinrich events, are reflected in pollen, stable isotope and geochemical records of marine cores retrieved off the Iberian coasts (e.g., D'ERRICO & SANCHEZ GOÑI; FLETCHER & SANCHEZ-GOÑI 2008). It has been conversely discussed, however, how reliable marine records are in reflecting palaeo-environmental changes on the IP (e.g., CARRÍON et al. 2008). Terrestrial evidence on the timing, nature and intensity of possible climate and environmental changes during the Middle to Upper Last Glacial is very limited. This knowledge gap is related to the apparent scarcity of terrestrial archives covering this phase. Besides the Padul Peat bog (PONS & REILLE 1988, ORTIZ et al. 2004) and the recently examined core of the Fuentillejo Maar (GALÁN et al. 2009), continuous land sequences of palaeo-environmental change are lacking. The C1-project aims at elucidating the cultural patterning of late Neanderthals and AMHs and at improving palaeo-environmental information during the Middle to Upper Palaeolithic transition on the IP.

Methodic approach

Our interdisciplinary working group conducts an array of archaeological and geoscientific analyses of selected archaeological sites ("on-site") and of nearby terrestrial geo-archives ("off-site"). New excavations and re-examinations of collections cover the entire cultural inventory as based on pottery, lithics, faunal and botanical remains. In addition, the cave sediment sequences are studied by modern sedimentological, geochemical and geophysical methods using multi-proxy approaches. A similar set of geological investigations are conducted on environmental archives such as polje infillings and lake sediments. Local chronostratigraphies are established and backed up by radiocarbon and luminescence methods. The palaeoenviron-mental and chronological data will be combined to yield more reliable reconstructions of environmental history in the areas of interest.

The presentation will briefly discuss the state of knowledge on cultural transition and climate change on the IP and will discuss the aims and methodic approach of the C1 project. First results of ongoing micromorphological, geochemical and granulometrical investigations of the Middle to

Upper Palaeolithic cave sequences at Cueva Morin (Cantabria) and Cueva de l'Arbreda (Catalonia) will be presented.

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Geomorphological and sedimentological indicators of early stage anostomosing in the lower Vistula River valley, north central Poland, prior to recent river regulation

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The Vistula River, taking into account the outflow, is the biggest one with a fully developed system of valley terraces in the Baltic Region. It is considered to have a constrained channel system (FALKOWSKI, 1990). The area occupied by the Holocene channel deposits is rather small and they are not still concordant with the present-day hydrodynamic channel conditions (no equilibrium meandering fluvial pattern is achieved). The sedimentation within the valley bottom resembles in some way an initial stage of the anastomosing fluvial system i.e. presence of large biogenic wetlands, fine flood deposits and fairly stable main channel belt (SMITH, SMITH, 1980; NORTH et al., 2007).

A development of the Lower Vistula River valley was strongly influenced by the older geological setting. The present valley in the basin areas resembles in many places the valley depressions, which had come into being before the Vistulian main stadial (MAKOWSKA, 1979) and its modern shape is a result of glacial, glaciofluvial, melt-out and fluvial relief imposition (e.g. DROZDOWSKI, 1982; BŁASZKIEWICZ, 1998; KORDOWSKI, 2001). After a retreat of the last ice sheet, there were large dead-ice blocks, which had left many kettle holes, ice-crevasse fillings, debris flow sediments and kame terraces.Their melting had a huge impact upon the development of the terraces. Due to their existence in the valley, two separate hydrological systems may have existed temporarily, locally governed by melting-out of the dead-ice and regional governed by melting-out or a retreating glacier. The Late Glacial Vistula had a braided channel pattern that is proved by investigations of topography beneath the present-day flood plain sedimentary cover. The analysis of sedimentological properties of the floodplain sediments indicates that the Vistula channel was fairly stable during its development. There is relatively small amount of proved avulsions. Changes of the river course as well as deposition of large sandy ribbons were caused by increased frequency of floods due to winter ice jams. The analysis of biogenic sediments leads to the conclusion that they are overwhelmingly limnic. A development of the floodplain was also associated with shallow and vast lakes development. These features allow assuming that development of the initial stage of an anastomosing-like fluvial pattern in the present Vistula floodplain was recently interrupted by the human impact (river regulation).

In the case of the lower Vistula region the anastomosing has been most probably caused by presence of many valley basins occurring over former valleys established prior to the last glaciation (Vistulian Main Stadial) and gaps between them, where no valley occurred. They have played to some point, a similar role to mountain foredeeps, favouring development of typical anastomosis (i.e. SMITH, SMITH, 1980; RUST, 1981; MIALL, 1996; MAKASKE 1998; MAKASKE et al. 2002; WANG et al. 2002).

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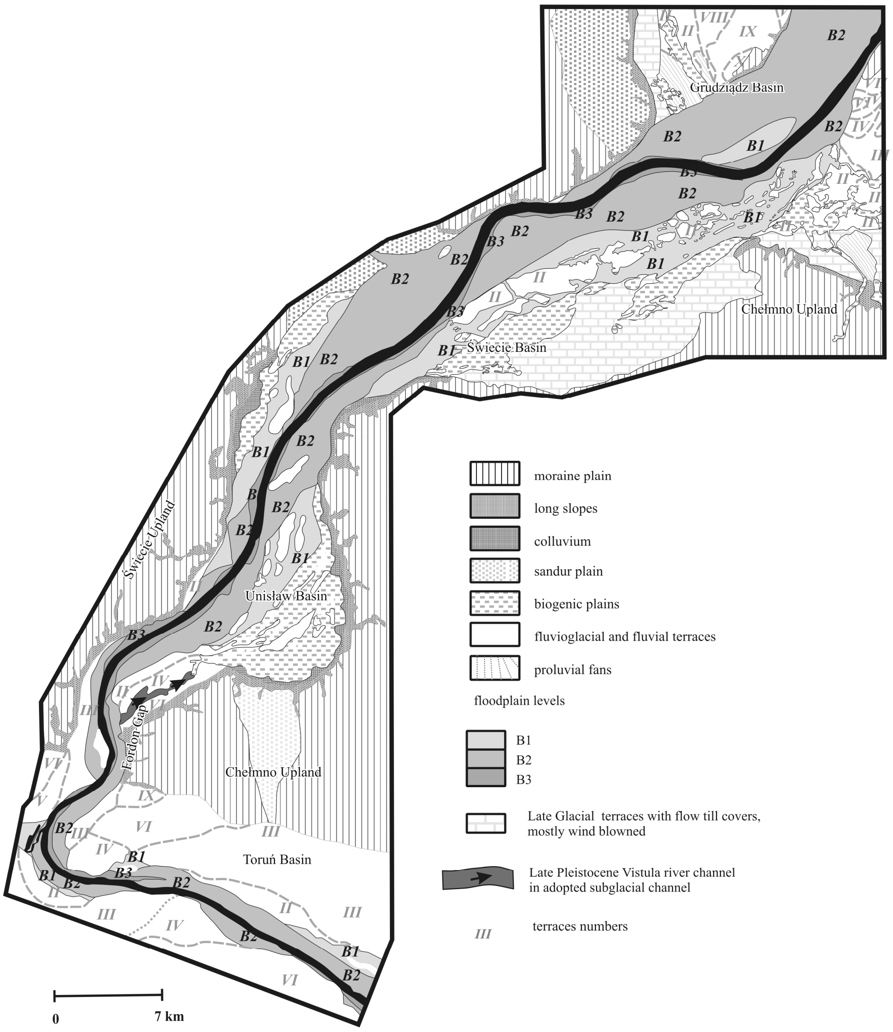

Fig. 1: Outline of the lower Vistula River valley.

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The lacustrine Weichselian Late Glacial to Holocene succession of the Niedersee (Rügen, Baltic Sea) – new results based on multiproxy studies

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The locality of the Niedersee, situated directly on the south-eastern cliff line of the Jasmund Peninsula (Isle of Rügen, Baltic Sea), is a classical Late Glacial site, which was yet studied by STEUSLOFF (1937), BOEHM-HARTMANN (1937) and KRASSKE (1937). The small depression of the Niedersee (kettle hole) is part of the glacially formed landscape of Rügen which can be traced back to the activity of the Weichselian ice sheet. The Niedersee reveals an excellent archive for palaeoenvironmental and palaeoclimatic reconstructions. Here, a new research were performed which allows for a more detailed and precise knowledge of the local development during the Late Glacial and early Holocene, and which provide also another tessera for a better supra-regional understanding. All in all, the sedimentary section of the Niedersee outcrop is characterized by lacustrine deposits of a small, shallow lake ranging from the the Weichselian Late Glacial to the Preboreal of the Holocene (~15,000 – ~10,000 cal. yr. BP). Sediments younger than Preboreal are present, but not certainly datable because of pollen corrosion. Dating is based on pollen analyses, AMS ^{14}C measurements, and the proof of the Laacher See Tephra (LST). It became obvious that the Niedersee section presents also an exceptionally complete sedimentary archive of the latest Weichselian, which includes the Meiendorf, Bølling and Allerød Interstadials. The rich pollen and macrofossil assemblages (e.g. plant remains, molluscs, ostracods) of the sediment samples reflect the changing climate and its influence on the regional palaeoenvironments. In general, the vicinity of the Niedersee was more or less characterized by open vegetation with tundra and steppe elements during the Weichselian Late Glacial. Increasing values of thermophilous elements within the vegetation and the fauna are distinctly recognizable during the Allerød Interstadial and then again with the beginning of the Holocene. In contrast to sections located further south (e.g. Brandenburg) the climatic signal of the Younger Dryas cooling event is remarkable stronger within the pollen spectra.

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Hydrological changes in the Mecklenburg Lake District (NE-Germany) during the last 1000 years

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The young morainic landscape in NE-Germany is characterized by a genetically mean developed heterogeneous river network. River valleys of different size are characterized by drainage patterns eighter in northern direction to the Baltic Sea or to southern direction to the North Sea. It comprises closed and drained lakes of different size, genetic background and hydrological conditions (KAISER et al. 2007). Previous investigations represent an important general overwiew of the Holocene hydrological evolution in particular regions of Europe based on a millenium scale and derived from separated investigations on fluvial and lacustrine systems (MAGNY 1992, STARKEL et al. 2006). However investigations focusing on different Holocene timeslots integrating geoscientific and archaeological records provide an opportunity to improve and refine these palaeohydrological models, reveal new insights of settlement and behaviour patterns within lake and wetland areas and provide important data for detecting (dominating) control mechanisms (climatic/anthropogenic) of hydrological changes (MAGNY 2004). While prehistorical human impact is negligible the increasing and asynchronous development of the cultural landscape since medieval times becomes apparent for northern Central Europe and leads to a superimposition of natural climatic and anthropogenic influences on the regional hydrological system. The aim of our compilation of old and new data is to deduce a geoarchaeological model of the Late Subatlantic palaeohydrology and -hydrography of the Mecklenburg Lake District in NE-Germany based on an integrative analysis of morphological, sedimentological, palynological und archaeological parameters, while natural and anthropogenic influences on the regional hydrological system are discussed.

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A depositional model for the Middle Pleistocene succession of Schöningen, NW Germany: Facies analysis, seismic stratigraphy and 3D subsurface modelling (GoCAD)

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Schöningen is one of the most important archaeological sites in Central Europe, where several Lower Palaeolithic artefacts have been discovered, including the famous hunting spears (Thieme, 1997). The open-cast mine Schöningen is located in the western rim-syncline of the Offleben saltwall. The ~45 m thick Pleistocene succession comprises deposits of the Elsterian and Saalian glaciation, separated by Holsteinian interglacial deposits. The Middle Pleistocene deposits are overlain by Eemian deposits and Weichselian loess.

Although much work has been done on the biostratigraphy and palynology of Middle and Late Pleistocene interglacial deposits, the depositional environment, their stratigraphic correlation and absolute age is still controversially discussed (e.g. Mania, 1995, Urban, 2007). We will document the stratigraphic evolution and internal facies architecture of the glacigenic and interglacial sedimentary succession and propose a new depositional model summarizing facies features, depositional processes and architectures. The outcrops were characterised from vertical measured sections and two-dimensional photo panels of outcrop walls. To reconstruct the larger-scale depositional architecture two shear-wave seismic lines were measured. Well data, outcrop data and geophysical data were integrated into a 3D geological model (GoCAD).

Palaeogene deposits are unconformably overlain by glacial Elsterian deposits that are restricted to an elongate, up to 1000 m wide, NNW-SSE-trending basin. The basal Elsterian succession consists of 5-17 m thick, cross-stratified sand and gravel, interpreted as glacilacustrine meltwater deposit. These meltwater deposits are overlain by up to 12 m thick massive diamicton, representing subglacial till. The till is locally overlain by glacilacustrine silt, sand and gravel. During the Holsteinian interglacial deposition took place within an NNE-SSW-trending, elongated lake, which was about 700 m wide and 2400 m long. The up to 5 m thick lacustrine deposits consist of peat and silt alternations, which can be subdivided into four shallowing-upward successions. These successions are interpreted as representing lake-level fluctuations caused by changes in precipitation and surface run-off, probably related to climatic variations. Palaeoflows were from north-westerly directions, suggesting that topography was similar to the modern topography. During the Saalian Drenthe glaciation, the succession was unconformably overlain by 3-7 m thick sand and gravel, which were deposited by high-energy meltwater flows in a glacilacustrine basin that was filled during glacier advance. The Drenthe deposits have the most widespread distribution and occur almost across the whole study area. These deposits became subsequently overlain by a 1-3 m thick subglacial till and are strongly deformed. Well data indicate the presence of younger interglacial lacustrine deposits that are probably Eemian in age and overly the Drenthe till. These deposits are up to 5 m thick and occur in an elongate, N-S-trending basin, which is 2200 m long and 700 m wide. The Middle Pleistocene succession is draped by loess of probably Weichselian age.

Our study implies that the sedimentary succession of Schöningen was in large parts deposited within a glacilacustrine and interglacial lacustrine environment (Lang & Winsemann, in review). The depocentre of this basin trends parallel to the salt wall and probably remained underfilled until the Saalian glaciation. The deposition and preservation of such a thick succession point to deposition within a relatively long-lived basin, probably related to a reactivation of salt structures by the advancing ice sheets.

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Nord Stream: secure gas supply for Europe

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The demand for natural gas in the European Union has seen a steady year-on-year increase over the past decades. At the same time the domestic supplies of the EU are running out. The existing network of import pipelines does not provide sufficient transport capacity to cover this supply gap. Therefore, OAO Gazprom (Russia), E.ON Ruhrgas AG (Germany), BASF SE/Wintershall Holding AG (Germany) and N.V. Nederlandse Gasunie (Netherlands) have joined forces to build Nord Stream – a new pipeline route for natural gas through the Baltic Sea. This will provide the European Union with an additional import system for additional volumes of natural gas.
Nord Stream AG plans to have the first of two parallel pipelines operational in 2011.
Each line is 1,223 kilometres long, providing a transport capacity of some 27.5 billion cubic metres (bcm) per year. Full capacity of about 55 bcm per year will be reached in the second phase, when the second line goes on stream. As a cross-border project, Nord Stream is subject to international conventions and national legislation in each of the countries through which it passes. It has invested 100 million Euros in environmental studies and planning and an Environmental Impact Assessment (EIA) was completed along the whole pipeline route.
Nord Stream has surveyed 40,000 line kilometres of the Baltic Sea in comprehensive geophysical and radiometric investigations. These investigations have shown that environmental impacts are temporary and of minor significance. Multiple munitions surveys are ensuring safe routing - about 80 munitions have been identified in the Finnish and Swedish EEZ and the Russian waters. Most of them have been already cleared by now.
The project is well on track – construction of the Nord Stream Pipeline has started in April 2010, with the first pipeline operational in 2011. The second pipeline will go on stream in 2012.

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Decay of the Late Weichselian Peipsi-Pskov ice stream in eastern Estonia

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There were two major Late Weichselian ice streams operating in Estonia during the decay of the Scandinavian Ice Sheet: the Riga ice stream in the west and the Peipsi-Pskov ice stream in the east. Between these two a small Võrtsjärv ice stream operated temporarily. In the east the Peipsi-Pskov ice stream bordered with the large Ladoga-Ilmen-Lovat ice stream and its smaller ice lobes (KALM 2010).

Flow direction of the Peipsi-Pskov ice stream was from northwest to southeast and partly followed the Peipsi bedrock depression. During the relatively rapid deglaciation (150 m/yr; HANG 2001) there were periods of ice front stagnations, traceable in current relief as ice-marginal formations. Five major zones of ice-marginal formations are usually distinguished in Estonia (RAUKAS et al. 2004, KALM 2010), which, in order of deglaciation are: Haanja, Sakala, Otepää, Pandivere and Palivere.

Often the ice-marginal zones are denoted on maps with continuous lines, although the age of their formation has not necessarily been synchronous. Along the major ice-marginal formations many smaller and sometimes diffusely located glacial radial and marginal landforms can be mapped with the help of satellite imagery and SRTM (Shutter Radar Topography Mission) digital elevation model (KALLA 2010).

Radial glacial bedforms show clearly the direction of ice flow during its final decay in the region. Based on the detailed ice-flow pattern of the Peipsi-Pskov ice stream the deglaciation chronology of the region needs to be updated. Our database for timing of the decay of the Peipsi-Pskov ice stream includes altogether 40 datings (14C and OSL age estimations). All of them are as upper-limiting ages of deglaciation. From location of the dated sites and the upper-limiting nature of the ages we derived deglaciation periods for the zones between the major ice-marginal formations in the area of Peipsi-Pskov ice stream: Haanja Heights (outside of the Haanja ice-margin) – 13-14.9 ka; zone between the Haanja and Otepää ice-marginal positions – 13.3-14.9 ka; zone between the Otepää and Sakala ice-marginal positions – 12-14 ka; zone between the Sakala and Pandivere ise-marginal positions – 12.7-13.9 ka; zone between the Pandivere and Palivere ice-marginal positions – 12.2-13.9 ka (Fig. 1).

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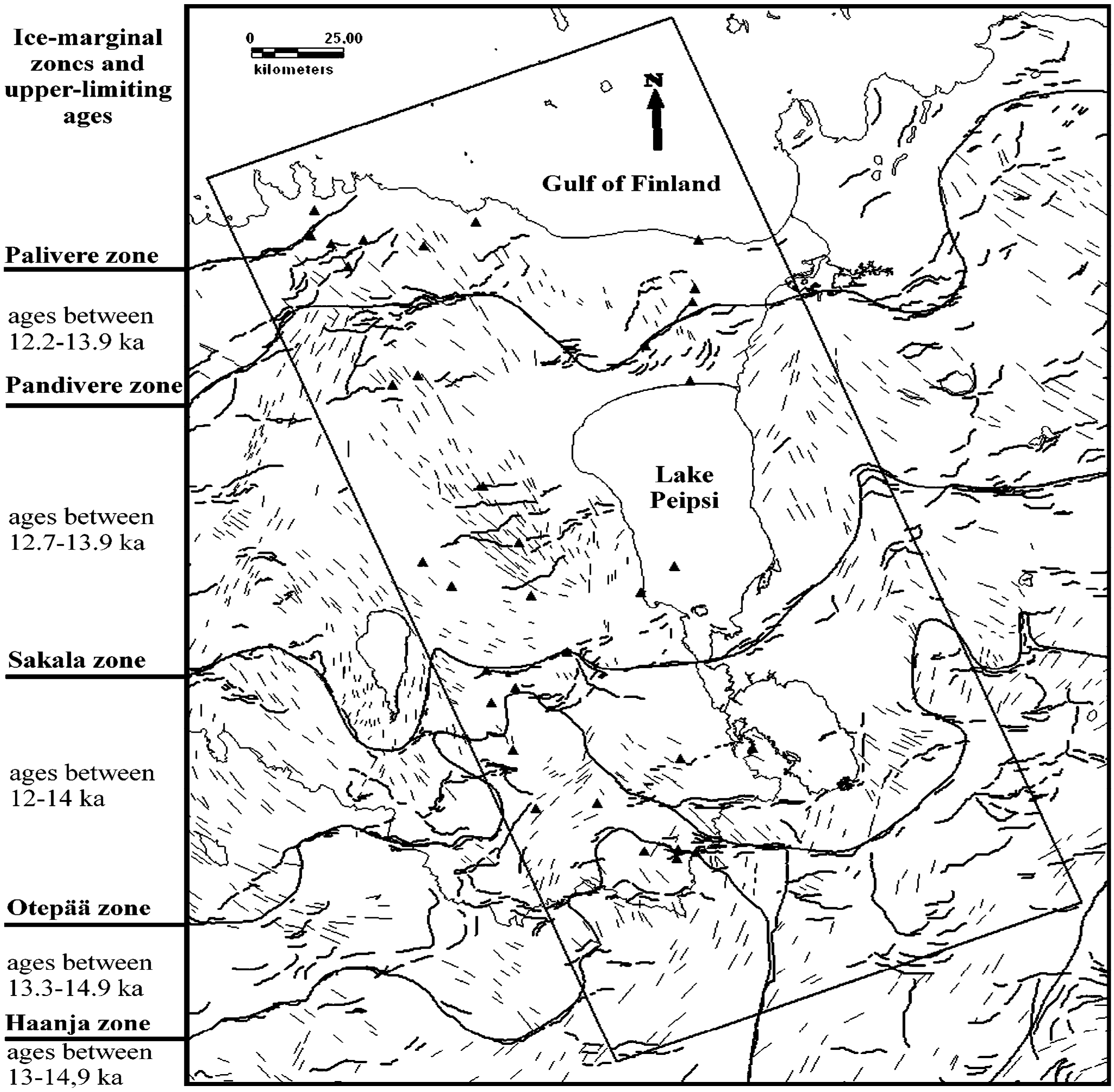

Fig. 1: Major ice-marginal zones with smaller glacial marginal and radial landforms. Upper-limiting ages in the area of the Peipsi-Pskov ice stream (▲- dated sites).

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Postglacial period of intensive freshwater Tufa precipitation in the region of Scandinavian glaciation

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The aim of this work is to determine the distribution of freshwater calcareous tufa deposits in time and substantiate the reasons of the beginning and decline of its precipitation after the last glaciation. Calcareous tufa is defined as a freshwater deposit of calcium carbonate, which precipitates in course of the loss of carbon dioxide from the aqueous solution. Tufa deposits are common in the Quaternary and older successions of Northern Europe (BARTOSH 1976, GOUDIE et al. 1993) but they are most characteristic to interglacial conditions with generally warm and humid climate when biological activity in lakes and springs is high. After the last glaciation the most intensive tufa formation occurred in the Early- and Middle Holocene but at present the tufa precipitation continues only in few exceptional locations.
We collected available in literature and our own unpublished data on directly dated freshwater tufa sections within and outside of LGM (Fig. 1). From this information we may conclude that in the glaciated areas the tufa deposition started few thousand years after the deglaciation. There are some indications in the literature (MAKHNACH et al. 2004) that the permafrost may have hindered the tufa precipitation after the deglaciation. There is ca 2000 yr interval (7400–9400 cal yr BP) when the tufa precipitation was most intensive and took place in the majority of the tufa distribution sites. Only in few overgrown lakes the tufa precipitation ceased already before this time interval. The tufa-dominated episode of deposition in lakes and ponds coincides with the rapid increase of ambient temperatures, derived from pollen (HEIKKILÄ & SEPPÄ 2003) and NGRIP data. This period coincides with increased evaporation and photosynthetic activity of aquatic plants and obviously required groundwater, rich in dissolved calcium carbonate. For the period of most intensive tufa precipitation the atmospheric CO_2 concentration has reached its typical pos-glacial values of 260-270 ppmv (MONNIN et al. 2001). Tufa deposition started to cease with the temperature downtrend and increased humidity in the Middle Holocene. After the Holocene climatic optimum paludification and overgrowing of lake shores intensified, which lead to decrease in water pH and thus hampered the tufa deposition.

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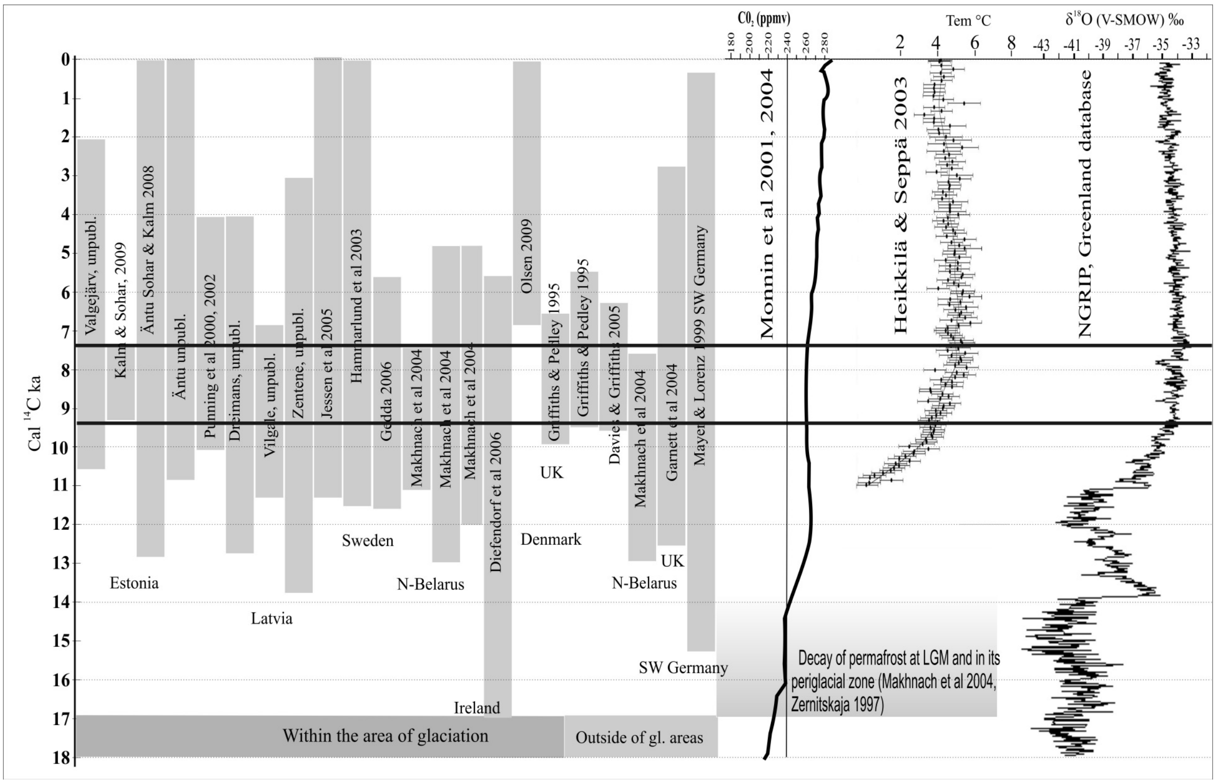

Fig. 1: Distribution of directly dated freshwater tufa sites in Europe and comparative graphs of CO_2 concentration (MONNIN et al 2001. Atmospheric CO_2 Concentrations Over the Last Glacial Termination. Science. 291.112 -114. MONNIN et al 2004. Evidence for substantial accumulation rate variability in Antarctica during the Holocene, through synchronization of CO_2 in the Taylor Dome, Dome C and DML ice cores. Earth and Planetary Science Letters 224. 45-54.), palaeotemperature (HEIKKILÄ, M. & SEPPÄ, H. 2003. A 11,000-yr palaeotemperature reconstruction from the southern boreal zone in Finland. Quaternary Science Reviews 22: 541-554.), $\delta^{18}O$ concentration (http://www.iceandclimate.nbi.ku.dk/data/). Horizontal bold black lines indicates the time interval when precipitation of tufa is observable in most section.

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Large scale architecture of a Holocene spit system – the stratigraphie of northern Sylt (southern North Sea)

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The barrier system of Sylt is part of the island chain that lines the coast of the southern North Sea. Sylt consists of a Pleistocene (Elsterian and Saalian) moraine core and two barrier spits, attached to the north and south. This study is focused on the northern barrier spit. Numerous studies, dealing with development and stratigraphy of this spit system, were published in the past. All are based on sediment cores drilled in the first third of the 20th century. In contrast, this study focuses on an extensive ground-penetrating radar survey and sediment core data, allowing a spatial interpretation of sediment geometries and facies distributions. A new stratigraphic framework for the northern barrier spit of Sylt is presented, showing that the spit has undergone a much more complex development during the latest Holocene than previously thought.

In parts the recent spit is underlain by coarse grained sediments showing northeastward dipping large scale foresets, which are interpreted as sediments of a former flood delta. The spit itself consists of a swash-bar sequence in the western part, facing the open sea, and up to 3 m thick washover fans towards the backbarrier bay (LINDHORST et al., 2008). Individual architectural elements are bound by extensive erosional unconformities and are interpreted to reflect the sedimentary signature of severe storms and subsequent spit recovery. The northernmost termination of Sylt is formed by a hooked spit, the so called Ellenbogen, which is much younger than the recurved main spit (LINDHORST et al., 2010). Here, beach-drift sedimentation allows for an ongoing spit progradation. The sedimentary architecture of Northern Sylt nowadays, is the result of several stages characterized by either spit growth or erosion, and reflects sea-level fluctuations as well as strong climatic impacts. The data also reveals that the present-day shoreline of the northern spit does not reflect the orientation of the genetically build spit axis which strikes northwest – southeast.

GPR and sediment-core data allow proposing a model of spit evolution, summarizing the development of northern Sylt since around 5000 BP. This model challenges the nowadays widely accepted hypothesis of a constant coastal retreat of northern Sylt during the last 5000 years. Former eolian deflation surfaces, preserved as erosional unconformities, indicate that the land surface of the spit tends to be in equilibrium with a given sea level (LINDHORST et al., 2008). This results either in erosion, during falling stages of the sea level, or in vertical aggradation, during periods of sea-level rise. As sediment availability is an important prerequisite for spit aggradation during base-level rise, artificial stabilization of migrating dunes and exceptionally high coastal dunes, preventing sand blow-out from the beach therefore reducing vertical spit aggradation during sea-level rise.

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Two striking push moraines: Peski/Belorussia and Jasmund/Rügen Island, NE Germany – common features and differences

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Structure, architecture and formation of the push moraine near Peski (Belorussia) are described according to LEV-KOV 1980 and oral communication in 1996. The Peski site is compared with the push moraine on the Jasmund peninsula (Germany, Rügen Island). It is common to both push moraines, that above a shearing zone within the chalk sequence the Upper Cretaceous and Pleistocene sediments - at Peski Tertiary sands additional - are glacigenous folded and faulted (imbricate structures). The ice rafted folds and slabs in both push moraines resemble to a great extend, while the architectures are fundamental different. Near Peski an arch-shaped zone of ice-pushed ridges has developed at the front of an extensive lobe of the inland ice, but in the Jasmund peninsula region an elevated area must have split the ice stream which followed the Baltic Sea depression into two parts which initially have flown around the elevation and the first ice pushed ridges (temporary nunatak). Therefore the glacigenic compression at Jasmund has started from the flanks of two ice tongues. The interpretation as an acute notched push moraine ('Kerbstauchmoräne') is compared with the idea of a firstly loop-shaped installed zone of ice-pushed-ridges, which have been reshaped by the ice later on.
Furthermore the geological position of both push moraines is discussed in relation to the fault structures below the Quaternary cover as well as to the repeated tectonic reactivations of these faults up to the Pleistocene period. The youngest vertical movements partly may have been released or strengthened by glacio-isostatic loading and unloading.
The glacigenous deformation near Peski is ascribed to the Sosch- (Warthe-) ice advance, but the formation of the Jasmund push moraine is classified as a Weichselian event (post Brandenburg phase). Characteristic of both events is that they followed a glaciation's climax after the maximum ice sheet propagation, just as is real for the formation of other push moraines in Belorussia and in southwestern part of the Baltic Sea. Obviously these declining climatic periods had provided exceptional soil physical conditions for ice effects on the underground.

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The stratigraphy and chronology of Late Pleistocene fluctuations of the Scandinavian ice sheet in parts of Rügen and western Mecklenburg

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Research into the extent and chronology of the fluctuations of the Scandinavian Ice Sheet (SIS) has been conducted for > 150 years, yet the general pattern and timing of SIS advances is only understood in a few areas, also referred to as type sites that are spaced apart by several hundreds of kilometres. Thus, a realistic and full understanding of ice sheet dynamics and its response to, and interactions with, palaeo-climatic conditions during the last glacial cycle (c. 110-11.5 ka) is still very incomplete. This is largely due to a pronounced lack of chronology in several parts of the Northern European Plain (NEP) around the Baltic Sea Coast, in turn the result of the absence of suitable material for most dating methods.
We here present the first results of detailed sedimentological logging and optically-stimulated luminescence dating of glaciolacustrine and glaciofluvial sediments intercalated with subglacial sediments exposed along selected cliff exposures on the Isle of Rügen and in western Mecklenburg. The aims of our work are to (a) establish the approximate ages of deposition of glaciofluvial and glaciolacustrine sediment facies thereby (b) bracketing the intercalated subglacial facies which are currently correlated by means of fine-gravel analysis, which we have also conducted. By placing these results in a wider regional context, we hope to elucidate (c) the nature and timing of marginal fluctuations of the SIS at a number of key localities.
Our findings indicate that earlier ideas of slow ice sheet response may require careful re-evaluation.

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Streamlined hills and channel systems in the Münsterland Embayment: evidence for catastrophic drainage of glacial Lake Weser

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Lake outburst related landforms have been studied in numerous examples from the last glaciation. However, examples from older glaciations are rare.
In this study we will document lake-outburst related streamlined landforms and channel systems in the Münsterland Embayment that formed during the catastrophic drainage of glacial Lake Weser.
Glacial Lake Weser drained catastrophically into the Münsterland Embayment as the western ice dam failed, probably releasing up to 100 km3 of water within a few days or weeks (Winsemann et al., subm.). The peak discharge was probably larger than 1x106 m3/s. Geographic information systems (GIS) and high-resolution digital elevation models (DEM) were used to map streamlined landforms and channel systems in front of lake overspills. Geological maps, 2450 well logs and the DEM were integrated into the 3D modeling program GOCAD to reconstruct flood-related palaeo-topographic surfaces and the internal facies architecture of streamlined hills.
Plunge pools are deeply incised into Mesozoic basement rocks and occur in front of three major overspill channels. The plunge pools are up to 780 m long, 400 m wide and 35 m deep. 1 – 10.5 km downslope of the overspill channels fan shaped arrays of streamlined hills are developed, covering an area of 60 – 130 km2, each, indicating rapid flow expansion at the mouth of the overspill channels. The hills commonly have quadrilateral to elongated shapes and formed under submerged to partly submerged flow conditions, when the outburst flood entered a shallow lake in the Münsterland Embayment. Hills are up to 4300 m long, 1200 m wide, 11 m high and have characteristic average aspect ratios of 1:3.3. They are separated by shallow, anabranching channels in the outer zones and up to 30 m deep channels in the central zones.
V-shaped chevron-like bedforms occur in marginal areas, approximately 4 - 9 km from the channel mouths. These bedforms have apices facing upslope, are 1.6 - 4 km long, 3 - 10 m high, and 0.8 - 2.7 km from limb to limb, with limb separation angels of 15 - 45°. Chevrons are interpreted to represent a combination of depositional and erosional bedforms that probably formed under supercritical flows spreading out from major channels.
We hypothesize that the post-Saalian landscape evolution of the Münsterland Embayment has considerably been influenced by catastrophic floods of glacial Lake Weser creating large trench-like valleys, which subsequently became the new site of river systems.

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Recent equivalents in Central Asia of Pleistocene glacial gastropod faunas of the Central European region and their significance for palaeo-zoogeographical and palaeo-ecological statements

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The study is based mainly on the assumption that analogies with the ecosystems of the glacial period in central Europe will not be found in the far north of Europe or in Northern Asia but are to be expected much further south in the cooler continental regions of central Asia. The molluscs of the glacial period in central Europe differ considerably from present-day, sub-polar mollusc findings due to the occurrence of a series of steppe varieties. These also include the xerothermous type *Pupilla triplicata* which has been found from recent times in central Asia as well.

In this context, it is also significant that glacial period index species of molluscs, e.g. *Vallonia tenuilabris, Vertigo pseudosubstriata* or *Pisidium stewarti*, which were first described from the Quaternary in central Europe, have surprisingly been discovered decades later in central Asia. Other "living fossils", such as recent evidence of *Pupilla loessica,* were therefore also to be expected.

Corresponding comparative investigations of Pleistocene central European and recent central Asian faunas have not previously been available. Therefore this contribution follows a new path to shed light on the history of the Quaternary environment in Europe.

The basis for this study was the numerous recent collections of central Asian gastropod biocenoses from the Tien Shan (Kirghizia, Kazakstan), the Russian Altai and the Baikal region (Russia) and from northern Mongolia. Mollusc material was also examined from the Quaternary (middle and late Pleistocene) from central Asia, especially from S Tajikistan, S Kazakstan and northern China.

Because of varying conceptions of the systematics in some of the groups of gastropods in central Asia, it was necessary for the objective comparison desired between recent and fossil faunas to undertake partial revisions, entailing not only shedding new light on zoogeographical problems but also the description of new species. The varieties concerned were, *inter alia*, the Vertiginidae, Pupillidae and Valloniidae and, because of up-to-date revisions, e.g. the *Vallonia* species.

New insights into the Vertiginidae relate, above all, to the distribution of *Vertigo substriata, V. lilljeborgi, V. genesii, V. geyeri, V. alpestris* and *V. parcedentata* in central Asia. The current zoogeographical data on these species which, until very recently, were considered "endemic to Europe", are of very great importance for interpreting paleo-zoogeographical processes in the Eurasian area (MENG 2008 b).

In the case of the Pupillidae, *Pupilla alluvionica, P. altaica* and *P. seminskii,* for example, were described anew. The distribution was mapped of a form of *Pupilla* previously not described for central Asia, the shell morphology of which corresponds to the central European glacial period index species *P. loessica*. It would appear that this is a "living fossil".

The main distribution of *P. loessica* is in the SE Altai which is more strongly continental (MENG & HOFFMANN, 2008, 2009 a, b).

For a concrete comparison of Pleistocene glacial faunas from the central European region with recent faunas in central Asia, the author chose the example of mollusc associations containing *Vallonia tenuilabris. V. tenuilabris* is one of the most widespread glacial index species in the Pleistocene of the central European region and occurs as a recent species adapted to low temperatures e.g. also frequently in central Asia. Focussing on *V. tenuilabris* and its accompanying varieties offered a practicable opportunity for a representative comparison between fossil and recent faunas adapted to low temperatures. It was thus possible to show that the Pleistocene glacial faunas of central Europe are very closely related to recent faunas in the southern Taiga belt (Altai, N Mongolia, Baikal region).

The recent habitats of *V. tenuilabris* in central Asia are, as expected, in areas with average annual temperatures markedly below 0°C. Although the preferred types of habitat ranged from mesophilic meadows and sparse woods up to the more humid alpine regions, this species showed a clear preference for more humid habitats such as marshes, meadowland and lake shores, humid meadows and alpine tundra. For the interpretation of the fossil biotic communities, this implies that *V. tenuilabris* does not constitute, as so often assumed, an obvious index species of glacial steppes but was much more predominant in more humid, glacial periods or more humid habitats (MENG 2009, HOFFMANN et al. submitted).

The gastropod material examined from the Quaternary (middle and late Pleistocene) from central Asia, especially from S Tajikistan and S Kazakstan, provides significant grounds for discussing the paleo-zoogeographical conditions in central Asia and the specific issues typical for the paleo-arctic region as a whole. Comparing central European and central Asian Pleistocene faunas, it is evident that endemic species predominate in central Asia, something that could be related to a higher aridity in these areas. More widespread paleo-artic or holarctic species, which also occur frequently in glacial habitats in central Europe and among the corresponding biocenoses in the central Asian mountains today, are markedly under-represented there.

New descriptions were undertaken of *Vallonia ranovi* from S Tajikistan and of *Pupilla talassika* from S Kazakstan (MENG 2008 a, MENG & GERBER 2008).

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Geopotenzial Deutsche Nordsee, Modul B: Ablagerungen, Baugrundverhältnisse und mineralische Rohstoffe des deutschen Nordseegebietes - Ziele, Sachstand und erste Ergebnisse

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Nach Ablauf des ersten von insgesamt vier Projektjahren wird ein erster Statusbericht über den Sachstand der bisherigen Arbeiten und die ersten Ergebnisse gegeben. Ein Ziel von Modul B ist die flächendeckende Klassifizierung der Sedimente am Meeresboden anhand von Korngrößenuntersuchungen aus Kastengreiferproben und Bohrproben. Für die zu bearbeitende Fläche von 41,100 km^2 wird der erste Entwurf einer Sedimentverteilungskarte am Meeresboden präsentiert, der eine Fortschreibung und in Teilbereichen Erweiterung des bestehenden Kartenwerks des BSH nach FIGGE sowie älteren Darstellungen nach FOLK abbildet. Insgesamt wird der Weg von höchst heterogenen Datenbeständen in Bezug auf Datenquellen, Datendichte und Datenqualität bis hin zu einer arbeitsfähigen und konsistenten Datengrundlage und deren Auswertung aufgezeigt. Ein wesentlicher Aspekt besteht dabei in der Kombination von Laboranalysen und parametrisierter Schichtinformationen aus Bohrungen.

In einem zweiten Arbeitspaket werden in ausgewählten Bereichen der Deutschen Nordsee auf der Grundlage von flachseismischen Daten und Vibrokernen des BSH und des Geozentrums Baugrundschnitte bis 50 m Tiefe mit exemplarischer Bedeutung für größere Areale erstellt. Noch diskutiert werden Überlegungen, auch den Schichtaufbau der obersten 6 Meter in hoher Auflösung darzustellen.

Zusätzlich werden erste Tendenzen aus Modul C – Geologische Grundlagen und Meeresspiegelentwicklung vorgestellt. Mit Datierungen aus tiefen Bereichen der Nordsee lassen sich im Küstenraum entwickelte Meeresspiegelkurven bis in den Zeitabschnitt 11,000 bis 8.000 yr. BP verlängern. Diese Daten finden Eingang in zahlreiche Modellierungen wie z.B. Meeresspiegelanstieg und isostatische Ausgleichsbewegungen, Paläoküstenlinien sowie Interpolationen in die Zukunft.

Zur kontinuierlichen Verbesserung der Datenlage werden im Verlauf des Verbundprojekts Schiffsausfahrten zur Gewinnung von Vibrokernen, Greiferproben und seismischen Profilen durchgeführt sowie weitere Daten externer Quellen genutzt und ausgewertet. Im Modul B arbeiten die Projektpartner Landesamt für Bergbau, Energie und Geologie (LBEG), Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) und Bundesamt für Seeschifffahrt und Hydrographie (BSH) eng verzahnt und sehr erfolgreich miteinander.

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High-resolution reconstruction of the Younger Dryas in NE-Germany based on varved lake sediments

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Varved lake sediments of the palaeolake Rehwiese, SW-Berlin, provide climatic and environmental information of the last Glacial to Interglacial transition (LGIT) in northeastern Germany on a sub-annual timescale. The lake basin of Rehwiese is part of a sub-glacial channel formed during the maximum ice advance of the Weichselian glaciation (Brandenburger Stadial). The lake was overgrown by peat in the younger Atlantikum to Subboreal at around 6 ka BP (PACHUR, 1988). Above basal sands of glacio-fluvial origin a ca 3 m thick sediment sequence of continuous biochemical calcite varves is developed, covering the time interval from the early Allerød to the onset of the Preboreal. A distinct volcanic ash layer has been correlated with the late Allerød Laacher See Tephra (LST), which has been dated at 12,880 varve years BP in varved lake sediments of Lake Meerfelder Maar, Eifel (BRAUER et al., 1999). A 1,400-year varve chronology with the LST forming the basal chronostratigraphic marker horizon has been established, comprising the late Allerød and the Younger Dryas (YD) until the onset of the Holocene. This represents the first varve chronology covering the entire Younger Dryas in eastern Germany. Pollen data provide biostratigraphical background for the classification. Two composite profiles taken in a distance of ca 20 m and consisting of two core sequences each have been compared in great detail through micro-facies analyses on large-scale thin sections allowing to define a series of distinct micro-marker layers. We thus were able bridge slightly disturbed section in one of the profiles with better preserved varves in the other. In addition, it was even possible to identify a minor gap of 15 varves in one of the sediment cores. In result a precise chronology has been established. Micro-facies analyses further allowed discussing even seasonal aspects of climate change during this time interval. This data set is complemented by additional micro-XRF element scanner data measured on impregnated sediment blocks (BRAUER et al., 2009) and TOC and C/N data. These multi-proxy data indicate a pronounced inter-annual and decadal-scale variability during the course of the YD. The Rehwiese sediment record will be compared in detail with the Meerfelder Maar varve data on the base of independent varve chronologies.

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The landslide database of Mecklenburg-Vorpommern and geohazard assessment at the Baltic Sea coast in NE Germany

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Several cliff slides that occurred at the coast of Jasmund/Rügen in 2005 were the starting point of field studies and landslide inventories to determine controlling factors of mass movements (OBST & SCHÜTZE 2006) and to evaluate the cliff stability (GÜNTHER & THIEL 2009). Nearly all steep cliff sections of the German Federal State Mecklenburg-Vorpommern have been observed since that. Mapping in selected areas, e.g. Groß and Klein Klütz Höved (west of Wismar Bay), Rerik-Meschendorf (west of Kühlungsborn), Stoltera (west of Rostock-Warnemünde), Fischland (between Wustrow and Ahrenshoop), Hiddensee (Dornbusch) and Wittow, Glowe, Jasmund, Dwasieden, Granitz and Mönchgut on the island of Rügen are the basis of building up a geohazard database. Herein, historical and recent slope failures and cliff collapses are documented and classified. At present about 500 landslides are included in the database. Most events occurred at Jasmund (167) followed by Mönchgut (81), Wittow (57), Fischland (41), Klein Klütz Höved (27), Dwasieden (27), Rerik-Meschendorf (23), Hiddensee (21), Stoltera (20), Granitz (15) and Glowe (11). The island of Usedom and the cliff of Groß Klütz Höved will be investigated later this year.

The inventory database comprises location, type, volume, activity and the date of occurrence for each landslide. Other parameters such as orientation and dip of the slope, position at the cliff and type of vegetation are also included, if determined. All these parameters are important for the GIS application and the modeling of the landslide susceptibility, i.e. a quantitative or qualitative assessment of the classification, type, volume or area. Susceptibility estimations on a local scale may also include descriptions of the velocity and intensity of existing or potential landsliding. Other data used for the GIS application derived from topographic and geological maps, pictures and drawings of outcrops, aerial photographs and digital elevation models. Critical cliff sections were additionally monitored using airborne and terrestrial laser scanning techniques. By interpreting multiple sets of aerial photographs or laser scanning data, multi-temporal inventory maps can be prepared (e.g. OBST et al. 2007).

One of the most important capabilities of GIS is the ability of the software to manage spatial data from different sources. An important point is that all in the GIS incorporated data remain available for editing and updating, for reproduction in form of maps or on-screen review, manipulation and querying and for GIS-based development and modeling of susceptibility. With the available data in place various methods can be applied to establish interrelationships and ultimately to establish levels of susceptibility and hazard.

Key vector data sets typically used in landslide zoning studies include landslide polygons, geology, geomorphologic and/or terrain units, cadastre, road, rail and utilities, land use and vegetation. Other data that can be imported may include borehole information, soil strength parameters, pore water pressures, rainfall etc. The key grid or raster data is the digital elevation model (DEM). GIS software can derive numerous data sets useful in landslide zoning from the DEM such as slope, aspect, flow accumulation, soil moisture indices, distance to streams and curvature to name only a few. A GIS model can be used to combine a set of input maps or factors using a function to produce an output map. The function can take many forms including linear regression, multiple regression, condition analysis and discriminate analysis etc.

Landslide inventories as well as geohazard analyses are needed to develop innovative concepts for coastal protection and new coastal zone management approaches. This also means that mapping and monitoring along the steep coast in NE Germany has to be done continuously by state geologist and in co-operation with universities and other research institutions.

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An integrated reconstruction of the Saalian glaciation in The Netherlands and NW Germany

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In MIS 6, around 170,000-150,000 years ago, large ice masses last covered The Netherlands and NW Germany (Saalian Drenthe Substage). It left many geomorphological features in the landscape, e.g. push moraines, sandurs and glacial basins. Throughout the 20th century extensive research has been done on this geomorphological assemblage and the sequence of glacial events, resulting in glaciation phase models (e.g. VAN DEN BERG & BEETS, 1987; EHLERS, 1990; RAPPOL, 1991; KLOSTERMANN 1992; SKUPIN et al., 1993). However, the various phase models each appear biased to specific features, subregions and types-of-data. Besides, new data and insights have risen since the construction of these models, starting to link proglacial with glacial features (e.g. BUSSCHERS et al., 2008; WINSEMANN et al., 2009).

Our research newly reconstructed the sequence of events during the Saalian, unifying the evidence in NW Germany with that in the Netherlands. We collected geological-geomorphological evidence (literature inventory) and new high-resolution elevation data in a inventory GIS. The GIS stores our newly constructed phase model, as well as earlier phase models. Our preferred reconstruction recognises four phases towards maximum ice-sheet extent, and a complex multi-phased deglaciation stage (ending with the Warthe Substage).

We present overview maps and will outline the elements of 'classic' knowledge and additional new lines of reasoning. We reviewed conceptual models of the phasing of events and related glaciological processes during the glaciation, responsible for the eventual ice-margin landscape. Improved structuring of data and insight regarding the phasing of the glaciation, contributes to better understanding of the glacial morphology and geology of the area and the processes that are involved. Besides new insight in the configuration of proglacial and deglaciation river and lake systems, it provides valuable data overview supporting regional quaternary geological studies (e.g. Province of Drenthe, Bregman, this conference).

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Under the Odra ice lobe, Weichselian glaciation: numerical experiments on groundwater flow, tunnel channels, and ice sheet stability

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A range of steady-state and time-dependent 3D numerical experiments has been carried out on subglacial groundwater flow under the Odra lobe, one of the largest ice lobes at the southern flank of the Scandinavian Ice Sheet during the last glaciation. The aim was to constrain the interactions between water, ice and sediment. Here we focus on the simulations of feedback mechanisms between the groundwater and channels at the ice-bed interface (IBI) that led to the formation of tunnel valleys abundantly occurring in the area and speculate on the influence of different drainage mechanisms on the ice sheet dynamics.

It is suggested that the subglacial channels formed at a late stage of glaciation triggered by the storage of meltwater at IBI that could not be evacuated to the ice margin as groundwater flow due to the relatively low hydraulic conductivity of the substratum. Channel formation triggered a dramatic re-organization of groundwater flow pattern. Once initiated, the channels served as discharge conduits for the groundwater generating multiple second-order catchments transient in time and space that captured a substantial portion of the subglacial groundwater before it reached the ice margin. This has led to the reduction of water pressure in the subglacial sediment and at IBI that possibly increased basal coupling, stabilized the glacier, and terminated ice streaming.

Spatial relations between the tunnel valleys and the hydrogeological characteristics of the bed indicate that subglacial channels preferentially formed where the hydraulic transmissivity of the bed was low. In these areas, due to high pressure gradients as indicated by our simulation, sediment injection into the channels and thus high erosion rates were particularly likely. The process of sediment evacuation by creep into the channel from below is confirmed by field observation elsewhere, which emphasizes the casual feedbacks between various elements of the subglacial system controlled by drainage-type-dependent water pressure distribution.

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Reconstruction of Holocene coastal foredune progradation using luminescence dating – an example from the Świna barrier (NW Poland)

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The two sandy spits of the Świna barrier (Wolin and Uznam) provide one of the most complete succession of Holocene coastal foredunes and dunes at the southern Baltic Sea coast. Therefore, the Świna barrier can be regarded as a key area to provide an insight into Holocene aeolian activity at the southern Baltic coast and the balance between the evolution of coastal foredune plains and coastal parabolic or trangressive dunes. Until now, the studies in this area have focused on the geomorphologic and geological investigations of the aeolian and coastal sediment succession (e.g. KEILHACK, 1912, 1914; BOR'OWKA et al., 1986; BOR'OWKA, 1990; OSADCZUK, 2002). However, from the chronological point of view, only a few radiocarbon ages of peat from the inter dune troughs are available (PRUSINKIEWICZ AND NORYŚKIEWICZ, 1966). Optically Stimulated Luminescence (OSL) dating is a powerful tool for the chronology of Holocene foredune plain development and dune activity because it estimates the time elapsed since the sediment last exposure to daylight. Hence, it gives direct depositional ages of the sediment bodies (e.g. foredunes or dunes).

The coastal sediments from the Świna barrier provide excellent conditions for OSL dating. The chronological data indicates that foredune progradation at the Świna barrier started soon after the fast sea level rise by the Littorina transgression slowed down at ~6.6 ka before today. A significant derease of foredune progradation rate occurred during the late Subatlantic transgression at ~1.2 cal. ka (800 AD). The progradation rate increased again during the "Little Ice Age" between 1550 and 1850 AD. Furthermore, the systematic dating of 28 OSL samples showed a negative correlation of foredune progradation with phases of aeolian activity in the surrounding area. The relationship between foredune progradation, coastal dune activity and the controlling factors (e.g. sea level, climate, human impact) will be discussed.

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Holocene development of the Baltic Sea in Tolkuse area, SW Estonia

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Southwestern Estonia in the eastern coast of Gulf of Riga is characterized by slow post-glacial isostatic uplift (about 1mm/yr) and slowly undulating low topography. Therefore even small increases in sea-level can easily lead to the flooding of substantial areas. The complex de-glaciation history of the Baltic Sea area, with up-dammed lakes and early phases of post-glacial seas has, at times, left southwestern Estonia submerged, while at other times, it emerged as terrestrial land. Therefore, transgressive deposition of water-laid sediments of the Ancylus Lake and the Litorina Sea have lead to repeated burial of soil, peat and gyttja deposits and associated settlement layers. Currently the Tolkuse mire at the coastal lowland of SW Estonian (Figure 1) was studied in order to reconstruct the shoredisplacement of the Baltic Sea and palaeo-environmental evolution of the area.
The Tolkuse mire (5500 ha) is locating between the Ancylus Lake and the Litorina Sea (Rannametsa) coastal ridges (Fig. 1). An 8 m long sediment core from the southern part of the mire, was investigated and preliminary results of lithostratigraphy, loss-on-ignition, diatom analysis and radiocarbon dates were used and applied with digital terrain model to reconstruct the evolution of the area. We discovered a 0.20 m thick peat layer buried under the layer of fine sand and gyttja which is covered by *Carex* peat (Fig. 2). Two radiocarbon dates from the buried peat layer indicate the pre-Litorina Sea lowstand at about 8.8-8.2 cal ka BP. This is the lowermost known buried peat layer in SW Estonia reflecting the pre-Litorina Sea low water level stage. Diatom analysis confirms that the silt layer below the peat contains large lake diatoms, such as *Ellerbeckia arenaria* and *Aulacoseira islandica*, typical to the Ancylus Lake freshwater environment. The sandy deposits above the peat contain already diverse assemblage of the littoral brackish-water diatoms indicating deposition in the Litorina Sea shallow lagoon. The sandy deposits are interbeded with thin peat layers characteristic to the transgressive sediments of the Litorina Sea found elsewhere in SW Estonia. Transgressive sands are covered by thick layer of gyttja deposits containing a mixture of planktonic and littoral brackish-water and marine diatoms suggesting basin with deeper water column and higher salinity. The gyttja is overlain by younger *Carex* type peat. The onset of peat formation is dated to ca. 4.2 cal ka BP (Fig. 2).

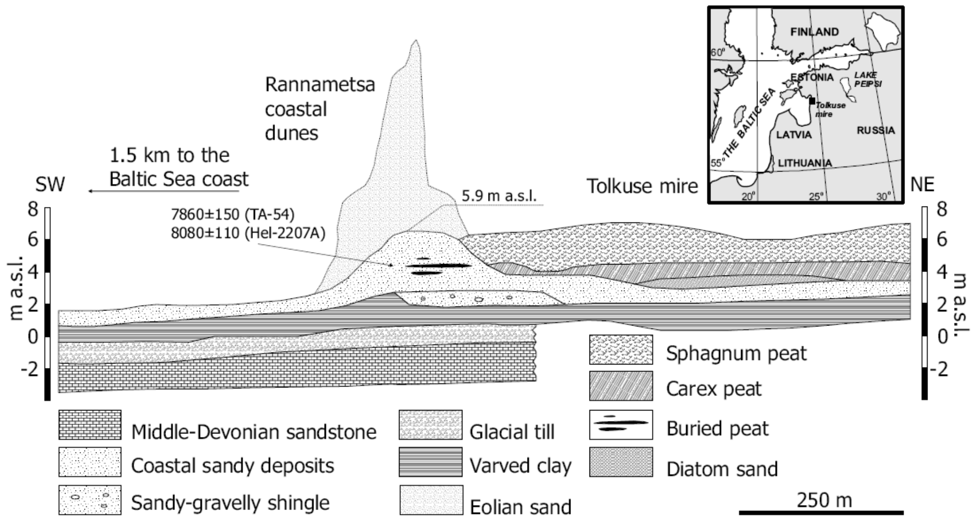

Fig. 1: Geological cross-section from the Rannametsa coastal landforms with datings (uncalibrated ^{14}C years) and Tolkuse mire (after HYVÄRINEN ET AL., 1992).

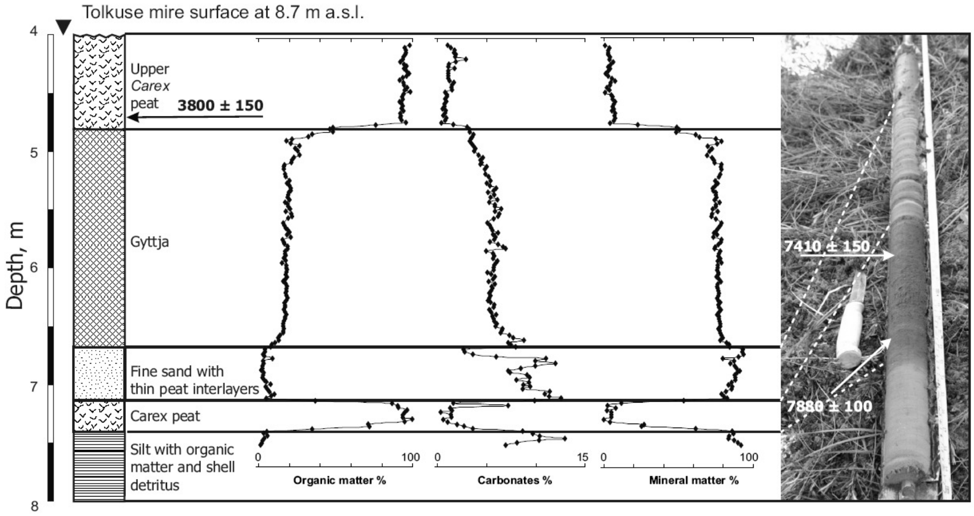

Fig. 2: Buried peat layer and results of LOI and radiocarbon dating (uncalibrated 14C years) from the Tolkuse sediment core from the 2009.

Palaeogeographic reconstruction shows that the study area has been flooded by transgressive waters of the Ancylus Lake at about 10.2 cal ka BP. and the palaeocoastline was located east of the Tolkuse mire at an altitude of 10-7 m a.s.l. During the Ancylus Lake regression the coastline retreated to the west from the Tolkuse mire and stopped probably close to the present-day shoreline (Fig. 1). HYVÄRINEN et al. (1998) described a section of peat and clayey gyttja (3-4 m a.s.l.) buried under the sandy deposits of the Litorina Sea at Rannametsa (Fig. 1). Earlier radiocarbon dates from Rannametsa and our dates from Tolkuse mire show the simultaneous formation of the buried peat deposits at about 9.0-8.2 cal ka BP and indicate the emergence and formation of wetland in Tolkuse area. The Litorina Sea transgression in the study area started at about 8.2 cal ka BP. During the transgression the coastal ridges at Rannametsa were formed damming up the Tolkuse lagoon. Sandy deposits alternating with thin peat layers were formed in the lagoon in shallow water conditions with active wave regime and erosion of older organic deposits. Stabilized shoreline position at Rannametsa during the transgression initiated probably the dune formation on top of the coastal ridge. At the time of the culmination of the Litorina Sea at about 7.3 cal ka BP, 20 km long and 5 km wide lagoon developed in Tolkuse area. The water-level in the lagoon was about 8 m a.s.l. in the north and about 6 m a.s.l. in the south and the water depth was up to 5 m. Our reconstructions show that Tolkuse lagoon had two passages: one in the north and another in the south. The northern passage was about 2 km wide and functioned initially as a main connection route with the Baltic Sea basin. Palaeogeographic reconstructions show that the northern passage was the first to close at about 6.0 cal ka BP due to the more intense land uplift. Radiocarbon dates from our sediment core suggest, that brackish water lagoon existed in Tolkuse area for 4000 years and terminated before 4.2 cal ka BP.

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Globale Korrelationen des tadschikischen vorletzten interglazialen Paläoboden-Komplexes nach MI Substadien und ein Vergleich mit Rheindahlen

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Einleitung

In den letzten 25 Jahren sind zahlreiche Löss-Boden Sequenzen von Aufschlüssen im Süden Tadschikistans von verschiedenen internationalen multidisziplinären Arbeitsgruppen untersucht worden. Es ist eine neue Geochronologie des Pleistozäns durch eine Korrelation mit marinen Sauerstoff-Isotopenstadien (MIS) vorgestellt worden. (z.B. FORSTER U. HELLER 1994; DING et al 2002)

Auf Grundlage dieser erfolgreichen paläoklimatischen Studien wurde von unserer Arbeitsgruppe der Aufschluss Chonako (Bezirk Chatlon/Tadschikistan) feinstratigraphisch untersucht und über MIS hinausgehend nach marinen Sauerstoff-Isotopen Substadien (MISS) untergliedert. Der vorletzte Interglazialkomplex (PK 2 – mit einer Mächtigkeit von 7 m und einem Alter von ca. 250 – 190 ka) wurde mit Proxidaten anderer Klimaarchive (Atlantik MD01-2447, Tenaghi Philippon, Baikalsee GC-1 + BDP-96-2, Atlantik ODP 980, Vostok) verglichen und einige Ergebnisse in J. SCHÄFER (2007) vorgestellt. Weitere Überlegungen betreffen nun Korrelationsmöglichkeiten mit (weniger vollständigen) Löss-Stratigraphien anderer Regionen. Aufgrund der Neugliederung der Aufschlüsse von Rheindahlen (NRW/BRD) durch W. SCHIRMER (2002) und der daraus resultierenden Zusammenfügung von drei Interglazialen zu einem differenzierbaren Interglazialkomplex (MIS 7) sowie verschiedener archäologischer Fundschichten bietet sich Rheindahlen als Vergleich an. Die Korrelation von Chonako III PK 2 mit anderen Klimaproxis sowie eine daraus abzuleitende neue geochronologische Interpretation von Rheindahlen sind Gegenstand des Vortrages:

Globale Korrelationen

Der paläoklimatische Vergleich mit den oben genannten Bohrkernen und der Juni -65 N Insolation führt zu folgendem Ergebnis:

1. Alle Datenserien zeigen drei Klimaoptima (MISS 7.1, 7.3 u. 7.5)
2. Das untere Klimaoptimum (7.5) ist vom mittleren (7.3) durch eine deutlich intensivere Kaltphase als das mittlere vom oberen (7.1) getrennt.
3. Die Kaltphase (MIS 7.4) korreliert mit einem Minimum an Insolation, einem Maximum an rekonstruiertem Eisvolumen sowie einem Abfall an arborealen Pollen und biogenem Silikat. In Chonako III PK 2 wird dies durch eine deutliche Akkumulation von Löss reflektiert.
4. Der Interglazialkomplex (MISS 7.1 bis 7.5) wird im Liegenden und Hangenden durch ausgeprägte Interstadiale (8.3 u. 6.5) von hochglazialen Bedingungen separiert.
5. Insbesondere das Interstadial MISS 8.3 zeigt eine Affinität zum MIS 7, die durch hohen Baumpollen- und biogenen Silikatanteil deutlich wird. Auch in Chonako III PK 2 zeigen sich Parallelen durch die Intensität des Interstadiales LI 3a.
6. Zusammenfassend möchten wir anmerken, dass neben hoch auflösenden Klimaproxis aus Bohrkernen auch terrestrische Untersuchungen feinstratifizierter Verwitterungshorizonte unsere Kenntnisse zur globalen Klimaentwicklung erweitern.

Korrelation mit Rheindahlen

Der geostratigraphische Vergleich mit Rheindahlen bestätigt im Wesentlichen die Neustratifizierung durch W. SCHIRMER (2002) gegenüber den älteren Gliederungen durch THIEME, BRUNNACKER & JUVIGNÉ (1981) oder J. KLOSTERMANN & J. THISSEN (1995). Aufgrund der feinstratigraphischen Unterteilung von Chonako III PK 2 nach MISS bietet es sich allerdings an, gegenüber W. Schirmers Vorstellungen einige Modifikationen mit folgendem Ergebnis vorzuschlagen.

1. Sowohl in Rheindahlen als auch in Chonako besteht der Bodenkomplex aus drei Klimaoptima, die weitgehend parallel dem gleichen Relief folgen.
2. Nach W. Schirmer ist in Rheindahlen der 1. Boden (Erkelenz Bt 2) vom zweiten (Rheindahlen Bt 3) durch Löss getrennt, während sich zwischen dem 2. und 3. Boden (Wickerath Bt 4) eine weniger deutliche Kaltphase zeigt. In Chonako ist dies umgekehrt (s.o. Punkt 2 u. 3).
3. Wir möchten Rheindahlen dahingehend neu gliedern, indem wir den 1. Boden mit dem 1. und 2. von Chonako korrelieren und MISS 7.1 und MISS 7.3 zuordnen. D.h. den 1. Boden von Rheindahlen betrachten wir als zweigeteilt.
4. Den 2. Boden von Rheindahlen (Rheindahlen Bt 3) korrelieren wir folgerichtig mit dem 3. Klimaoptimum von Chonako (MISS 7.5). Damit liegt der bekannte Kälterückschlag (Löss zwischen Erkelenz Bt 2 und Rheindahlen Bt 3) wie in Chonako 3 im MISS 7.4.
5. Der 3. Boden von Rheindahlen (Wickerath Bt 4) liegt nach Schirmer im MISS 7.5. Er ist aber deutlich weniger stark verwittert als beide hangenden Böden. Sein interglazialer Charakter im globalen Klimageschehen ist zu diskutieren. Wir sehen jedoch guten Grund ihn mit dem intensiven Interstadial MISS 8.3 zu korrelieren (s.o. Punkt 4 u 5).
6. Zusammenfassend lässt sich somit in Rheindahlen der oberste Boden (Erkelenz Bt 2) mit MISS 7.1 bis 7.3 und der mittlere Boden (Rheindahlen Bt 3) mit MISS 7.5 korrelieren. Der untere Boden (Wickerath Bt 4) korrelieren wir mit MISS 8.3.
7. Die archäologischen Funde und Befunde von Rheindahlen betrachten wir sowohl mit Schirmers Neugliederung als auch mit unserem Vorschlag als archäochronologisch abgesichert. Wir können damit weitgehend E.M. IKINGER (2002) bestätigen.

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Pedostratigraphy and climatic evolution of the Pliocene and Quaternary in the western Mediterranean

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Soil genesis proceeds during environmentally stable times without morphodynamic activity, and is related to humid phases with a dense vegetation cover, whereas contrary processes of soil erosion and sedimentation proceed during dry phases with opened vegetation (ROHDENBURG, 1970). In the western Mediterranean, cyclically alternating pedogenesis took place in the Pliocene (5.3-2.6 Ma) and continues in the Quaternary (since 2.6 Ma).

In the western Mediterranean (Spain), mighty fluvial fans in the Granada Basin contain 85 paleosols of different age, of which 65 developed in the Pliocene (GÜNSTER and SKOWRONEK, 2001). A fan on the Costa Blanca (south of Cabo Roig) assembles seven red fossil soils and seven calcrete complexes which have most likely developed during the Late Pliocene and the Early Pleistocene (WAGNER et al., 2010). A cliff profile near Vista Allegre (Ibiza) with 30 fossil soils (ROHDENBURG and SABELBERG, 1973) probably is of similar age. The large cliff profile Cala Penyes Roges (Mallorca, 28 m height, 1450 m length) comprises 38 soils which have developed during six interglacial-glacial cycles in the Quaternary (ROHDENBURG and SABELBERG, 1973). Near Colònia de Sant Pere (Mallorca) a fan in a low cliff formed in the Late Quaternary, as was confirmed by ROSE et al. (1999).

Our presentation relates to the stratigraphic and morphogenetic nomenclature of ROHDENBURG and SABELBERG (1973) based on the stratigraphy of loess series in Central Europe (KUKLA, 1969). It focuses on the pedostratigraphy of the above profiles with regard to soil colour (redness), calcretes, texture, Fe dynamics, chemical composition and micromorphology.

The pedostratigraphic record reflects pronounced soil development in the Early Pliocene (5.3-3.6 Ma) and the Early Quaternary (2.6-1.8 Ma), suggesting a sustained change between environmental stability and instability since the Pliocene. Fluctuations in temperature and humidity are obviously small. Active dune formation within the soil sediment sequences indicates arid and cool conditions during interglacial-glacial cycles. Generally, the soil formation intensity declined since the Middle Quaternary. Soil genesis is rather intense in the Holocene (since 11.7 ka). This mainly results from distinguished wet winter seasons with reduced evapotranspiration and pronounced dry summer seasons, and is further promoted by enhanced decomposition of organic material and intense chemical weathering (ROHDENBURG and SABELBERG, 1969). Such intense soil genesis is however overlapped by man-made soil erosion.

A distinct pedostratigraphy therefore reflects varying climatic conditions in the western Mediterranean. The according climate changes are however moderate in terms of both temperature and humidity in the Pliocene and Quaternary. Consequently, conditions of soil formation can distinctly change by rather small variations in climate. The climatic cyclicity affecting pedogenesis on one hand and erosion resp. sedimentation on the other is also approved by paleobotanical studies (WIEGANK, 1993).

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Habitat effect on oxygen isotope fraction in Holocene subfossil Ostracods

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Benthic ostracod carapaces (ca 0.5-2.0 mm in size) preserve well in freshwater calcareous sediments. Forming low-Mg calcite carapaces they use host water chemical components, and thus, reflect past water stable isotope composition and temperature. Ostracods crawl on sediments or swim above water body floor. Some species may consider as exobenthic species, swimming or crawling among aquatic plants. Thus, ecological preferences may affect the stable isotope fractionation.

The study material is from the Varangu tufa pit, northern Estonia. The annual air temperature of the region is +4.4 ºC (July temperature +16.1 ºC). The pure tufa (carbonate content ca 98 %) started to form in the paleolake at ca 9300 cal yr BP and the water body ceased at ca 7500 cal yr BP. Ostracod subfossils were picked out from 5 cm thick sediment layer (represents 60-80 years), aged ca 8500 cal yr BP. Subfossils of two species were the most abundant in studied material (*Pseudocandona rostrata* and *Metacyprs cordata*). Benthic ostracod *P. rostrata* is the cold-stenothermal species, found in lake and ponds fed by groundwater. Exobenthic summer form *M. cordata* prefers floating vegetation in eutrophic shallow-water habitats avoiding groundwater (DANIEOLOPOL et al. 1996; MEISCH, 2000). Subfossils of *P. rostrata* have the mean $\delta^{18}O_{V\text{-}PDB}$ -8.75 ‰ with the analytical precision ≤0.3 ‰ (SD = 0.34). The mean $\delta^{18}O_{V\text{-}PDB}$ of *M. cordata* calcite is -10.05 ‰ (SD = 0.64).

High dispersion of results of stable isotope analyses of *M. cordata* is caused by variability of the temperature and evaporation effect of the surface water. Current data show the groundwater temperature is constant in northern Estonia, ca 6.5 ºC. Therefore, *P. rostrata* oxygen isotope fractionation is less variable (SD=0.34). Ostracod subfossil material suggests the groundwater feeding water body which upper layers warmed up and a thermocline occurred during the summer in the Early Holocene. Species with the restricted ecological niche are more valuable resource for isotope studies.

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The Baltic Sea and Lake Ladoga history inferred from the paleolimnological data

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The early human movements in the North-eastern Baltic area occurred under the background of drastic environmental changes, primarily related to the modifications of the hydrological network. These were largely controlled by the changes in the configuration and hydrological regime of the Baltic Sea and those of the Ladoga Lake during the course of Final Pleistocene and Holocene. The advanced methods of radiocarbon dating combined with the palaeoenvironmental and palaeolimnological studies make it possible to correlate the early stages of human settlement with the evolution of waterways in the entire North-eastern Baltic area. This was largely achieved in 2003–2009 in the frames of INTAS and RFBR sponsored field projects conducted in the easternmost part of the Baltic Sea and nearby territories around the Ladoga Lake basin. The aims of the project included the detailed chronological assessment of the following processes: (1) Reconstruction of the Baltic Sea and Lake Ladoga evolution in the Late Pleistocene and Holocene; (2) Emergence and duration of the Baltic–Ladoga Strait; (3) Emergence and duration of the Ladoga Lake transgression; (4) Emergence of the Neva River; (5) The effect of changes in the waterways on the subsistence and movements of prehistoric communities. The main methods of investigation were coring and sampling of lake and mire deposits with the subsequent high-resolution radiocarbon dating, pollen and diatom analyses. The core sampling was carried out with the use of a strengthened 1 m long Russian corer (inner diameter 5 and 7.5 cm). Coring of lake bottom deposits was carried out both from ice (in winter and early spring) and from rafts (in summer).

The ancient water connection between Lake Ladoga and the Baltic in the northern lowland of the Karelian Isthmus has been originated after the ice retreating ca 14,000-12,000 cal BP. At that time, until the catastrophic dropping of the Baltic Ice Lake (BIL) water-level happened ca 11,500 cal BP, Lake Ladoga was a deep easternmost bay of the BIL. During the BIL stage the highest shoreline reached c. 50-60 m a.s.l. in the northern part of the Karelian Isthmus. All studied lakes were flooded the BIL waters. Varved-type clay sediments were formed at that time. Arctic climatic and environmental conditions with stagnant ice/permafrost and sparse shrub, herb and grass vegetation on barren soils characterized the central highland of the Karelian Isthmus prior to 12,650 cal yrs BP. Steppe-tundra and cold, dry conditions are inferred between 12,650-11,200/11,000 cal yrs BP. After 11,500 cal BP a straight/river existed in the northern part of the Karelian Isthmus during ca 7000 years. During the Yoldia Sea regression of the Baltic (11500-11 000 cal. BP) Lake Ladoga was re-connected with the Baltic. Water level of Lake Ladoga and lakes in its basin was dropped. The vegetation was arctic tundra with sparse vegetation, which made the soils susceptible to erosion as reflected by the silty clayey sediments in Lake Ladoga. Most of the studied lakes were isolated. The earliest evidence of human settlement in north-eastern Baltic Area is attested at Antrea-Korpilahti (11,200-10,250 cal BP) where artifacts were found in the deposits of a channel between the Baltic and the Ladoga Lake. *Pinus-Betula* forests with some *Corylus* became frequent in the region and show the transition into a boreal vegetation type starting at around 11 000 cal yrs BP. Between 11,000-10,000 cal yrs BP favorable climatic conditions are indicated in the catchment, the last remnants of stagnant ice/permafrost may have melted and soils had probably become more stable.

Warm conditions continued and a trend towards greater humidity/less evaporation can be observed at around 10,000 cal yrs BP, from when on boreal forests seem to have become wide spread. The studied lakes were transgressed twice between 10,700 and 9000 cal. BP and later after a small regression between 8000 and 5000 cal. BP, corresponded with the Ancylus Lake and the Littorina Sea stages of the Baltic. Both the Ancylus Lake and the Littorina Sea transgressions in the Hejnioki area, to the east to Viborg (modern Ladoga-Baltic threshold, 15.4 m a.s.l.), reached their highest level between ca. 20 and 22 m a.s.l. respectively. The terrestrial vegetation was characterized by broad-leaved forests although spruce was expanding throughout the period. Around 4000-3000 cal BP a new outflow - the River Neva, was formed due to the influx of fresh water from the Saima water-system and isostatic uplift caused a rise of the water level of the Ladoga Lake known as "Ladoga transgression", which afterwards completely reshaped the waterways of the entire area.

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The age of landslide areas at the Swabian Jurassic Escarpment

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At the slopes of the Jurassic cuesta scarp in SW-Germany, pedological and mineralogical investigations were carried out in landslide areas. So far, it is possible to distinguish two well-defined landslide areas, one of them belonging to the Pleistocene, the other one characterised by Holocene movements. In general, the distribution of soils and sediments is strongly linked to the age of landslide deposits. In Pleistocene landslide areas, the parent material of the studied soils is formed by periglacial cover beds of Late Pleistocene age, consisting of Jurassic, aeolian and volcanic components. The upper periglacial cover bed was recognised as the most important marker horizon in the studied slope areas. There, the existence of minerals originating from the eruption of the Laacher See volcano, dated to 12,900 yr BP, could be demonstrated for the first time. Most of the Pleistocene landforms are characterised by well-developed soils, like Clayic and Vertic Cambisols, whereas relic soils exclusively occur in the oldest parts of landslide deposits.
Landslide areas affected by Holocene slope processes do not exhibit periglacial layers, as mass movements removed periglacial sediments and former soils extensively. As a consequence, the parent material is different from those of Pleistocene landslide areas. Therefore, sediments in these areas are characterised by Jurassic components and only initial soils are present. Furthermore, results of ^{14}C-datings and pollen analyses are presented.

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Chronostratigraphy of Lower Austrian loess/palaeosol sequences

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Loess/palaeosol sequences exhibit detailed archives of terrestrial palaeoenvironmental changes and landscape evolution. Unfortunately, most loess sequences lack a reliable absolute chronology and hence these changes are difficult to constrain in time. Radiocarbon and luminescence dating have been used to establish chronologies for the Late Pleistocene, whereas for Middle Pleistocene loess deposits there has been no generally applicable and reliable instrumental dating method.
Only recently new luminescence dating techniques opened the opportunity to accurately date Middle Pleistocene sediments. Very promising results were obtained using elevated temperature post-IR infrared stimulated luminescence (IRSL) dating (BUYLAERT et al., 2009). THIEL et al. (accepted, submitted, in prep.) have applied post-IR IRSL dating to several loess/palaeosol sequences in Lower Austria, an area covered by up to 30 m thick loess deposits.
We present an overview of the dating results presented in these studies in comparison to formerly presented chronostratigraphies (e.g. ZÖLLER et al., 1994) and discuss the problems arising from the new chronology.

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Climatic variations or human impact: A review of Holocene aeolian reactivation phases in the European sand-belt

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Aeolian sediments are known to be sensitive to human impact and have established as an important subject of palaeoenvironmental studies. While distinct phases of aeolian sedimentation during the Late Glacial have been parallelised across Europe, reviews concerning Holocene aeolian sediments are still few, very heterogeneous and usually on a regional scale.
Here we try to present an overview about the aeolian activities in the European sand-belt throughout the Holocene based on a broad range of luminescence, radiocarbon and archaeological datings. While the luminescence datings are used to identify phases of increased accumulation, ^{14}C-datings from fossil soils, peat layers or archaeological features covered by aeolian sands are comprised to detect phases of stability and to gain termini post quos for the following reactivation.
Subsequently the results of this overview on Holocene aeolian sedimentation will be used to discuss weather human impact or climatic respectively other ecological factors are prevalent during distinct phases. Integrating first results of a regional study in Northern Germany, special emphases will be placed on the possibility influence of Mesolithic man on dunes, the detectability of the Neolithic landnam and the Bronze and Iron ages.

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Response of the Jeetzel River, Northern Germany, to Late Glacial and Early Holocene climatic change

FALKO TURNER

Over the last two decades several studies have improved the knowledge on late quaternary evolution of river systems in European landscapes. However, descriptions of well dated Late Weichselian sequences, which enable to link the transformation of river systems with climatic changes, are still rare. Here we present first results from the drainage basin of the *Elbe* River. Investigations focus on the response of the medium sized river *Jeetzel*, a western tributary of the *Elbe* in Northern Germany, to climatic fluctuations during the Late Glacial and Early Holocene.

Intensive field surveys within the river valley were combined with detailed Pollen analysis and radiocarbon-dating on preserved palaeochannel sediments to establish a chronology of the Late Glacial river system development. While analysis of ostracods and green algae aim to reconstruct local climatic and environmental conditions during the Pleistocene / Holocene transition, periods of aeolian activity are determined by OSL-dating on riverine dune sediments.

Three Late Glacial and several Holocene generations of river channels were detected. The climatic improvement at the end of the last glacial caused a change from a braided river system to a transitional system with a first step of incision, while high aeolian activity is registered. This transitional system was replaced by a deep incised large meandering system with a single meander during the Meiendorf-Interstadial (sensu USINGER 1998). A similar meandering system with the trend of aggregation prevailed over Allerød, a period of intensive settlement activities by Federmesser groups along the river course, and Younger Dryas times. By the onset of the Holocene a new phase of incision occurred and a meandering system with several small meanders developed. In contrast to many other European river systems no distinct terrace levels were formed by this process. The detailed stratigraphical, chronological, palaeoecological and archaeological studies enable to infer river system and landscape structures during different time slices, especially the period of late glacial Federmesser settlement.

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Late Saalian glacial Lake Weser (NW Germany): sedimentary record, lake-level history and fluvial response to catastrophic drainage

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The existence of large glacial lakes at the southern margin of the late Saalian (Drenthe) Scandinavian Ice Sheet in northern Germany has controversially been discussed for about 100 years. In this study we document the palaeogeography and evolution of glacial Lake Weser. A total of 20 sand and gravel pits and more than 2300 well logs were evaluated in order to document the regional pattern and character of glacial lake deposits in the Upper Weser Valley. Additionally we employed shear-wave seismics, digital elevation models, and geographic information systems to improve earlier palaeogeographic reconstructions of glacial Lake Weser. Existing fluvial terrace models are reconsidered and will be discussed in relation to glacial lake formation and catastrophic drainage.

The principle lithologic evidence for a deep glacial lake in the Upper Weser Valley is the presence of ice-marginal subaqueous fan and delta deposits, the widespread occurrence of fine-grained lake bottom sediments, and ice-rafted debris far beyond the former ice margin. Successive closure of overspill channels led to an overall lake-level rise to a highstand of ~ 200 m a.s.l., controlled by the altitude of lake overspill channels (WINSEMANN et al., 2009; 2010). During this lake-level highstand glacial Lake Weser was up to 150 m deep, covered an area of ~ 1700 km^2 and more than 100 km^3 water was stored in the lake basin. The lake drained catastrophically southwestward into the Münsterland Embayment as the western ice dam failed. Three catastrophic drainage events are recognized, releasing up to 70 km^3 of water within a few days or weeks. The drainage routes are characterized by streamlined hills, deep plunge pools, oversteepened channels and trench-like valleys, cut into bed rock and older Pleistocene deposits (MEINSEN et al., subm.; WINSEMANN et al., subm.).

In contrast to former fluvial terrace models we assume that most of the fluvial record of the Upper Weser Valley is not older than late Saalian in age and related to rapid base-level fall during catastrophic lake drainage. Fluvial deposits high above the recent floodplain form bar-like streamlined bodies in the lee of major hills, interpreted to record the intense reworking of older Pleistocene deposits during initial lake outburst. Exceptionally high sediment accumulations at lower altitudes are interpreted as deltaic deposits, mainly recording the deposition of large amounts of upstream eroded sediments during rapid lake-level fall and related lake-level lowstands (WINSEMANN et al., subm.).

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Reconstruction of the Vistula ice stream lobe during the maximum extent of the Last Glaciation, central Poland: preliminary results of the research project

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Ice streams, defined as zones of channelized rapid ice movement within an ice sheet, pose one of the most interesting study objects of present glacial geology. They are a few hundred km long and a few dozen km wide. The ice flow velocity in ice streams exceeds 400 m/year and is 7-8 times faster than that of the surrounding ice. In recent years convincing evidences of palaeo-ice streams within Pleistocene ice sheets have been delivered (see PATTERSON, 1997; JØRGENSEN & PIOTROWSKI, 2003; BOULTON & HAGDORN, 2006; JENNINGS, 2006).

As a result of the research undertaken so far the basic geological criteria have been defined in order to identify the palaeo-ice streams within the extension of the last glaciation (STOKES & CLARK, 2001). On the basis of the studies, which also included numerical models, the Vistula ice stream was suggested as one of the secondary palaeo-ice streams within the southern Baltic depression (PUNNKARI, 1993). The activity of the Vistula ice stream, however, has not been documented on the basis of the above criteria and the existing works are only of conceptual character (MARKS, 2002; MORAWSKI, 2009; WYSOTA et al., 2009).

The goal of this research is to identify and analyse geospatially the geomorphological and sedimentological record of the Vistula ice stream lobe in central Poland; to reproduce the subglacial processes against in bed conditions, determine the ice-flow pattern as well as delimit the parts of diverse ice velocity; to investigate the dynamics of the Vistula ice stream lobe in relation to the existing models and analogies to other palaeo- and modern ice streams.

Three groups of methods were used in this study: GIS/geostatistic, field research and laboratory investigations. The geospatial analysis of published and unpublished geological and geomorphological data as well as the results of the field and laboratory research remains the main study method. The field research is conducted in several key sites located within the Vistula ice lobe as well as in a few subareas of the glaciomarginal zone associated with the maximum limit of the ice advance. The investigations in the key sites include the following: sedimentological features of tills and their contact with the bed, measurements of directional elements, dispersal of erratics from tills, as well as geomorphological and morphometric analysis of landforms. Laboratory research include lithological and petrographic features of tills, micromorphology of tills and the determination of an age of intra-till deposits based on absolute dating.

Solving the above research problems will enable the authors to reconstruct palaeoglaciology and palaeogeography of the Vistula ice stream lobe during the maximum extent of the last glaciation, such as characteristics of the ice movement and its bed conditions, spatial and temporal mobility of the ice stream, and its role in the distribution of ice masses in the southern margin of the Scandinavian ice sheet. Moreover, it will lead to solving a larger, still discussed issue, i.e. the one referring to the age of the maximum extent of the last Scandinavian ice sheet within the central Poland.

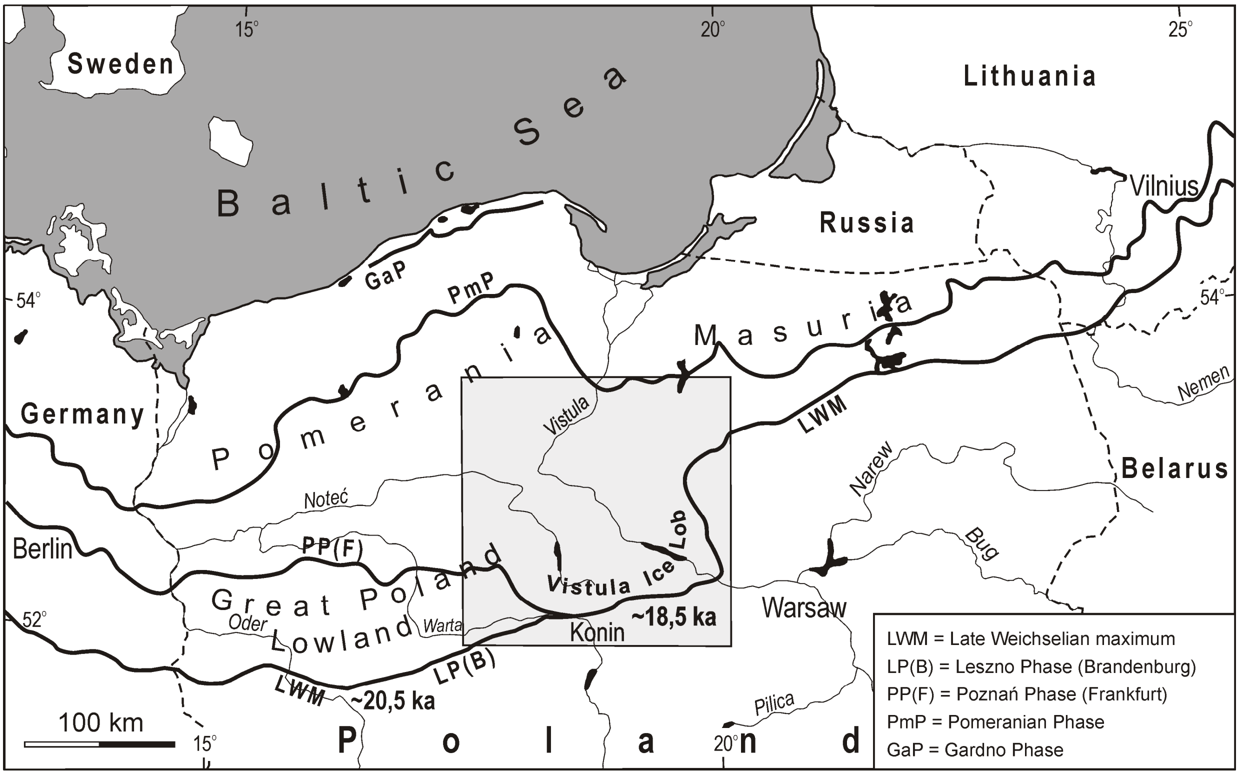

Fig. 1: The Vistula ice stream lobe area in relation to the Late Weichselian maximum extent of the Scandinavian ice sheet in central Poland.

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Poster | Posters

The Younger Dryas cooling in NE-Germany

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The Weichselian Lateglacial (14.7-11.7 ka cal BP) is marked by rapid climatic changes in the North Atlantic region. These changes, such as the onset and termination of Greenland Stadial 1 (or Younger Dryas), are clearly visible in the Greenland $\delta^{18}O$ records (e.g. LOWE ET AL., 2008). These cold events are thought to originate from meltwater pulses into the Atlantic Ocean (CLARK et al., 2001). Understanding how these changes propagated further inland will provide insights into the spatial variation of climatic changes and the influence on the vegetation development. Here, we present a high-resolution multi-proxy study from the Friedländer Große Wiese (FGW) in NE-Germany. The study comprises oxygen isotope (qualitative climate reconstruction), chironomid (quantitative summer temperature reconstruction) and pollen (vegetation reconstruction) analyses.

The FGW is located north of the Rosenthaler end moraine (> 14.6 kyr BP). It is part of the former Haffstausee (BRAMER, 1964), a large proglacial lake that formed in front of the retreating ice sheet. The FGW Lateglacial basin is likely formed by thawing of dead-ice. Subsequently, lake marl formed in the basin. The onset of lake marl formation at the FGW is estimated at the later part of the Allerød, based on the presence of Laacher See tephra in the lower part of the fill. The Allerød and Younger Dryas deposits reach an exceptional thickness of ~ 5 m. This allows a high-resolution reconstruction of climatic and environmental changes at the site. The chironomid record indicates warm conditions during the first part of the record. The landscape consisted of mixed birch-pine forest, which developed into a pine dominated forest. During the Younger Dryas, cold water chironomids expanded and carbonate precipitation decreased. Furthermore, the pine forests became more open, and erosion led to the input of sand into the basin. At the transition to the Holocene, both the oxygen isotope record and the chironomid record indicate a rapid shift to warm conditions. As a result of the climatic warming, lake marl formation resumed and closed forests re-established.

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The Quaternary base of the German North Sea; first results of the project Geopotential of the German North Sea (GPDN) module–A2

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The Quaternary succession of the German North Sea has rarely been studied as a whole during the past decades. At the same time there is an increasing demand for information about the German North Sea by economy and science. The activities in the fields of offshore-wind farms, their connection onshore, raw material industry, pipeline and cable installations, and the closing of knowledge gaps about evolution and stratigraphy demonstrate the necessity of a more accurate and modern analysis of this specific geological period.

So far only one publication of BRÜCKNER-RÖHLING et al. (2005) presented a map of the thickness of the up to 850m thick quaternary deposits, however without any stratigraphic subdivisions or onshore connection. While others deal with more local structures like glacial tunnel valleys (LUTZ et al., 2009) or the local correlation of wells like SCHWARZ (1996), just to name a few.

The project Geopotential of the German North Sea (GPDN) which started in April 2009 as a joint project of the State Authority for Mining, Energy and Geology (Landesamt für Bergbau, Energie und Geologie, LBEG), the Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften and Rohstoffe, BGR), and the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie, BSH) is indented to unify any available data from different stratigraphic levels and sources, fill gaps if needed with new data, and compile one common database from the Permian to the Holocene (for more details see http://www.geopotenzial-nordsee.de). This is done in cooperation with the neighbouring countries Great Britain, The Netherlands and Denmark for an optimum fit with their already existing data and models. The module-A2 located at the State Authority for Mining, Energy and Geology (Landesamt für Bergbau, Energie und Geologie, LBEG) is going to create a detailed 3D model of the Quaternary succession of the German North Sea.
We here present as a fist result the modified new base of the Quaternary as it was compiled from mainly seismic data provided by the BGR and BSH and well information.

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Wind pressure: Formulas, comparisons and wind transport

LUDWIG BIERMANNS

Reasons for the movement of the air masses are differences in temperature from the air, the ground, the surface water, as well as variations in the relative atmospheric humidity with time and space. Changes in density and weight of the different air masses and, with this, instabilities in the troposphere, are unavoidable consequences. Winds come up, until an atmospheric stability has been reached again. Wind, as a dynamic phenomenon, is felt as a lateral air pressure, which increases, when the wind is going to be stronger.

The conversion factor for the speed from km/h to m/s is 0.277 778, and from m/s to km/h, simply 3.6. The wind speed, given in knots, means, nautical miles per hour = 1.852 km/h (table 1). The general value for the density of the air, ρ, is 1.2287 kg/m³, which is considered standard value for the calculation of the wind pressures [2; 3; 5] as compiled in tab. 1. The reference temperature is ca. 17° C for ρ, as given above. The standard atmospheric pressure is 1013.25 hPa. This means that, with falling temperature, the density of the air increases, and when the temperature rises, the density of the air decreases. As a consequence, the wind pressure is higher with the same wind speed, but with lower air temperatures; and the wind pressure is less with the same speed, but with higher temperatures. Under cold weather conditions, the density of the air and, consequently, also the effect of the wind pressure, is higher than with milder temperatures and with the same wind speed. For this reason, when the density of the air, used for the calculation, differs by more than ± 5 % (± 0.0614 kg/m³) from the value 1.2287 kg/m³, then a correction should be done.

In the following formula, the link $0.5 \cdot v^2 \cdot \rho$ is the lateral pressure of the wind against objects (water, solid material), called the dynamic pressure of the wind [2; 4]. The link $0.5 \cdot v^2$, in its turn, is the kinetic energy [1], and the formula is:

$$p_t\,[\mathrm{hPa}] = 0.5 \cdot v^2 \cdot \rho \cdot 0.01 \qquad (1),$$

with v = wind speed [m/s]; ρ = density of the air [kg/m³].

The unit of the wind pressure, p_t, is mostly designated with hPa in the literature, where 1 hPa corresponds to a load of 10 kg/m². As the atmospheric pressure, however, is already defined with hPa, where 1 hPa = 100 N/m² = (100 kg · m · s⁻²)/m², the definition for the total pressure, p_t, as given in eq. 1, should be modified, because the meaning for the wind pressure is kg/m², and not N/m² [2; 3; 5]. The atmospheric pressure can be considered a static phenomenon. Wind, however, is a dynamic phenomenon and is felt as a lateral pressure. In order to fill this demand, eq. 1 should be modified like this:

$$p_t\,[\mathrm{kg/m^2}] = 0.5 \cdot v^2 \cdot \rho \cdot 0.1\,\mathrm{s^2/m} \qquad (2),$$

where 0.1 s²/m = conversion factor.

In absolute numbers, the calculated values from eq. 2 do not differ from those of eq. 1; merely the value for kg/m² is by the factor of 10 higher than for the value, given in hPa.

All kind of particles, with a size from less than 0.0001 to 0.003 mm (0.1 to 3 µm), e.g. dust, salt, cinder particles, very fine-grained ash particles and organic matter, are suspended in the atmosphere. Droplets from slightly wet fog, close to the size of aerosols, between 0.005 and 0.01 mm in diameter, are still virtually suspended in the air. A droplet with a size of 0.01 mm just falls with a speed of ca. 10 mm/s (36 m/h). Slight up currents, with a wind speed of less than 0.3 m/s, however, already keep the drop in suspension. The size of droplets from wet fog varies between 0.01 and 0.05 mm. The speed of fall, with 0.05 mm, makes some 250 mm/s (900 m/h), provided, there is no wind. Under favourable conditions, very fine-grained particles are transported over hundreds, in extreme cases, even over several thousands of kilometres. A classical example for this is the transport of dust by the trade winds from the Sahara desert into the Atlantic Ocean, which, normally, reaches a distance of more than 3000 km away from the African continent. A wind speed of less than 1.5 m/s (5.4 km/h), already, is enough for the transport of these particles over such a distance. This corresponds to a wind pressure of less than 0.0138 hPa, or less than 0.138 kg/m^2.

In conclusion, wind, of which its reasons are atmospheric instabilities, is a dynamic phenomenon. Predominantly wind speed, but also air temperature and atmospheric pressure contribute to the wind pressure, which better should be given in kg/m^2, and not in hPa.

Table 1: BEAUFORT scale: wind force, wind speed and wind pressure.

Wind force after BEAUFORT:		Wind speed (conversion scale) in:			Wind pressure:	
degree:	designation:	[m/s]:	[km/h]:	[knots]:	[hPa]$^+$:	[kg/m^2]$^+$:
0	calm	< 0.3	< 1	< 1	< 0.001	< 0.01
1	Light air	0.3 – 1.5	1 – 5	1 – 3	0.001 – 0.015	0.01 – 0.15
2	Light breeze	1.6 – 3.3	6 – 11	4 – 6	0.016 – 0.069	0.16 – 0.69
3	gentle breeze	3.4 – 5.4	12 – 19	7 – 10	0.07 – 0.18	0.70 – 1.18
4	Moderate breeze	5.5 – 7.9	20 – 28	11 – 15	0.19 – 0.38	1.19 – 3.8
5	fresh wind	8.0 – 10.7	29 – 38	16 – 21	0.39 – 0.71	3.9 – 7.1
6	strong wind	10.8 – 13.8	39 – 49	22 – 27	0.72 – 1.17	7.2 – 11.7
7	moderate gale	13.9 – 17.1	50 – 61	28 – 33	1.18 – 1.80	11.8 – 18.0
8	fresh gale	17.2 – 20.7	62 – 74	34 – 40	1.81 – 2.63	18.1 – 26.3
9	Strong gale	20.8 – 24.4	75 – 88	41 – 47	2.64 – 3.66	26.4 – 36.6
10	Whole gale	24.5 – 28.4	89 – 102	48 – 55	3.67 – 4.95	36.7 – 49.5
11	storm	28.5 – 32.6	103 – 117	56 – 63	4.96 – 6.52	49.6 – 65.2
12	hurricane	32.7 – 36.9	118 – 133	64 – 71	6.53 – 8.37	65.3 – 83.9
13	hurricane	37.0 – 41.4	134 – 149	72 – 80	8.41 – 10.5	84.1 – 105
14	hurricane	41.5 – 46.1	150 – 166	81 – 89	10.6 – 13.0	106 – 130
15	hurricane	46.2 – 50.9	167 – 183	90 – 99	13.1 – 15.9	131 – 159
16	hurricane	51.0 – 56.0	184 – 201	100 – 108	16.0 – 19.3	160 – 193
17	hurricane	> 56.0	> 201	> 108	> 19.3	> 193

$^+$ With a wind pressure of 1 hPa, there exists a load of 10 kg per m^2 [2; 3; 5].

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Deformation bands in Pleistocene sediments

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Deformation bands are planar structural elements that occur in porous sandstones, even in the unconsolidated state. Whereas faults are discrete surfaces, deformation bands are much thicker, tabular zones of continuous displacement. They have attracted much attention in the past because of their low permeabilities and their potential impact on fluid flow in sedimentary basins (FOSSEN & BALE, 2007). Not many studies have focused on the geometry and physical properties of deformation bands in unconsolidated sediments and sandstones (e.g. CASHMAN & CASHMAN 2000). It has also been postulated that deformation bands often show reduced grain-size as a consequence of cataclasis or mylonitisation (e.g. CASHMAN & CASHMAN 2000).

In general, deformation bands are only exposed in two dimensions. Lithified sandstones do not allow the analysis of the three-dimensional geometrical arrangement of deformation bands in detail. The size of deformation bands is also below the resolution of standard geophysical methods. Unconsolidated sands, in contrast, allow the outcrop to be physically removed in stages to obtain information regarding the third dimension. Deformation bands can occur in both, compressional and extensional regimes. We present an outcrop-based, 3D geometrical study of deformation band faults in unconsolidated sands, which we sequentially exposed in a volume of 1.5 m^3. From this data, we created a 3D model and were able to determine the three dimensional geometry of the strata, deformation band fault thickness, along-strike fault throw, and the total horizontal extension. In combination with thin section analysis, we discuss the mechanisms of deformation within the bands.

The three-dimensional model is cut by a set of nine major deformation bands, all with a normal sense of displacement; one set of six faults strike SE-NW, dipping NE by ca. 50°, the other set of three faults strike NNE-SSW, dipping WSW by ca. 45°. The former cross-cut the latter, thus their age relationship is shown. In the dip direction the faults are straight, but slightly arcuate in their strike direction. We identified seven distinct stratigraphic horizons, from which we were able to analyse along-strike displacement and total extension due to faulting. The three dimensional model shows that thickness of the deformation bands varies elliptically and ranges from zero to 4.5 cm. We calculated horizontal extension along three sections, perpendicular to the strike of the faults. Because fault displacement varies so much along-strike, extension ranges from 30 to 60%. Clearly the deformation is unevenly distributed on this scale. Nevertheless, these are very high amounts of deformation and this has wide implications when upscaled to a whole outcrop or locality.

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The evolution of East Lithuania glaciolacustrine basins in Late Pleistocene

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The evolution of Vilnius – Warsaw – Berlin urstrom was interpreted in different perception. Long time existed opinion that urstrom was formed by wide (1 – 10 km) and deep stream. This basic opinion followed Lithuanian and Polish geomorphologist in first half of 20th century. Only since 8th decade formed another opinion: the East Lithuania sandy plain was formed by glaciolacustrine basin and numerous glaciofluvial streams.

The urstrom had very complicated structure: 13 terraces are in this sandy plain. The highest terrace is in southern part of Vilnius territory. The highest terraces (8 – 13) were formed by glaciofluvial streams whereas lower terraces (5 - 7) in most cases indicate old glaciolacustrine basin shorelines. The wide turfy parts and narrow valleys of urstrom parts provide this opinion.

In Late Glacial (Weichselian) a one time existed seven large glaciolacustrin basins. The oldest existed in Brandenburg (Grūda) Stage. It's occupied glaciodepressions between Neris Middlestream, Vilnia and Dainava ice–tongues. It's basins were small and shallow. The basins was in high level: the eastern basin which affluent by Neris Middlestream and Vilnia ice-tongues shoreline was fixed in 220 m a.s.l. Western basin, which affluent by Vilnia and Dainava ice-tongues – in 200 m a.s. l.

In Frankfurt (Žiogeliai) Stage cascade of glaciolacustrine basin existed in East Lithuania. The highest level these basins had in north part and lowest – in south. The Žeimena glaciolacustrine basin was in 160 – 170 m a.s.l., the Vilnia – 155 – 160 m, the Dainava – 135 – 160 m. The shoreline altitudes coherently sink from north-east to south-west (Figure 1). The lowest Katra basin was in contemporary Lithuania – Belarus border. In south-east Lithuania extant some shoreline terraces, which was in 135, 130, 125 and 120 m a.s.l.

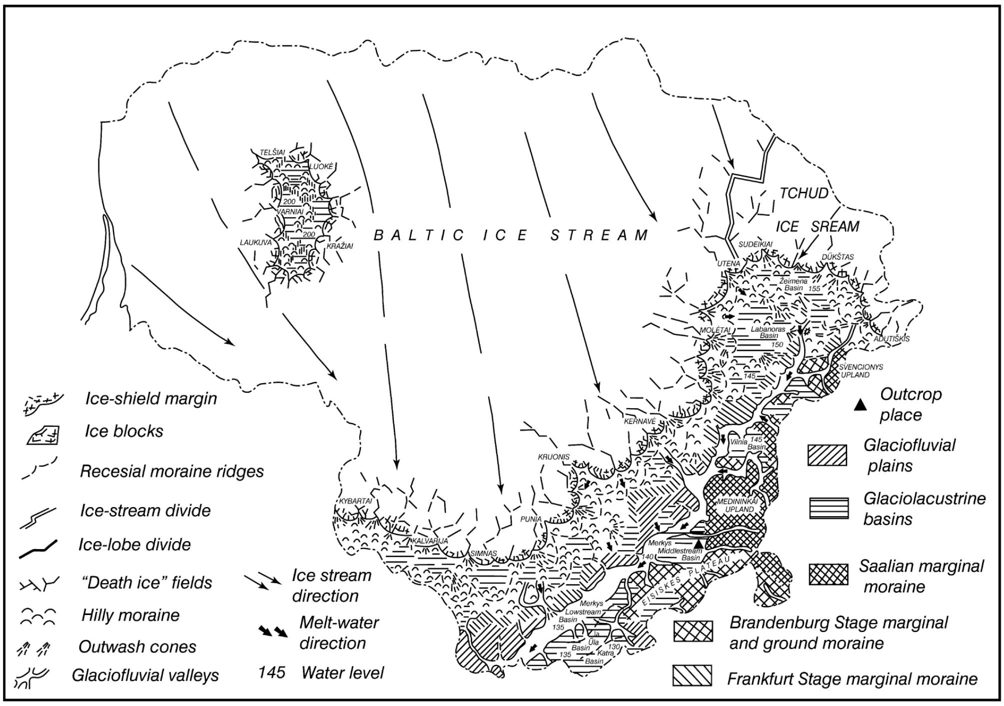

Fig. 1: Deglaciation of Lithuanian territory in East Lithuanian Stage.

Next important reason, which evidence to glaciolacustrine basin existence are old gullies network. The gullies which mouth opened in glaciolacustrine basins have complicate structure: multi-arms, volatile longitudinal section. Long time of existence decided different possibilities in gullies evolution: when basins water level sink, the longitudinal section of gullies followed them.

The mouths part of gullies in time become in convex form. This process repeated and gullies mouth longitudinal section had some steps.
The changes of sediments illustrated evolution of glaciolacustrine basins. In old shoreline levels (135, 130, 125 and 120 m a.s.l.) are fine-grained and coarse-grained sediments layers. Coarse-grained layers are thin and oblique (Fig. 2).
The glaciolacustrine basins were stretched among two uplands belt: Saalian Ašmena Upland in east and Weichselian marginal Baltic Uplands in west. Distance between its uplands are only 10 – 60 km and this fact had essential importance for evolution all urstrom.

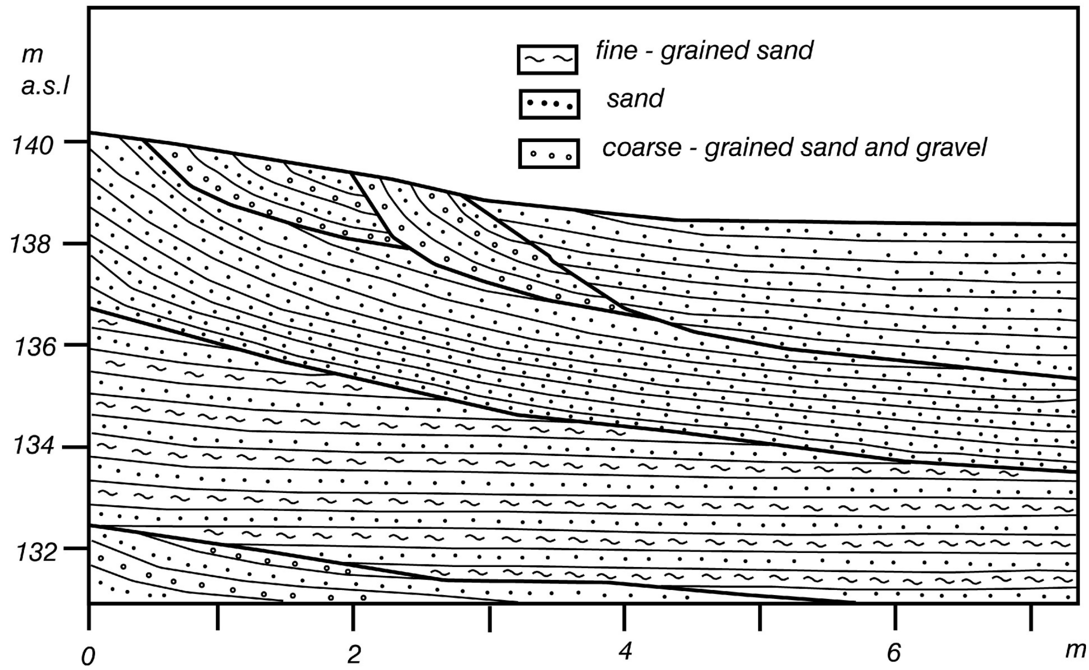

Fig. 2: Outcrop of Merkys Middle-stream glaciolacustrine basin.

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Late Holocene and present-day fluvial morphodynamics in small catchment areas of Central Germany

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During the past decades strong runoff events repeatedly occurred in small drainage basins of the European low mountains. In numerous events runoff was connected with erosion and transport of extensive bed load. Runoff events were predominantly triggered by rainstorms, which were limited to the catchment areas. They partly caused severe economic loss.

The present study focuses on fluvial morphodynamics in northern Hesse and Lower Saxony. In this area runoff and transport of bed load occurred in small tributary catchment areas of the Fulda, Werra and Oberweser rivers. In general, the small drainage basins are used by agriculture and forestry. Drainage channels are developed as gullies and are incised into solid bedrock, Quaternary hillslope sediments, alluvial fills, and anthropogenic deposits. Vertical incision into the bedrock may be in the range of decimetres to meter per event (Figure 1). Furthermore, in single cases sediment discharge amounted to 16.000 m^3 in addition to the suspension load (Table 1).

On the base of historical analyses about 50 severe runoff events with a maximum frequency of 10 events during 1965 are recorded during the past 150 years in the study area. Field survey, sedimentological analyses and dating reveal intensive runoff processes since the Neolithic. In this context potsherds, which were detected in an alluvial cone of the “Rehgraben gully” close to the city of Kassel, were dated to the Linear Pottery culture. Furthermore, findings of fossil wood were recovered in the same alluvial cone. Radiocarbon dating reveals calibrated ages which are for the most parts younger than 2000 years. On the basis of recent dates we suppose to identify sediments of the severe runoff event of 1342 in the middle of Europe.

Current studies in the Rehgraben catchment area aim to distinguish fluvial morphodynamics on a temporal scale and to estimate potential Holocene erosion rates.

Fig. 1: Significant vertical incision into bedrock after a catastrophic runoff in April 1994 - Rehgraben gully, northern Hesse.

Tab. 1: Geomorphologic and hydrologic characteristics of selected torrents in the Fulda-Werra-Oberweser region

Torrent and drainage area				Discharge and bed load during the last 120 years		
Torrent	Drainage area [km²]	Relief [m]	Max. slope [%]	Mean discharge [l/s]	Max. discharge [m³/s]	Max. bed load [m³/event]
Elsterbach	5,5	341	9,5	34,5	3,5	Several hundred
Rehgraben	2,84	155	12,8	-	~ 50	~ 16.000
Hemelbach	12,6	302	5,4	40 – 50	6 – 8	2.000 - 3.000
Wandersteinbach	3,47	202	13,7	-	~ 40	2.200
Rattbach	4,8	248	9,4	30 – 40	-	500 – 1.500
Vogelsangbach	8,5	422	12,3	~ 40	-	Several hundred

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Relevance of tectonic and structural parameters in Triassic bedrock formations on landslide susceptibility in Quaternary hillslope sediments

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Important controlling factors of mass movements are generally soil water, geometric-topographic terrain factors, and various geologic parameters that have a direct or indirect connection to soil-mechanical properties of slide masses. Furthermore, tectonic parameters in the context to the susceptibility of mass movements are also of importance. Aim of the present study is to identify the relevance of tectonic and structural parameters in bedrock formations for landslides in periglacial hillslope sediments on top of the bedrock.

The research area is part of the southern Solling anticline, a saddle structure in the Middle Bunter Sandstone formation in northern Hesse and southern Lower Saxony (Germany). In this geologic formation sandstone, siltstone, and mudstone are interbedded with impermeable strata. The uplift of the Solling anticline, in particular during the Quaternary, resulted in a partially intensive dissection of the Bunter Sandstone plateau into separate blocks with disrupted, tilted, and partially rotated layers. Frequent small-scale changes in strike and dip are due to these processes.

The study of landslide sites in northern Hesse and southern Lower Saxony shows that mass movements in periglacial cover (Figure 1a/b) beds frequently occur on slopes that show significant accordance between slope aspect and the dip direction of bedrock strata. In addition

Figure 1a/b: Characteristic landslides in Quaternary hillslope sediments in the southern Solling area.

to slope inclination, low values of dip/aspect-ratios are of major importance. The structural conditions of the bedrock have an indirect impact upon landslides in the superposed hillslope sediments. Stratum and joint water flow along water impermeable strata cause water infiltration and moistening of the periglacial hillslope sediments on top of the bedrock. In this context it is clear that the influence of strata dip on water flow along bedding planes is essential for the occurrence of subterrestrial springs, and thus for the moisture penetration and destabilisation of the Quaternary hillslope sediments. The study show that mass movements are frequently linked to sites of outcrop springs and occur after long periods of rainfall.

With the help of statistical and GIS-based analyses, possible factors that control landslides were statistically evaluated and weighted. They were subsequently included in an empirical-statistical model and transferred into a susceptibility map that allows identification of potential hazard areas due to landslides. This method contributed to a better understanding of the process connections and also to a verification of the working hypothesis.

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The Quaternary base of Lower Saxony: 3D modeling and integration of new data

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The base of the Quaternary in Lower Saxony was published by KUSTER & MEYER (1995) as a map. We modelled the base of the Quaternary using the 3D software GoCAD. To improve the model we develop workflows to integrate the continuous flux of new data.

Former work and method

The base of Quaternary sediments in Lower Saxony is one of the most frequently demanded maps in the domain of hydrogeology. It was published at a 1:500,000 scale by KUSTER & MEYER (1995), as result of extensive evaluation and interpretation of borehole data. These isolines are digitally available on the Map Server Cardo (LBEG 2010).

Using the isolines, we created a 3D surface in GoCAD (Paradigm 2010). We started to improve and refine this surface by integrating all available data. These include wells, borehole-logs, cross-sections, seismic, as well as recently introduced methods like airborne electromanetics. Integration of new data is a long process since for instance continuously new boreholes will be drilled. Thus, it becomes necessary to create workflows that allow the inclusion of all kinds of data. During this process we are faced with major challenge concerning the heterogeneity of data quality.

We took the first steps to develop a workflow by looking at all available data, which are mainly wells:

- Search for problems – i.e.: inconsistency of the GoCAD interpolated surface and well markers!
- Analyse the problem! i.e.: why is there no match? When and how was the borehole drilled? Who carried it out?
- Decide, wether the surface needs to be corrected or the borehole data need another interpretation to achieve a match between borehole databank of Lower Saxony (BDN) and the 3D model!

If the analysis of cross sections shows mismatch – this is mostly because there are no data – the modeller has to decide which scenario is the most appropriate.

- Interpretation of a geologist rules – so we correct the automatic interpolation. (One could think this is mainly the case)
- Or: is the interpretation, as developed in a cross-section. Not possible in 3D? Then interpolation is appropriate solution!

In any case, of course we integrate the knowledge about the geological development of the sedimentation area, especially erosion patterns by glacial processes.

Integration of faults

Small-scale structures like Tertiary thrust horsts can form complex water routing systems. Without a deeper understanding of these structures an interpretation can easily fail. Simplification of the structures is necessary, but the degree of simplification needs to be clarified to avoid overseeing highly effective water routing such as the hydraulic functions of faults. Thus these structures need to be closer characterized for the geological information itself, i.e. the base of the Quaternary, as well as for applied hydrogeology.

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Dating and quantifying anthropogenic sediments at a Neolithic site in Central Germany (Wetterau)

ALEXANDER FÜLLING

The aim of the study was to get a detailed insight into the history of soil erosion on a loess ridge within an intensively agriculturally used area. Colluvial slope deposits were dated by Optically Stimulated Luminescence (OSL). It was then tried to correlate the OSL ages with archaeologically visible phases of human activity assuming that colluvial sediments are the result of man made soil erosion. Moreover, sedimentation rates of hillfoot colluvia were calculated, and a simple sediment budget was established on slope scale.

The research area (approx. 1 km^2) is situated in the northwestern part of the loess-covered Wetterau Basin (state of Hesse, Germany) representing the northern continuation of the Upper Rhine Graben. The predominant soil types of the Wetterau Basin are Luvisols, which often inherited characteristics of Chernozems formed during Early Holocene. Fertile soils as well as the mild and dry climate of this region favoured permanent human settlements since the Early Neolithic at about 7500 years ago.

38 OSL datings of hillfoot colluvia and pit fills were carried out, sampled within an area including a former settlement of the Linear Pottery culture (Niederweisel). The dating results are in a good agreement with archaeologically proven human activity phases of this region (SAILE 1998). The probability density distribution of all OSL ages (Figure 1) shows peaks within the Middle Ages (1150 and 660 AD), the Roman period (120 AD), the Bronze Age (1360 BC), and the Early to Middle Neolithic (5180 BC). One has to consider, that the peak sizes are dependent both on the sampling mode and on the individual age errors; hence, they doesn't reflect any sediment volumes. However, the peak positions are typical for loess-covered landscapes in South Germany (LANG 2003) and for colluvial layers dated in hole Central Europe (DREIBRODT et al. 2009).

Mean sedimentation rates could be calculated after linking the OSL dating results with the stratigraphy of the investigated profiles. Fig. 1 shows a distinct increase at the beginning of the Bronze age followed by a slight trend to higher rates with maximum values during the Middle Ages.

Finally, a simple slope scale sediment budget was developed after detailed soil mapping. The total volume of colluvium within the study area was determined by interpolation of about 300 bore profiles. The on-slope erosion was calculated taking into account the degree of soil truncation. Preliminary results show, that roughly 40 % of the eroded materials were redeposited on-slope, wheras 60 % are either stored in the valley fills or were transported out of the study area by fluvial transport.

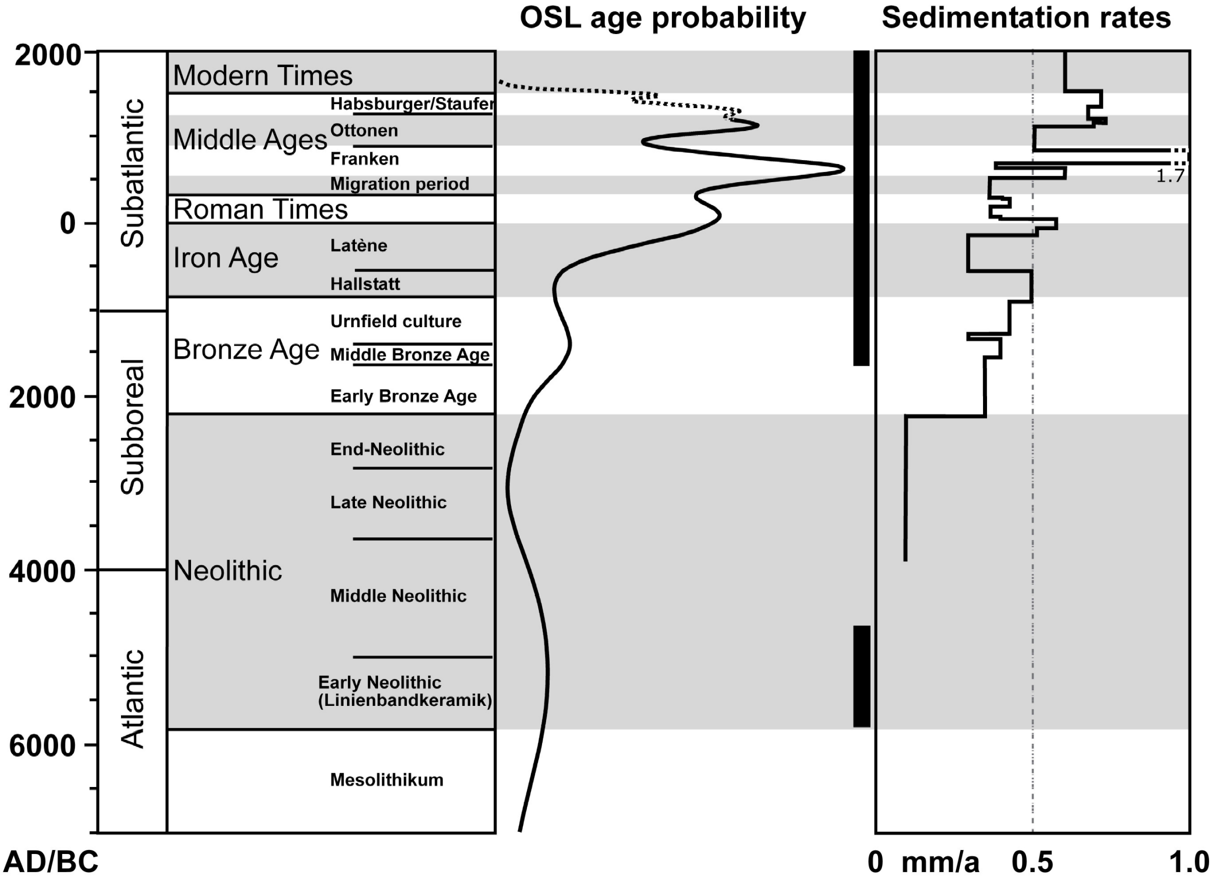

Fig. 1: Probability density distribution of 38 OSL ages from soil erosion-derived colluvial sediments and mean sedimentation rates of the dated profiles at the foot of the hill slopes. Known human activity phases are indicated by black bars.

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Vegetation history and development of environmental patterns in Labanoras region (eastern Lithuania) in the Late Pleistocene and Holocene

ANDREJUS GAIDAMAVICIUS, MIGLE STANCIKAITE & JONAS MAZEIKA

Complex study (pollen, loss-on-ignition and ^{14}C-isotope survey) of two sediment sections taken from Bevardis and Verpstinis lakes situated in the Labanoras region (eastern Lithuania) was carried out in order to reconstruct the vegetation changes and development of environmental pattern during the post-Glacial. Biostratigraphical data supplemented by the results of ^{14}C measurements indicated on going sedimentation started since the Allerød Interstadial. Pollen data suggested the formation of a *Pinus-Betula*-dominated forest during the Allerød, while the Younger Dryas was characterised by the development of open herb-shrub vegetation in the area. An early Holocene peak of the *Picea* curve recorded in the Lake Verpstinis core was dated back to 8180-7980 cal BP confirming early Holocene immigration of this tree into area. Despite the predominance of sandy soils culmination of the broad-leaved forest including *Tilia, Quercus and Ulmus* is seen during the Holocene climatic optimum at about 7600-6200 ^{14}C BP. Signs of human impact are minor in both diagrams indicating minor human interference.

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Late Quaternary river terraces at the middle reaches of the River Lech – first results

BENJAMIN GESSLEIN & GERHARD SCHELLMANN

The study area is located at the middle reaches of the river Lech between the Upper Bavarian towns of Schongau and Landsberg. Research focuses on the differentiation of Late Pleistocene and Holocene river terraces of the Lech. The valley itself is framed by a Würmian moraine landscape on the east side and *Obere Süsswassermolasse* (Upper Freshwater Molasse) covered by remnants of the oldest Pleistocene on the west side. The Quaternary history of the river Lech has been investigated by e.g. PENCK & BRÜCKNER (1909) and KNAUER (1929). In particular the Late Quaternary valley bottom was examined by BRUNNACKER (1959), DIEZ (1968) and SCHREIBER (1985).

All terrain features were surveyed by field mapping under usage of high resolution Digital Elevation Models (Airborn-LIDAR data, 2x2 m resolution), which were provided from the OFFICE FOR SURVEYING AND GEOINFORMATION. Fluvial deposits and soil development were investigated in outcrops and by manual corings. The thickness of the Quaternary valley fill was reconstructed by examination of reports from boreholes. Terrace ages are based on radiocarbon and OSL datings, historical maps and archaeological data.

The Lech valley bottom is dominated by differently elevated Würmian terraces – so called *Niederterrassen* (Lower Terraces) and their *Teilfelder* (subfields). The *Hauptniederterrasse* (Main Lower Terrace) and its three subfields engage about 65% of the valley bottom. These terraces are composed of horizontal and trough bedded layers of cobbles and sandy gravels. While the Main Lower Terrace is directly connected to the Würmian LGM (Last Glacial Maximum) moraines (e.g. GROTTENTHALER 2009) all subfields levels are younger and have no direct connection to a terminal moraine. OSL dating of fluvial sands of the Main Lower Terrace dated to 22030 ± 2030 BP confirm a Würmian Pleniglacial age. The youngest Würmian terrace the Ws3 was built up during the Lateglacial, perhaps the Younger Dryas according to a ^{14}C age of 10120 ± 60 BP of an embedded mollusc shell.

The Holocene terraces incorporate up to ten differently elevated terraces (qha to qhj3, Tab.1). In contrast to the older Holocene terraces the Subboreal and Subatlantic terraces are covered by floodloam with thicknesses of up to 2 m.

The oldest Holocene terrace, the qha1 terrace, was formed during the early Preboreal according to the radiocarbon age of 9950 ± 50 ^{14}C BP of an embedded mollusc shell. In the study area, the qhm1 terrace of Atlanticum age is the most widespread river deposit in the Holocene valley floor. Two fragments of wood embedded in loamy clods inside the gravel deposits yielded ages of 5720 ± 40 and 5900 ± 40 ^{14}C BP. The next younger terraces, the

qhm2 and qhm3, may have been formed during the Subboreal. The youngest valley floor was formed during the Subatlantic period. The floor can be divided up into at least three terraces, the qhj1 to qhj3, which accompany the recent course of the Lech. The surfaces of these terraces are characterized by several palaeochannels and palaeomeanders. Their ages are according to some archaeological data and historical maps: qhj1 Roman age, qhj2 Medieval age, qhj3 Modern age.

Tab.1: Chronology of Late Quaternary Lech river terraces.

Terraces	Local terrace names	Age	Evidence of age
qhj3,,	Jüngste Auenstufe	Modern Age	Historical maps
qhj2,,	Jüngere Auenstufe	Medieval Age	Archaeological data
qhj1,,	Ältere Auenstufe	Roman Age	Archaeological data
qhm3(1,2),G	Stufen von Seestall	Subboreal	---
qhm2(1,2),G	Stufen vom Lorenzberg	Subboreal	---
qhm1,G	Stufe von Mundraching	Atlanticum	5720 ± 40 ^{14}C BP wood embedded in loamy clod 5900 ± 40 ^{14}C BP wood embedded in loamy clod
qha1(1,2),G	Stufen von Epfach	Preboreal	9950 ± 50 ^{14}C BP mollusc shell embedded in loamy clod
Ws3,G	Stufe von Friedheim	Würmian Lateglacial	10120 ± 60 ^{14}C mollusc shell embedded in loamy clod
Ws2,G	Stufe von Unterigling	Würmian Pleniglacial	---
Ws1,G	Stufe von Schongau und Peiting	Würmian Pleniglacial	---
Wh22,G	Stufe von Altenstadt	Würmian Pleniglacial	---
Wh1,G	Hauptniederterrasse	Würmian Pleniglacial	OSL dating of fluvial sands 22030 ± 2030 BP

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An approach to assess the rock slope stability and shallow landslide susceptibility of the Jasmund cliff area (Rügen Island, Germany)

ANDREAS GÜNTHER[1] & CHRISTINE THIEL[2]

The famous Jasmund cliff of Rügen Island (Germany) is composed of soft, intensely fractured, Cretaceous chalk rocks which are in many parts pseudo-concordantly overlain by Pleistocene glacial deposits consisting of till, clay, and sand (STEINICH, 1972). Both stratigraphic successions have undergone strong glacial deformations during the Late Quaternary, resulting in tight folding and shearing of the Pleistocene deposits, and thrusting accompanied by more open folding of the Cretaceous chalkstones. The entire lithostratigraphic sequence was uplifted and segmented into thrust-bounded structural complexes during the last glacial and subsequently capped and discordantly overlain by the youngest glacial sediments. The Cretaceous rocks now form a steep cliff more than 100 m in height that is subdivided by gently dipping slope sections where Pleistocene deposits predominate.

Since the last glacial period, the Jasmund cliff has been subject to gravitational mass movements. The stability of the soft Cretaceous chalk is chiefly controlled by the orientation and the conditional properties of pre-existing geological discontinuities (joints, bedding planes), while the sliding susceptibility of the Pleistocene sediments is governed by their structural position, geomorphological setting and material composition (e.g. OBST & SCHÜTZE, 2006). In Jasmund, large-volume cliff failures comprise complex rock falls of the Cretaceous chalk along water-saturated discontinuity planes during or after periods of high precipitation. In many cases of Cretaceous chalk collapses, Pleistocene glacial sediments, composed of impermeable tills and permeable sands, are also mobilized. Because the chalk is a considerably soft material with high porosity, the rock fall materials (when saturated) are subject to intense dissolution and fragmentation processes and are rapidly transformed into chalk flows (e.g. HUTCHINSON, 2002; OBST & SCHÜTZE, 2006). Recently, the interest of the coastal cliff stability significantly increased due to spectacular large-volume cliff failures and landslides that occurred over the last few years.

We present an evaluation of both the structurally-controlled failure susceptibility of the fractured Cretaceous chalk rocks and the topographically-controlled shallow landslide susceptibility of the overlying glacial sediments for the Jasmund cliff area (GÜNTHER & THIEL, 2009). We combined techniques involving spatially distributed kinematical rock slope failure testing with tectonic fabric data, and both physically- and inventory-based shallow landslide susceptibility analyses. The rock slope failure susceptibility model identifies areas of recent cliff collapses, confirming its value in predicting the locations of future failures. The model reveals that toppling is the most important failure type in the Cretaceous chalk rocks of the area. The shallow landslide susceptibility analysis involves a physically based slope stability evaluation which utilizes material strength and hydraulic conductivity data, and a bivariate landslide susceptibility analysis exploiting landslide inventory data and thematic information on ground conditioning factors. Both models show reasonable success rates when evaluated with the available inventory data, and an attempt was made to combine the individual models to displaying both terrain instability and landslide susceptibility. This combination highlights unstable cliff portions lacking discrete landslide areas as well as cliff sections highly affected by past landslide events. Through a spatial integration of the rock slope failure susceptibility model with the combined shallow landslide assessment we were able to produce a comprehensive landslide susceptibility map for the Jasmund cliff area.

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State and properties of organic matter at different stages of the salt marsh soil development

PIOTR HULISZ[1], LUISE GIANI[2] & SŁAWOMIR. S. GONET[1]

Salt marsh soils (Salic Fluvisols) are diverse saline soils under the influence of seawater. They can be inundated periodically during the daily (low marsh) and neap tides (middle-high marsh) as well as episodically during tides (high marsh). The discussion on the genesis of salt marsh soils have been conducted for many years. Some authors suggested than these soils can be formed through a combination of geo- and pedogenesis (SCHROEDER, BRÜMMER 1969; GIANI 1992). Therefore, the question arises, how mentioned processes occur in different types of marsh, depending on the intensity of flooding. From the standpoint of soil genesis the qualitative and quantitative properties of soil organic matter (SOM) seem to be particularly important. That is why the aim of this paper was to determine the state and properties of soil organic matter at different stages of the salt marsh soil development.

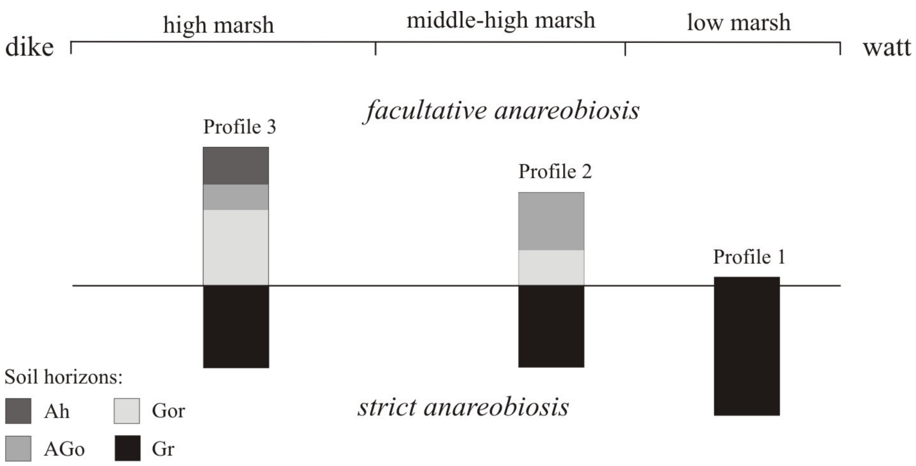

Fig. 1: Location and morphology of soil profiles

The study was carried out in July 2007. Sampling sites were selected so as to represent the saltmarsh soils of the southern North Sea coast (Cäciliengroden, Germany) – Figure 1. Three pedons were sampled and analysed according to standard methods. Additionally, the following properties were determined: elemental composition (CNS Variomax Analyser), humus composition (by Kononova-Belchikova method), structural features of soil organic matter (by CPMAS ^{13}C NMR method).
In the studied areas halophilous vegetation occurred. In the surroundings of profile 1 (low marsh) only single plants were present (mainly Salicornia spec.)
The parent material of the study soils was clay mixed with humus (4.7 - 4.8 % Corg). In surface horizons of middle-high and high marsh soils (profile 2 and 3) some enrichment in Corg was noted. It was related to the presence of relatively permanent vegetation cover (6.51-6.84%).
Low marsh soils showed very specific qualitative properties of organic matter. Moreover, no typical soil humous horizon was observed in profile 1. The first horizon was a Gr (gleyic with strong reduction), but also stating that others begin with a Gor horizon (gleyic with both oximorphic and reductomorphic features). These soils were characterized by low humic to fulvic acids ratio values (C_{HA}:C_{FA} 0.41 - 0.51) and low percentage of humic acids in organic carbon pool (6.8 - 9.1%). It can suggest that the precursors of this organic matter was mainly algae and other marine plants. The impact of regular tides and strong anaerobic conditions probably influenced on the increase of SOM aromaticity index which was two times higher than in profiles 2-3.

However, humus substances of terrestrial origin predominated in high marsh soils. These soils are less flooded and more aerated. Consequently, the netto production of SOM is much more higher than in low marsh, so the aerobic conditions mainly decided about the direction of SOM transformation. C_{HA}:C_{FA} ratio value in Ah horizon was 0.81 – typical for full developed soils. It was also confirmed by the spectra of ^{13}C NMR (Figure 2). The aromaticity index (23.7) was close to that met in forest soils (BEYER ET. AL 1996).

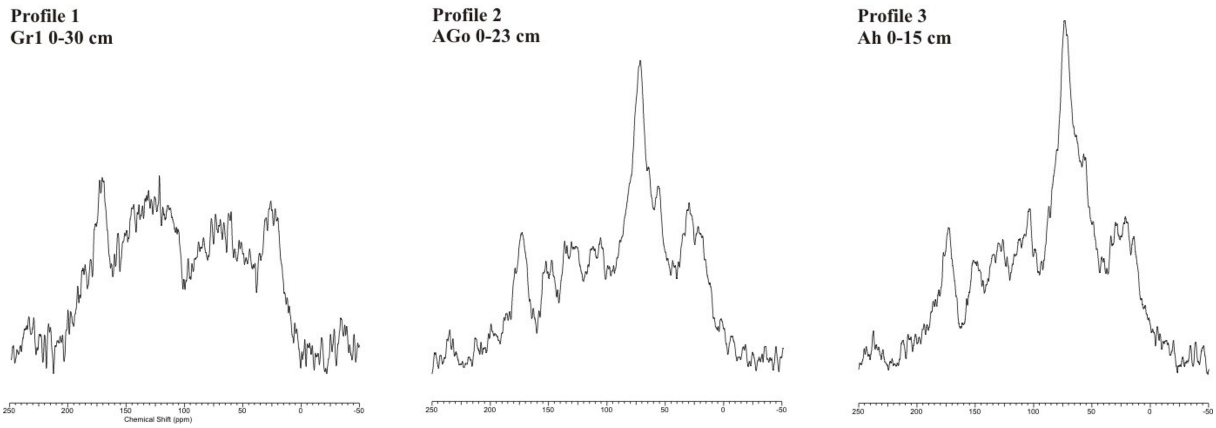

Fig. 2: CPMAS ^{13}C NMR spectra of the surface soil horizons.

Besides the presence of the initial humous horizon (AGo), the evidence of the transitional character of middle-high salt marsh soils (profile 2) were both low C_{HA}:C_{FA} ratio value (0.55 - like in profile 1) and ^{13}C NMR signal line shape similar to profile 3.
The results lead to the conclusion that quantitative and qualitative differentiation in SOM properties corresponded to salt marsh soil development stages. Organic matter of low marsh soils showed some features typical for bottom sediments and SOM transformation in high salt marsh soils was mainly caused by the soil-forming processes. In this light, it is difficult to resolve whether despite the relatively high Corg content and the presence of vegetation profile 1 can be considered as a soil or a sediment.
This study was financed by Ministry of Science and Higher Education (grant no. N305 231135).

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Late glacial and Holocene evolution of Central European lake lands in the light of interdisciplinary studies

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Lowland lake lands with fresh, expressive relief, mosaics of habitats and ecosystems are among the most widely spread and the most characteristic landscapes of Central Europe, in the range of the last Pleistocene glaciation (Würm, Weischselian) extent. However, such landscapes are susceptible to relatively quick transformations according to natural and anthropogenic processes, until the total disappearance of their primary features. Much more extensive former distribution of lake lands can be established considering the range of older Pleistocene glaciations.

The aim of that work is to describe and summarize landscape evolution of the young glacial lake lands on the example of chosen area of the Bory Tucholskie, Pomeranian Lakeland (Northern Poland). The system of four lakes: Mukrz, Ostrowite, Dąbrowa and Błądzimskie and neighboring wetlands is the object of the studies. They occupy a huge depression of the melt-water origin lying in the border area of morainic plateau and outwash plain with system of low dunes. The land surface of the area started to form according to deglaciation of the Pomeranian phase of the Weichselian glaciations, ca 16,8 ka BP. Complex studies of relief, hydrography and soils allowed distinguishing three stages of landscape evolution.

1. Late glacial – period of intensive glaciofluvial and periglacial processes leading to formation of general features of the landscape (e.g. ice-sheet melting, glaciofluvial deposition, forming of dunes) and hydrographical net (forming of lakes and directions of outflow). The exhumation of depressions preserved by dead-ice blocks which started during the oldest dryas period allowed forming a huge palaeo-lake. Relics of it can be found on the lake terrace surface as rendzina-like soils (Calcaric Leptosols) spread in the surrounding area.
1. The landscape at the time of lake formation was a treeless tundra with clusters of willows, sea buckthorn and shrub birches.
2. Eo-mesoholocene – period of stable formation of soils and vegetation (succession of forest vegetation and soil development varying according to site conditions) and slow alterations of hydrographical net (probable shrinking of palaeo-lake, accumulation of lake sediments, development of peatbogs).
3. Neoholocene – period of intensification of human-initiated or accelerated processes strongly altered relief (denudation, aeolian processes), water conditions (building melioration ditches, disappearance and shrinking of lakes and wetlands), vegetation (remove of forests, changes in plant-species structure) and soils (shrinking of wetland soils area, accelerated mineralization of organic matter, spreading of area of podzolization process).

Lowering of water level in system of lakes by 1.3 m (except Mukrz lake) and change of wetlands into meadows since the XIXth Century caused the most intensive changes of landscape proceeding now days.

The results of our studies in general are in agreement with results of other authors, analyzing evolution of relief, water conditions, soils and history of vegetation in landscapes of lowland postglacial lake-lands and can be used as the general scheme.

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Usefulness of lateral meltwater channels in palaeo-ice-sheet reconstructions in northern Finland

PETER JOHANSSON

Lateral meltwater channels occur in the fell region of northern Finland, where at the final stage of the deglaciation the temperate ice lobes covered the valley floors while the summits and the upper slopes were nunataks. The supraglacial meltwater and water from the melting snow was flowed on the surface of the ice sheet. It was concentrated at the contact between the ice margin and the sloping fellside and there eroded a lateral meltwater channel. During the glacial retreat, subglacial surfaces that were previously covered and protected became exposed and a succession of parallel channels was incised into the newly exposed ground creating a distinctive series of lateral channels. Spacing and rates of channel formation were controlled by the topography of the slope, erodibility of the till surface and stream discharge.

The morphology of these channels is variable with the length varing from 100 m to 1 km. At high elevations, they are often short and shallow, less than 0.5 m. The land surface slopes between 6° and 10°. Some have a gouge like form, whereas others may simply have a cross-section that resembles a step or a terrace cut into the slope. At low elevations, the land surface slopes between 3° and 7°. The channels are distinct, 1 - 2 metres deep and the distance between them is 3 - 5 m. This is due to the fact that the rate of melting and the volume of the meltwater were greater as the ice lobe diminished. On the steep slopes (>10°), the ice margin did not migrate laterally as ice thinned and channels did not form. The lateral channels are commonly open at both ends, beginning and ending inconspicuously. They may also terminate in downslope chutes as meltwater was diverted into the glacier via a crevasse. There are also examples of how meltwater concentrated only along one margin of the ice lobe, due to the fact that this area was in a position to receive solar radiation while the opposite margin was in the shade most of the time. The majority of the lateral meltwater channels are situated between altitudes of approximately 250 m and 580 m. The deepest channels were formed at the sides of the ice lobes since the water flow and erosion here was strongest. On the proximal slopes of the nunataks, the gradients were gentle and the channels that formed were shallow.

The lateral meltwater channels are of great importance in the study of deglaciation, since they help construct the position of the ice margin in great detail, which gives a picture of the inclination of the ice sheet, its surface gradient and thinning. The gradient of the ice sheet ranged from 2.5 m near the top of the fell to 5 m each 100 metres in the lower areas, indicating steepening of the ice margin at its snout. The ice margin thinned approximately 1.2 to 3.5 m per year. The channels have been used to delineate the retreat of the ice margin, as well. In some favourable places, the individual channels are regular and the distance between them remains almost constant. There they may have formed due to the annual rate of recession of the ice margin. The rate varied in different parts of northern Finland. In the most northern and eastern parts of the region, which deglaciated soon after the Younger Dryas stadial, around 10,800 - 11,300 years ago, the recession of the ice margin varied 70 - 130 m per year. In the final phase of the deglaciation, ca. 10,000 years ago, the rate of retreat increased to 120 - 220 m. This illustrates the climate warming and the contraction of the continental ice sheet, which in turn accelerated melting and the retreat of the glacial margin. The results from the lateral channels are compatible with the general development trend of deglaciation in northern Finland.

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Sediments, structures and special phenomena in the Cenozoic type region of Central Germany – a contribution to the landscape and climate evolution

FRANK W. JUNGE & LOTHAR EISSMANN

Vast man-made outcrops of lignite coal mining and a grid of boreholes with a density unequalled worldwide have made it possible to prove that the Saale-Elbe region constitutes one of the most important natural archives witnessing of the earth's climatic and geological history, especially for the Cenozoic, an era in which the most significant climatic changes occurred throughout the history of the earth. Often, the sediment layers lie on top of each other in the same way as the pages of a book. The main feature is the interplay of seas and continents, and this from the most ancient Tertiary until the most recent Quaternary, the present time. Over a period of more than 50 million years, the global climate changed over gradually and in long cycles from the subtropical „Greenhouse climate" of the Early Tertiary to warm, moderate conditions and later to the moderate beech climate of the Pliocene and the Early Quaternary. Long-lasting permafrost periods characterised by wide valleys immersed in frost debris with obviously short warm-up cycles are followed by a period of three temporary ice sheet invasions preceded by long-lasting permafrost phases and followed by temporary ice melting phases, which in turn were followed by merely short, but drastic warm-up phases (interglacial periods).

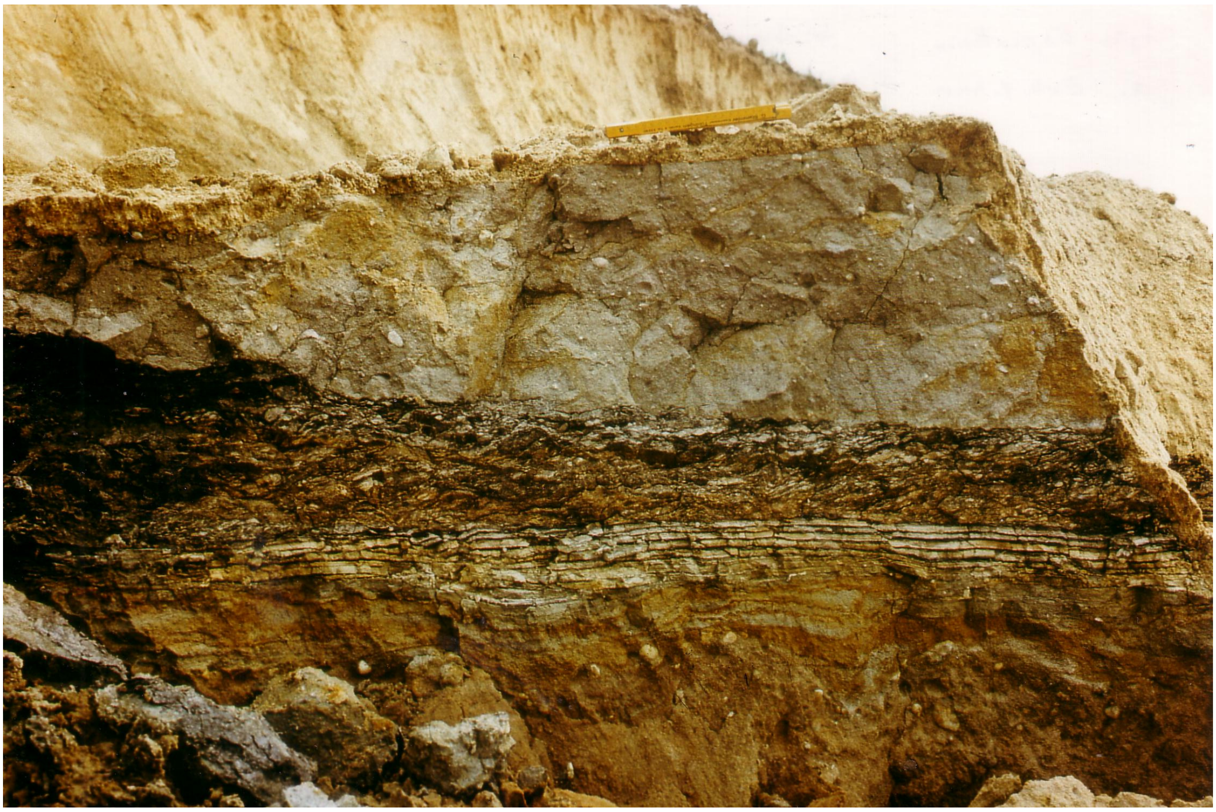

Fig. 1: The ice dammed lake sediment of the Dehlitz-Leipzig varved clay below the first Elsterian glacial till appears in its lower part undisturbed (varvity), in the upper part glacihydromechanicly deformed by flowing melting waters. The glacial deposit (till) lie like a board on the deformed varved clay. 1978. Opencast lignite mine Espenhain. Picture by W. Baumann.

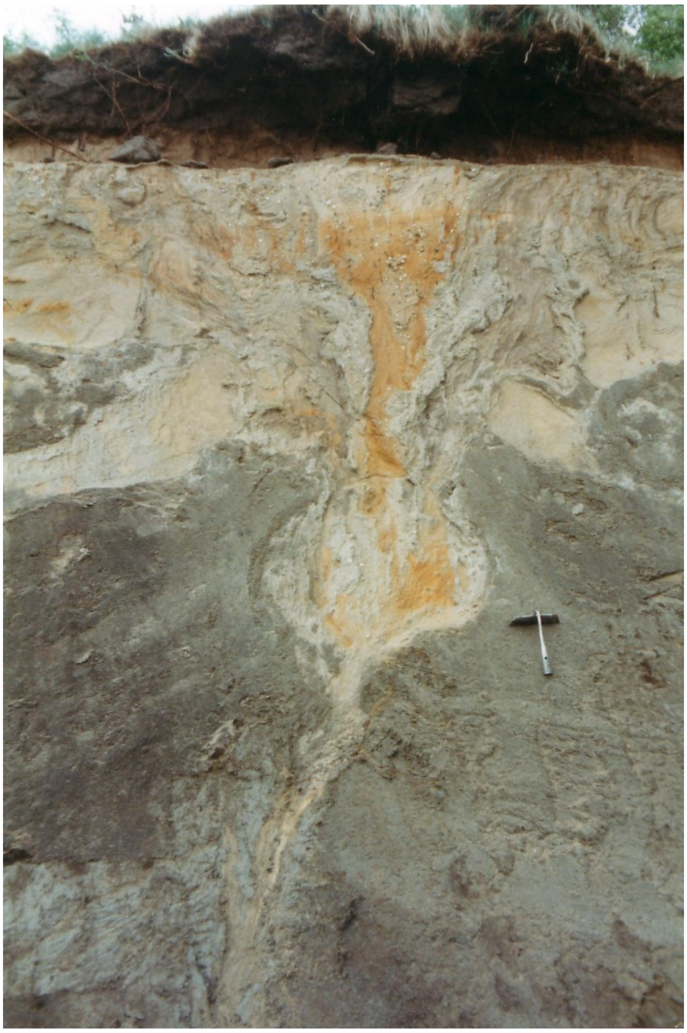

Fig. 2: The broad and wedge-shaped frost structure which is filled with sediments of Weichselian age and is characterized by cryoturbation in its upper part shows a well rounded sac-like protrusion in its lower part. This for many Weichselian ice wedges typical phenomenon is evidently the result of incipient gravitative sinking processes that accompanied simultaneously the thawing process of ice wedge (incipient involution layer formation). The structure ends in subjacent lake sediments of Late Saalian ages (silts). May 1995. Opencast lignite mine Gröbern. Picture by F.W. Junge.

A whole scenery of sediments, structures and phenomena of the glacial (e.g. glacigenic deformations, melt water channels) and periglacial areas (e.g. permafrost structures, diapirism) illustrate the many hundreds of large-scale and small-scale changes in the natural climate-forming process including its extremes of the maximal extension of the Scandinavian ice sheets and the Siberian permafrost. Numerous special phenomena of geochemical (e.g. silifications, concretionary formations), faunistic (e.g. large mammals), floristic (e.g. leave flora, tree trunks) processes, and last but not least the relics of anthropogenic activities of more than 350,000 years (e.g. artefacts) are further testimonies of the landscape and climate forming processes of the last 50 million years which are common to the entire Central European area. By selected photo documents and graphics systematically presented and explained (see examples of Figures 1 and 2), the lecture will illustrate the scope and diversity of the sediments, structures and special phenomena discovered in the unique outcrops of Central German large-scale lignite mines. The base of the presentation forms a submitted for publication german-language book manuscript of the same topic.

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Sedimentological record of Late Weichselian and Early Holocene in the Zbójenko kettle-hole in north-central Poland

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In the south-east part of the Dobrzyńskie Lakeland in north-central Poland there are vast glacial basins the relief of which is dominated by drumlins. They are located in the hinterland of the maximum extent of the Kujawsko-Dobrzyńska Subphase, the Poznań Phase of the last glaciation (Weichselian) in Poland and within the so-called Chrostkowo snout morainic zone. In one of such basins in the vicinity of the village Zbójno there is a vast drumlin field, which was studied by Nechay (1927), Jewtuchowicz (1956), Niewiarowski *et al.* (1995), Olszewski (1997) and others. One of these authors paid attention to the fact that the drumlin forms are separated by kettle-holes filled with small water bodies. They have not yet been studied and that is why this paper aims at presenting mineral and biogenic sedimentation in one of them on the basis of interdisciplinary research methods.

The study object was an intra-drumlin trough filled up with biogenic deposits (Zbójenko). The Więckowski probe was used for collecting undisturbed cores of the deposits down to the mineral bottom. The base for the biogenic deposits was grey glacial till. The cores of the 5.9 m thick biogenic deposits were used for palynological and macroremains analysis. Moreover, the contents of organic carbon (analyser CHN) and macroelements (ICP-MS) were determined together with the ^{14}C dating.

In the roof of the profile, from 5.9 to 4.95 m, there was gyttia covered with high peat, mainly *Sphagnum* (Fig. 1), of diverse level of decomposition (H4 to H1 by the scale of von Post). The development of this type of peat is also observed nowadays.

According to the palaeobotanic analyses the floor of the biogenic material (5.84 and 5.86 m) was deposited during the period of the arctic climate at the end of Old Dryas. The plant community was dominated by tundra with shrubs of sea-buckthorn (*Hippophae rhamnoides*), juniper (*Juniperus*), dwarf birch (*Betula nana*) and willow (*Salix*). Minimum July temperature for dwarf birch is 7ºC (Brinkkemper *et al.* 1987).

After that the climate warmed (Bölling Interstadial), which initiated the advance of forest communities (5.30-5.80 m). At first these were open birch forests (*Betula*) with an admixture of Scots pine (*Pinus sylvestris*). Their development was halted during Younger Dryas (5.25-4.90 m)., i.e. the final episode of Late Glacial. Cooler and dryer climate caused the forests to retreat and the tundra communities to develop. They included a large amount of juniper shrub (13%). When the water disappeared the lowering was invaded by trees (*Betula* sect. *Albae*, *Pinus sylvestris*). After a short episode of the development of fen the area in question was taken by a raised bog represented by *Sphagnum.*

Continental climate and poor habitat at the dawn of Holocene (the Pre-Boreal Period) favoured the spread of pine-birch and pine forests (4.90-4.10 m). The plant taxa which then appeared showed larger climatic and habitat needs (*Corylus avellana*, *Ulmus*, *Quercus*).

During the Boreal Period (4.10-3.70 m), when habitat condition significantly improved, hazel became common and gradually birch communities were displaced. Moreover, elm, oak and other thermophilous species advanced, including lime trees (*Tilia*) and common ash (*Fraxinus excelsior*). Waterlogged areas were overtaken by alder communities (*Alnus)*.

The results of physicochemical and chemical analyses of the deposits corresponded with the palaeobotanic data. In terms of the contents of the selected elements (organic C, Na, K, Ca, Mg) within the profile, it is possible to delimit three zones of accumulation, each for one of the types of the deposit (Fig. 1). Moreover, there were also visible transitional sedimentological and climatic zones, such as the zone between Late Glacial and Holocene (4.95-4.80 m) and between the Pre-Boral and Boral Periods (4.30-4.15 m). The deposits found in the base had an insignificant contents of organic matter (OC 0.47-0.89%) of the nearly neutral reaction (pH 6.6). Maximum contents of calcium, magnesium, sodium and potassium amounted to, respectively, 14.2, 5.6, 0.23 and 5.7 g·kg^{-1}. Gyttia deposits had a diverse content of the organic carbon (from 12 to 40%) and the reaction similar to the deposits in the base (pH 6.1-6.3). The maximum concentration of Ca was 9.9, Mg – 4.0, Na – 0.9 and K – 6.5 g·kg^{-1}. In the overlying peat organic carbon was much over 41%. At the beginning of the raised bog's sedention (4.9-4.55 m) the calcium concentration was relatively high (up to 14 g·kg^{-1}). In such deposits the mean contents of this easily migrating element is 1.8 g·kg^{-1} (Borówka 1992). This might suggest that the peat was enriched with calcium through leaching from the catchment basin. This idea is also supported by the high ration of Ca:Mg (14-20) and a slightly acidic reaction (pH 5.9-6.1). This might have been connected with the mentioned short episode of the development of the fen which was determined on the basis of the analysis of the macroremains.

This study was financed by Ministry of Science and Higher Education (grant no. N N306 282935).

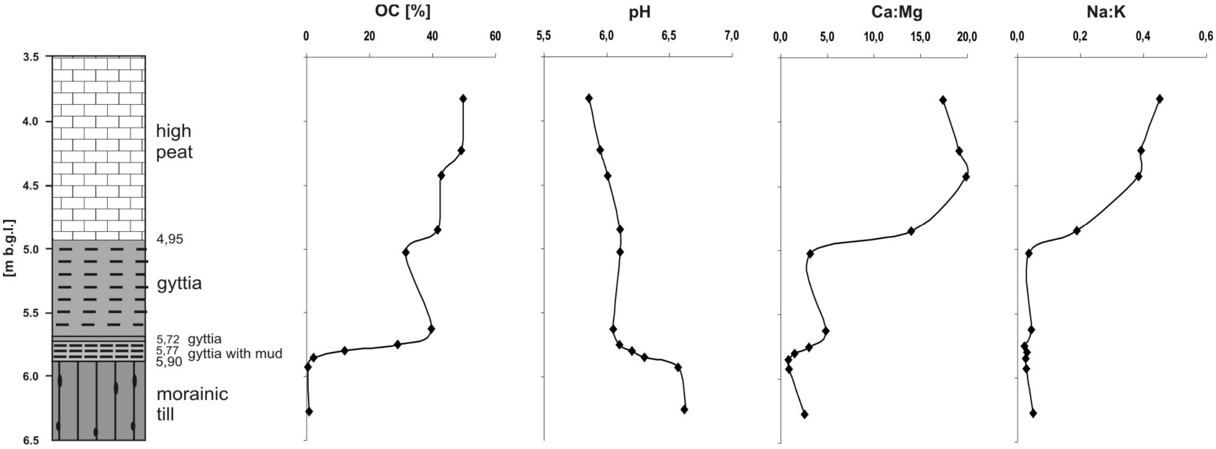

Fig. 1: Litological sketch and vertical distribution of selected elements in Zbójenko profile.

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A man-induced landslide in Lower Austria: natural conditions versus man-made causes

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In many cases, composition and characteristics of hillslope sediments are of particular importance related to landslide research in low mountain areas. The interaction of geologic, geomorphologic, and hydrologic factors determines the susceptibility for mass movements, which is affected by human impact as well. The present study aims to investigate factors that control mass movements and natural and anthropogenic impacts.

On March 8th 2009, a landslide of 30.000 to 50.000 m^3 occurred that destroyed a large part of a sports ground in the village of Hintersdorf, municipality of St. Andrä-Wördern (Lower Austria). As a result of extensive water supply ground liquefaction was initiated and the slide mass moved in form of a mud flow about 200 m down slope. As a consequence a small forest area and a fishpond were destroyed and an adjacent road was damaged. Closely to the event, first studies started and showed that the Hintersdorf landslide was triggered by extensive water saturation combined with hydrostatic pressure inside the slide mass. Heavy and long-lasting rainfalls and the start of snowmelt caused strong seepage and soil water saturation. Furthermore, insufficient ground drainage and overflow of a small retention pond intensified the unfavourable impact on soil-mechanical stability.

Further studies included archive data analysis, field survey, as well as laboratory analysis and showed that high landslide susceptibility at the Hintersdorf landslide site was caused by a bundle of factors that control the process: The sports ground was built nearby the head of a trough valley that collects interflow and surface run-off from the surrounding slopes. The Flysch bedrock is covered extensively by clayey slope deposits. Furthermore, in the area of the valley head a waste deposit was operated up to the 1980's that resulted in a thick waste filling there. The Hintersdorf sports ground was constructed in 1984 on top of the waste body.

Preliminary results show that hillslope sediments and soils in the landslide area are almost impermeable due to their high amount of clay. On the one hand, they are able to seal the floor and to prevent the penetration of polluted water. On the other hand they provide a slide plane for mass movements. In contrast, the comparably low consolidated waste body forms a water reservoir. Due to technical operation, for example the deposition and mechanical compaction of soil material in context with the construction of the Hintersdorf sports ground, the waste body was partly sealed. To outline the result it can be stated that the unfavourable meteorological conditions during the first days of March 2009 caused an increased water pressure in the waste body, which triggered the landslide with damages to forest and infrastructure in Hintersdorf.

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Late Quaternary hydrologic changes in northeast Germany

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Palaeohydrologic knowledge is an essential precondition for several actual environmental issues, such as sourcing of hydrologic changes, re-evaluation of land use strategies and implementation of wetland restoration measures. Even the interpretation of modelled future impacts of climatic and land-cover changes may be improved using (pre-)historic analogies. To improve the understanding of respective interactions, a review of palaeohydrologic findings was performed for northeast Germany with its glacial landscapes of different age. An overview on drainage system evolution during the late Pleistocene and Holocene is given, focussing on the regional development of rivers, lakes and peatlands. River development was examined with focus on valley(-floor) formation and depositional changes, river course changes and palaeodischarge/-floods. Major genetic differences exist among 'old morainic' (Elsterian, Saalian) and 'young morainic' (Weichselian) areas, and among topographically high- and low-lying valleys, which latter are strongly influenced by water-level changes of the North and Baltic Seas. Lake development was analysed with respect to lake formation, which is dominantly driven by late Pleistocene to early Holocene dead-ice dynamics, and with respect to depositional changes. Furthermore, lake-level changes have been in the focus, showing highly variable local records with some conformity. Review of peatland development concentrated on phases of peatland formation and on long-term groundwater dynamics. Close relationships between the development of rivers, lakes and peatlands exist particularly during the late Holocene by complex paludification processes in low-lying river valleys. Until the late Holocene regional hydrology was dominantly driven by climatic, geomorphic and non-anthropogenic biotic factors. Initial structural geologic findings suggest that tectonic and halokinetic influence played a more pronounced role on the hydrographic evolution than previously assumed. Since late mediaeval times human impact by, for instance, damming of rivers and lakes, construction of channels and dikes, and peatland cultivation, has strongly influenced the drainage pattern and the water cycle. Finally natural changes through long-term climatic and geomorphic processes were exceeded by impacts resulting from short-term human actions in the last c. 50 years as discharge regulation, hydromelioration and formation of artificial lakes.

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The automation of implementing geological structure of Quaternary sediments in a regional hydrogeological model, the Latvia case, Baltic artesian basin

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The Quaternary sediments within the borders of Pleistocene continental ice sheets are characterized by large degree of heterogeneity in any scale starting from joint systems and sand stringers in tills on a centimeter scale to the alternation of glacial lowlands and uplands in a scale of hundreds of kilometers. Infiltration rate of shallow groundwater deeper in to the Earth – single major external forcing governing the flow of deep groundwater – is determined by the structure of quaternary sediments at the top of the Earth surface. Developing regional hydrogeological models in such a situation is met with problem to what extent the geological structure can be generalized. The approach can range from assigning simplistic single-layer structure or trying to implement any single bit of geological knowledge about considered sediments in the model. In first case oversimplification is obvious and hydrogeological properties of quaternary sediments need to be defined in the process of calibration, e.g. adjusting single parameter, such as infiltration rate. In the second case work load is overwhelming, but satisfactory results in a limited time span is not likely to be achieved.

Baltic artesian basin covers the territory of Estonia, Latvia and Lithuania as well the territory of Kaliningrad and tiny margins of mainland Russian Federation near borders of Baltic States and the very North of Poland. It is situated in the territory where landscape is dominated by the relief and sediments of Pleistocene continental glaciations. This artesian basin is studied extensively, but most modeling studies are restricted to the territory of single states (e.g. Vallner, 2003). Recently a project was launched with ambition to model the full territory of Baltic artesian basin; however the emphasis on the single country, in this case – Latvia – remains (see web-page for details: http://puma.lu.lv/english-summary/).

Within this project an ambition is made to develop an automated algorithm to create the geometry of geological structure of Quaternary sediments on the basis of existing systematized knowledge of geological structure. Topographic and geological maps as well as maps of geomorphologic regions with associated schematic (simplified) geological cross sections will be used. The borehole data will be used as both input data and calibration tool for the generalized model. The aim is to develop set of rules and descriptions that can be fed to computerized algorithm creating respective geological structure for the need of regional hydrogeological model.

This study is supported by the ESF projects No. 2009/ 0212/ 1DP/ 1.1.1.2.0/ 09/ APIA/ VIAA/ 060 and 2009/ 0138/ 1DP/ 1.1.2.1.2/ 09/ IPIA/ VIAA/ 004.

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Kame terraces as an indicator of conditions of deglaciation in Lithuania during the Last Glaciation

DANGUOLĖ KARMAZIENĖ

A new geological material on the structure of the Pleistocene srata deposits and formation peculiarities of kame terraces in Lithuania is presented. The kame terraces formed between dead ice blocks and the external (with respect to the glacier lobe), i.e. distal slopes of the marginal morainic ridges left by glacier lobes of the Last (Upper Nemunas, Late Weichselian) Glaciation (Figure1). The kame terraces have been subdivided into the glaciofluvial (sand, gravel) and glaciolacustrine (clay, silt) according to their lithological composition (Figure 2, 3).

Fig. 1: Situational scheme. 1 - glaciofluvial kame terraces (size not in a scale); 2 - glaciolacustrine kame terraces (size not in a scale); 3 - limit of the ice-sheet of the Last Glaciation; 4 - the most expressed recessional marginal morainic ridges of the Last (Upper Nemunas, Late Weichselian) Glaciation: EL - East Lithuanian, SL - South Lithuanian, ML - Middle Lithuanian, NL - North Lithuanian; 5 - the main highlands of Lithuania formed during the Last Glaciation; 6 - location of geological cross-section.

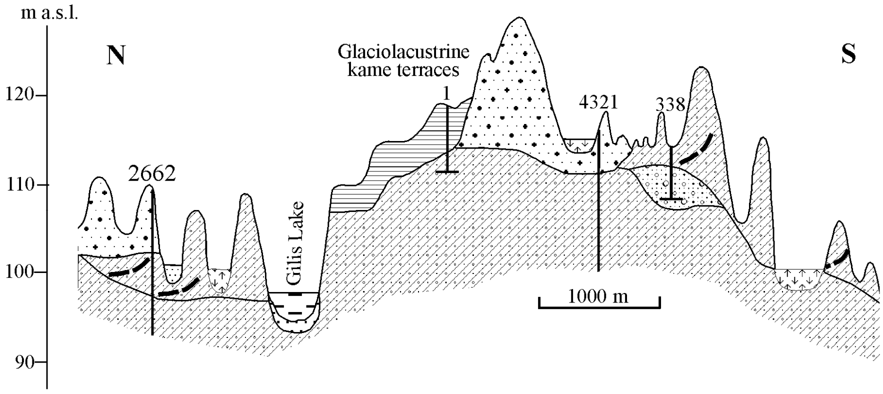

Fig. 2: Geological cross-section glaciofluvial kame terrace close to Užventis. Location of cross-section indicated in Fig. 1. 1 – basal till; 2 – flow till; 3 – gravel; 4 – very coarse sand; 5 – fine sand; 6 – silty sand; 7 – silt; 8 – clay; 9 – peat; 10 - borehole and its number.

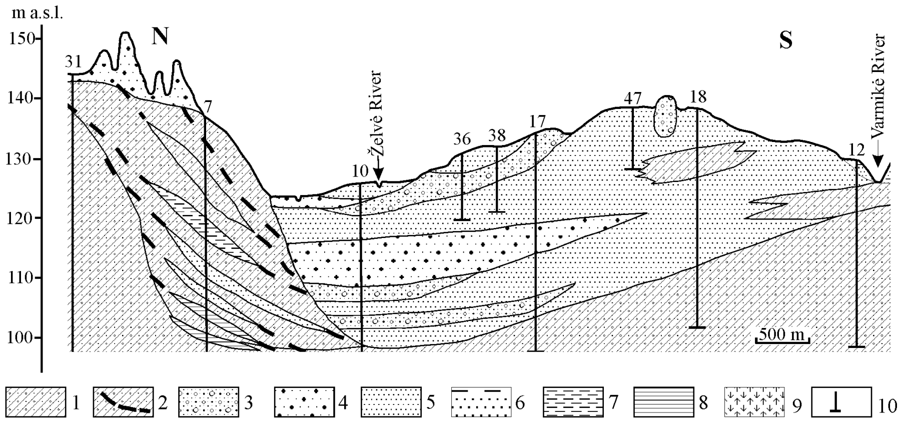

Fig. 3: Geological cross-section glaciolacustrine kame terrace close to Daugai. Location of cross-section indicated in Figure 1. For legend, see Figure 2.

The kame terraces adjoining the distal slopes of the recessional marginal morainic ridges of the Last Glaciation have been found and examined. The origin of these terraces could be explained only by the hypothesis that the accumulation of the above-mentioned marginal ridges and kame terraces took place between the margin of active ice lobes and the blocks of dead ice. (Bitinas, Karmazienė, Jusienė, 2004). Supposing that when the glacier of the Last Glaciation was melting, it was the arial and not the frontal deglaciation that was definitely dominating. The cold periods of glacier activation (so-called stadials and phasials) were changed with warmer periods. However, the latter periods were too cold and too short that the territory could be deglaciated completely, that is why they cannot be interpreted as interstadials or interphasials according to the climatostratigraphic criterion.

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Monetary damage assessment of landslides in Northern Hesse and Southern Lower Saxony

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The diploma thesis "Monetary damage assessment of landslides in Northern Hesse and Southern Lower Saxony" is based on a landslide database, which describes landslide damages in the study area of Northern Hesse and Southern Lower Saxony from the beginning of the 20th century until the year 2007. The database consists of approximately 300 landslide events, nearly each of them characterized by the triggering mechanism, the type of movement, the spatial extension, the magnitude and especially the related damages. The different claims are classified in damage related to road and railroad infrastructure, residential, industrial and public buildings, agriculture and forestry as well as public supply and disposal facilities. The thesis focuses on a standardized collection of the complex direct and indirect damages within the mentioned object categories. Especially the indirect landslide damages are very difficult to assess, nevertheless some general ideas and results are discussed. First of all, the scientific approach of this study targets a detailed description of the governmental and business planning and workflow after a landslide event. This framework is the basis for the successive damage monetization across all different object categories. The aim is to generate standardized monetary parameters, which base upon the costs or the replacement costs of respective disaster response, remedial actions and long-term protection measures.

By means of expert interviews in the fields of road and railroad construction, geotechnical and civil engineering, public administration, craft, banking and insurance industry numerous different monetary parameters are surveyed. Cleaning costs per running meter, road and railroad embankment costs per running meter, rock fall net costs per square meter, average geotechnical report costs, administrative costs as well as diminution in value of real estate should cite as some examples for the different monetary parameters. Hence, the standardization of the resulting costs on concrete physical or logical units allows a supra-regional application of this approach.

An important aspect of this thesis, therefore, is to highlight the possibilities for a general monetary damage assessment uncoupled of the study area of Northern Hesse and Southern Lower Saxony. In the following the surveyed monetary parameters are used to calculate the damage of each landslide event documented in the database since the year 1980. The thesis concentrates only on the time interval of the last 30-years with approximately 130 landslide events, since the geotechnical development of the different remedial actions conflicts with a proper damage assessment before the eighties of the last century.

In the next step the monetary parameters are applied to the different specifications of the landslides listed in the database. Thus, details about the landslide dimensions and the respective remedial actions are well suited for the application of the surveyed monetary parameters. The monetary assessment of the different costs resulting from disaster response, remedial actions and long-term protection measures bases on the prices of the year 2010. Inflation makes it necessary to implement an inflation-adjustment, since the prices of the year 2010 are used for the costs and the replacement costs of the landslide damages for the total 30-year time interval.

The author is aware of the immanent uncertainty, which corresponds to the generation and the application of the monetary parameters, and hence refers to vague and oversimplifying parts within the approach. After calculating the estimated costs of each landslide event, the results are mapped for a clear overview of the different spatial and temporal distribution patterns of the monetary damages. Finally, the results of this thesis and their manifold possibilities of application, especially in the fields of spatial planning, natural hazard management and insurance industry, are discussed.

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Dating of sediments (Infrared-Radiofluorescence method, IR-RF) at the type locality of the Wacken peat

MATTHIAS R. KRBETSCHEK[1] & HANS-JÜRGEN STEPHAN[2]

The organic bed of the Wacken thermomer was detected in the sixties of the last century, exposed in a clay pit near the village of Wacken, West Holstein (Fig. 1). Menke presented an already detailed pollen diagram of that warm phase in spring 1964 during the 37. Tagung der Nordwestdeutschen Geologen. Comparing it with the floral assemblages of the Eemian, Holsteinian, and Cromerian he stated a new thermomer of interglacial rank. The type profile and the pollen sequence were published not earlier than 1968 (Menke) and 1969 (Dücker). The Wacken bed was found intercalating the upper portion of a complex sediment succession that had been dislocated "en bloc" at the pushing ice front of a Saalian glacier re-advance. Its base is built up by Elsterian glacial deposits, overlain by glaciolacustrine to glaciomarine clays and silts (Lauenburg clay) grading upwards into marine Holsteinian silts and fine-grained sands with a marine boreal-temperate fauna. The Holsteinian beds are overlain by a thick succession of very fine-grained sands with ripple marks characterised by many thin lenses of darker silt in the lower part and thin streaks of organic particles in the upper part ("flasersand"). Menke interpreted them as belonging to the end phase of Holsteinian sedimentation.

For a longer time they were thought to represent a wadden sediment (Dücker 1969). However, fauna and other wadden-sea features are lacking. More likely they are fluviatile-estuarine (river) beds. They are overlain by the so-called "white sand", several metres thick, mainly consisting of eolian fine-grained sands. In the upper part these sands become coarser, badly sorted, contain single gravelly grains, are interbedded by some clay layers within the first metres and more or less periglacially disturbed (Mehlbek cold phase). The uppermost clay layer is strongly convoluted ("kerkoboloid horizon", Fig. 2). Between this horizon and the overlying organic bed of the Wacken warm phase periglacial sands with "microcryoturbations" continue. In the midst of the seventies a drilling at the bottom of the pit reached confined ground water. The artesian water flow could not be controlled. The pit was rapidly submerged. In a land slide most of the Wacken succession with the organic bed slid into the developing lake. Its water level was continuously rising.

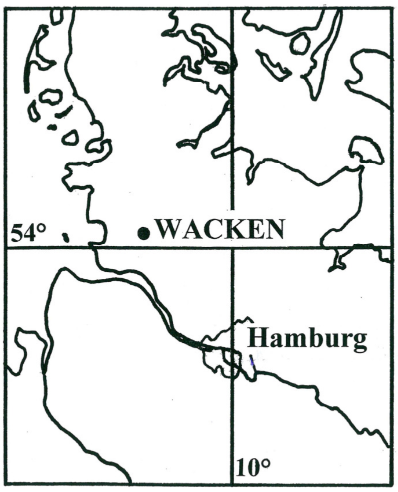

Fig. 1: Location of study site Wacken.

Fig. 2: Wacken peat and underlying sediments of the Mehlbek cold phase with kerkoboloid horizon. Photo: Stephan 1978.

In 2008 only 1 m of the uppermost periglacial sands below the margin of the organic bed was still visible. There the overlying peat is thinning out and split into some streaks. Seizing this last chance, samples were taken from the sands for luminescence dating of sediments (Fig. 2).
The Infrared radiofluorescence (IR-RF) method was applied to determine the age of sediment deposition. A single aliquot dose determination procedure was used (Erfurt & Krbetschek 2003) to account for problems which can arise if sediment grains (100-200 µm) of potassium feldspar used, have not been sufficiently exposed to natural sunlight prior to deposition. Two of the five samples (Wac 2, Wac 5a) which have been dated, show indications of such conditions and so far only maximum ages could be obtained therefore, making further measurements on these samples necessary. However, interpretation of the entire results and especially that of well bleached sediment samples (Wac 1, 3, 4), reliably correlates the dated upper sequence section to MIS 8-MIS 7. Most probable is therefore a link of the Wacken thermomer with an early warm phase of MIS 7.

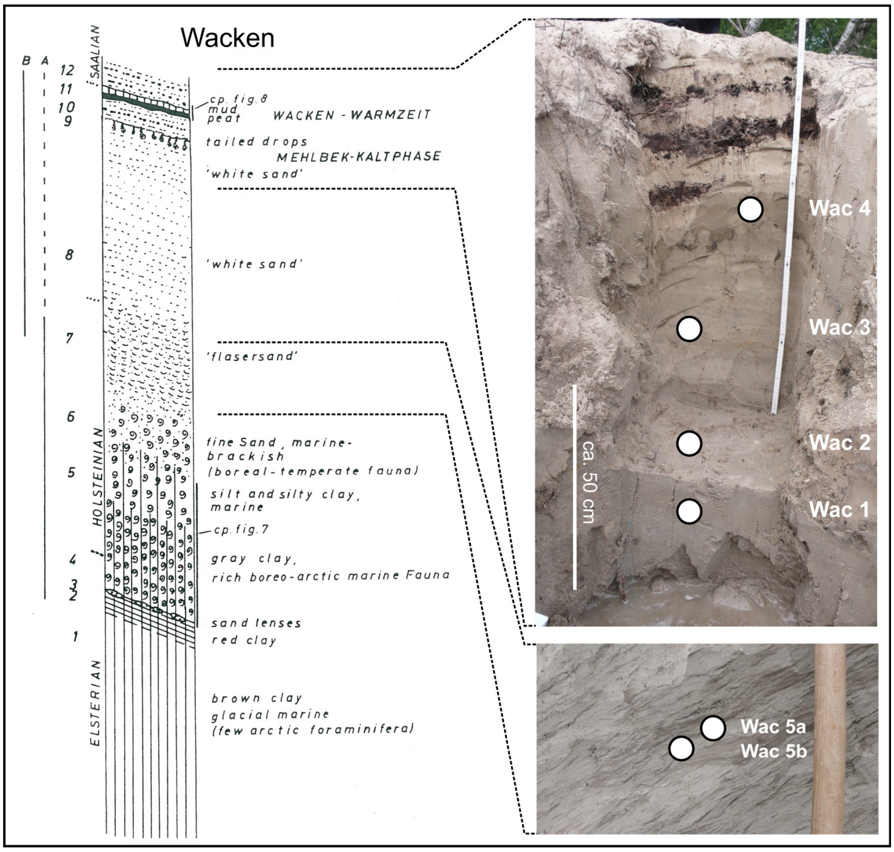

Fig. 3: The “Flasersand” and the uppermost part of the Mehlbek sediments in 2008, ca. 10 m to the left. Sample positions and the approximate correlation of the remaining sequence sections to that of the former outcrop (left: Menke, 1980) is shown.

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Der Geopark Nordsachsen – Quartäre Landschaftsgenese und geotouristische Potentiale

ANNETT KRÜGER & JÜRGEN HEINRICH

Informationen über geowissenschaftliche Sachverhalte, zur Entstehung unserer heutigen Landschaft und deren Nutzungspotential gewinnen im Zuge der Umweltbildung seit den neunziger Jahren zunehmend an Bedeutung. Die Entstehung von Landschaften, deren Genese, Oberflächenformung, naturräumliche Ausstattung und auch deren Nutzung durch den Menschen wird weltweit in Geoparks vermittelt. Dabei wird ein Geopark im Allgemeinen– auch ohne nationale bzw. internationale Anerkennung- als ein Gebietsstatus einer naturräumlichen Einheit verstanden, die bestimmte Ausstattungsmerkmale ausweist und diese vereint. In einem Geopark werden Geotope, in neuerer Teminologie auch s.g. Geopunkte, infrastrukturell und touristisch erlebbar in Form von Geo-Routen/Erlebnispfaden u.a. zugänglich gemacht. Als Geotop werden dabei neben geologischen auch landschaftsgenetische, bodenkundliche, botanische, archäologische und kulturhistorische Sehenswürdigkeiten verstanden. Ein Geopark ist insofern als eine Region mit landschaftlicher Schönheit und besonderen geologischen, geowissenschaftlichen Merkmalen zu verstehen. Die Ausweisung eines Geoparks und die geotouristische Vermarktung erfolgt dabei einerseits mit dem Ziel einer Umweltbildung, aber auch unter dem Aspekt des Geotopschutzes sowie unter Berücksichtigung regionalplanerischer Gesichtspunkte mit dem Ziel einer nachhaltigen Landschaftsentwicklung.
Im Jahr 2006 wurde der Geopark Nordsachsen gegründet, eine Anerkennung als nationaler Geopark wird angestrebt, steht aber derzeit noch aus. Die Region des Geoparks Nordsachsen liegt am Rande der Leipziger Tieflandsbucht, im Bereich des Nordsächsischen Platten- und Hügellandes, welches sich durch seine enge Verzahnung von flachwelligen Moränenplatten und hügeligen bis kuppigen Festgesteinsdurchragungen auszeichnet.
Der Geopark Nordsachsen erstreckt sich von der Auenlandschaft der Mulde im Westen über die Hohburger und Dornreichenbacher Berge bis zu den Ausläufern der Dahlener Heide im Osten.
Der geologische Bau wird für den Naturraum des Nordsächsischen Platten- und Hügellandes in vier Stockwerke gegliedert:

- **Grundgebirge (Nordsächsischer Sattel)** mit Grauwacken- und Schiefergesteinen des Präkambriums (insbesondere des Proterozoikums) und des älteren Paläozoikums,
- **Molasse-Stockwerk (Nordsächsischer Vulkanitkomplex)** mit verfestigten Sedimenten und Eruptivgesteinen des Rotliegenden,
- **Deckgebirge** mit verfestigten Sedimenten des Zechsteins und des Bundsandsteins (**unteres Deckgebirge**) sowie des Tertiärs und Quartärs (**oberes Deckgebirge**).

Die heutige Oberfläche des Geoparks Nordsachsen wird neben den vulkanischen Gesteinen und tertiären Ablagerungen insbesondere durch die Prozesse und Ablagerungen des Quartärs, speziell des Pleistozäns, geprägt. Morphologisch treten im Geopark Nordsachsen mächtige Grundmoränen aus der Elsterkaltzeit nicht in Erscheinung, dagegen jedoch saalekaltzeitliche Ablagerungen. Der Hauptvorstoß der Saalkaltzeit führte bis zur Linie Geithain - Grimma - Döbeln – Lommatzsch. Die Inlandeismassen rückten nach Abschmelzen mehrmals wieder vor, bei einem späteren erneuten Vorstoß kam es zur Bildung der Dahlener Stauchendmoräne und dem dazugehörigen Sander am Südrand, welcher den Osten des Geoparks Nordsachsen begrenzt. Der erdoberflächennahe Untergrund wird im Wesentlichen durch im Periglaial abgelagerte, äolische Sedimente (schluffiger Treibsand bis Sandlöß, 0,5-1m mächtig) als Ausgangsgestein der Bodenentwicklung geprägt. Diese wurden in Leelagen während der Saalekaltzeit und insbesondere während der Weichselkaltzeit akkumuliert. Sie bedecken die älteren Gesteine und reichen bis zu den höchsten Erhebungen des Gebietes hinauf. Bis zur Saalekaltzeit lag der betrachtete Raum des Geoparks Nordsachsen zwischen den großen Entwässerungslinien des Elbe- und Mulde- Saale- Systems, das Flussnetz in der heutigen Form ist erst seit der Weichselkaltzeit entwickelt. An der Mulde, die den Geopark westlich begrenzt, sind daher

Flussschotter der Weichselkaltzeit weit verbreitet und insbesondere zwischen Wurzen und Thallwitz stark ausgeprägt. Im Holozän tiefte sich die Mulde in die Schotter der Weichselkaltzeit ein, ohne sie restlos abzutragen. Heute liegen die 8-12m mächtigen weichselkaltzeitlichen Schotter 2-5 m über dem Aueniveau und bilden die Niederterrasse. Sie stehen in Verbindung mit der Mulde und führen Grundwasser, welches für die Wasserversorgung Leipzigs gefördert wird. Die weichselkaltzeitlichen Schotter werden im Auenbereich der Mulde von fluvialen Sedimenten (Auelehm) überdeckt.
Entsprechend dieser Ausgangssubstrate findet man im Geopark Nordsachsen verschiedenste Bodenformen. Im Auenbereich der Mulde und der Lossa sind vorwiegend Braunaueböden (Vegas) aus Auelehm über Flussschotter ausgebildet. Auf Geschiebestandorten treten in der Regel Parabraunerden, über Schmelzwassersanden Braunerden auf. Über kaolinreichen Verwitterungsmaterialien und Geschiebelehmen entwickelten sich vor allem Staunässeböden (Pseudogleye), wogegen über oberflächennah anstehendem Gestein Trockenstandorte mit Regosolen ausgebildet sind. An den Hängen der Festgesteinsdurchragungen sind Braunerde-Fließerden über Hangschutt entwickelt. Die natürliche Vegetation wird im Geopark Nordsachsen vorrangig durch Stieleichen-Hainbuchenwälder mit Anteil an Winterlinde gebildet. Auf Trockenstandorten herrschen Traubeneichen vor.
Die so dokumentierte breite geowissenschaftliche Palette an lokalen, regionalen und überregionalen geologischen Besonder- und Eigenheiten zeigt das enorme Potential für die Entwicklung von Geotourismus. Dieses Potential an naturräumlicher Ausstattung der Region bildet die Grundlage für die Etablierung des Geoparks Nordsachsen. Dies bezieht sich aus geologischer Sicht insbesondere auf die Standorte der Gletscherschliffe („Kleiner Berg“, Spitzer Berg“ u.a.), an welchen die Theorie der Inlandeisvorstöße wissenschaftlich belegt werden konnte. Diese Kleinode stellen neben den anderen, in der Region vorhandenen geologischen Potentialen aufgrund ihres thematischen Schwerpunktes eine wesentliche Basis für den Geotourismus dar, insbesondere auch im Hinblick auf die Abgrenzung zu anderen Regionen wie z.B. das Leipziger Neuseenland.
Die so beschriebene naturräumliche Ausstattung lässt sich für den geowissenschaftlich interessierten Betrachter anhand zahlreicher Geotope erlebbar gestalten. Im Rahmen des Posterbeitrages sollen diese entsprechend benannt und beschrieben sowie ihre Eignung als touristischer Anlaufpunkt dokumentiert werden. Die Umsetzung für geotouristische Angebote werden im Rahmen des Posterbeitrages dokumentiert.

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Distribution of raw material for prehostoric flint artefacts in Lithuania

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The first Lithuanian postglacial (Late Palaeolite) inhabitants used flint for production of knives, burins, borers, scrapers, axes, arrowheads, etc. The network of finding sites of Palaeolithic and Mesolithic flint artefacts almost coincides with the distribution of flint concretions (nodules).

The study was accomplished in a few stages: 1 – familiarization with the archival and literary material on the spread, composition and genesis of siliceous rocks in Lithuania and neighbouring countries (Belarus) and its systematization; 2 – analysis of characteristic flint artefacts of the Stone Age stored at the Lithuanian museums and their statistical evaluation and sampling for laboratory examination; 3 – field works in the Lithuanian regions known for flint artefacts and sampling for laboratory examination; 4 – laboratory work and statistical and graphical generalization of obtained data.

Direct Current Arc Emission Spectrophotometric analysis was used for determining the distribution of some macro- and microelements in flint varieties (flint concretions, siliceous nodules, stratified gaize) and in archaeological flint artefacts for highlighting the differences. Twenty eight chemical elements were determined (Ag, Al, B, Ba, Ca, Co, Cr, Cu, Fe, Ga, La, Li, Mg, Mn, Mo, Nb, Ni, P, Pb, Sc, Sn, Sr, Ti, V, Y, Yb, Zn, and Zr). The measuring units were mg/kg for most of them or percentage for Al, Ca, Fe and Mg.

The artefacts, most likely, are made of the raw material of triple genesis: Upper Cretaceous concretions, Upper Cretaceous stratified flint and Upper Devonian siliceous rocks. The artefacts of South Lithuania ancient settlement can be identified as made of the local flintconcretions. However, the raw material of Western Lithuania artifacts is presumably of two types: flint concretions imported from the south and the local stratified flint (silicified gaize).

The Cretaceous flint concretions (with a typical concentric structure) and Devonian siliceous nodules (silicified rounded rock concretions) are sized 2–30 and even 70 cm. The Upper Cretaceous gaize and thin interlayers (lenses) of its silicified varieties lying in the carbonaceous rock mass are known in Lithuania. Silicites were scattered over a large territory by advancing glaciers in south-western, southern and south-eastern directions. It was observed that the network of finding sites of Palaeolithic and Mesolithic flint artefacts almost coincides with the distribution of flint concretions in the Upper Cretaceous carbonaceous sediments.

The grey gaize and its strongly silicified varieties sometimes referred to as flint attracted attention when studying the evolution of the cultural landscape of Žemaičiai Upland. These flint artefacts are genetically related with the erosion relicts of the Late Cretaceous Campanian rocks in the sub-Quaternary surface, which were used as a tool material in the Stone Age.

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Mid- to Late Holocene human impact on a till plain recorded in sediments of a kettle-hole (Kühlenhagen, NE-Germany)

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In advance of the installation of the OPAL-gas pipeline geoarchaeological investigations took place at a kettle-hole close to village Kühlenhagen (Western Pomerania) in August 2009 (RUCHHÖFT et al. 2010). The study site is embedded into a flat and undulating till plain, which is characterized by several kettle-holes and rather small wet depressions representing local sediment traps for colluvial sediments (HELBIG et al. 2002). According to adjacent archaeological findings from the Neolithic to Modern times they are sedimentary tracer of human impact.
The sedimentary fill of the investigated depressions comprises basal sediments of basal peat, gyttja and aggradational peat reflecting Early to Mid-Holocene hydrological changes. The upper sequence of colluvial layers and interposed organic sections indicate temporal varying human impact. While AMS ^{14}C, palynological and archaeological dated buried peats, half bog and a mineral humic horizon reflect interim phases of surface stability, relative dated colluvial sands linked to the adjacent local archaeological records display phases of modest to accelerated prehistorical and historical human activities resulting in erosional processes during the Late Neolithic period, the transition Late Bronze Age to Early Iron Age, the Medieval and finally since the New Ages. Accumulation of the youngest colluvium finally leads to the marginal filling of the kettle-hole up to the recent surface.

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Hazards and benefits from melting glaciers in the Hindukush, Chitral, Pakistan

ROMAN LAHODYNSKY, RIAZ UL HASSAN & MUHAMMAD RAHMAT ULLAH KHAN

Accelerated melting of glaciers during the hot summer seasons causes mud flows and floods, damaging villages, roads, irrigation channels, gardens and crops. The catastrophic debris flow in Sonoghur, June 2007, may be followed by subsequent events, but protective measures are feasible. The Trichan-Attakh Irrigation Channel will distribute glacier water from the Tirich Mir through a tunnel for the irrigation of more than 10000 acres of arable land high above the Turikho River gorge.

Das von der Klimaerwärmung beschleunigte Abschmelzen der Gletscher während der heissen Jahreszeit verursacht Schlammströme und Überflutungen, welche Siedlungen, Straßen, Bewässerungskanäle, Gärten und Felder zerstören. Ende Juni 2007 mobilisierte ein Gletschersturz einen Schuttstrom, welcher große Teile der Ortschaft Sonoghur (ein Kulturdenkmal im Bezirk Chitral) unter sich begrub. Der Schutt- und Schlammstrom verliess dabei das Bett des dem Mastuj Fluß zuströmenden Seitenbaches, welcher sich am talaufwärts gelegenen Rand des eigenen Schwemmfächers eingegraben hatte. Da die Bevölkerung vor dem herannahenden Schutt- & Schlammstrom fliehen konnte, waren keine Menschenleben zu beklagen. Es entstand jedoch beträchtlicher Sachschaden durch Zerstörung der Häuser und Gärten. Die Bevölkerung wurde auf die westliche Talseite des Mastuj Flusses gebracht, wo sie in Notquartieren mit Blick auf das verlorene Eigentum untergebracht ist. Im Rahmen einer Vorstudie gemachte Beobachtungen im Gelände lassen erwarten, dass der Ort durch entsprechende technische Maßnahmen (breiteres, vertieftes Gerinne) vor weiteren Schuttströmen geschützt werden kann.
Der Trichan–Attakh Bewässerungskanal (Mulkoh, Chitral, NWFP) stellt das derzeit größte, im Bau befindliche Projekt zur landwirtschaftlichen Bewässerung der trockenen Hänge westlich des Turikho Flusses dar. Die Ortschaften (Uthal, Drasan u.a.) an den Hängen oberhalb der Schlucht des Turikho Flusses nutzen zunächst die lokalen Gerinne und die Schneeschmelze zur Bewässerung der Gärten und Felder. An vielen flacheren Hangabschnitten wurden kleinere Bewässerungsteiche angelegt, reichen aber schon im späten Frühjahr bei weitem nicht aus. Die Idee, schmelzwasserreiche Bäche von den Gletschern des Tirich Mir (7700m) umzuleiten, bestand bereits seit 1986, konnte aber von der Bezirksverwaltung in Chitral allein schon aus finanziellen Gründen nicht verwirklicht werden. Die Bewässerungsabteilung der Regierung der NW-Grenzprovinz hat nach einer Machbarkeitsstudie die Ausarbeitung eines Kanalprojektes in Auftrag gegeben, mit welchem seitens der planenden Firma MR-Consult begonnen wurde; beratend unterstützt von den für GC-Salzburg am Lowari-Tunnel tätigen Geologen und Ingenieuren. Im Zuge dieser Tätigkeit wurde die Kanaltrasse begangen und aufgrund von Geländeaufnahmen und einer Bohrung eine geologische Tunnelprognose für den ca. 730m langen Scheiteltunnel erstellt sowie die Position des Einlassportals verlegt. Die Kanaltrasse verläuft vom Attakh-Gol über eine Strecke von ca.15km Luftlinie auf über 4000m Seehöhe zum Zani-Pass generell in SW-NE Richtung in stark verfalteten Epidot-Chlorit-Glimmerschiefern und Quarzphylliten der Wakhan-Formation (Perm-Trias). Der Kanal wird das Wasser des Attakh-Gletscherbaches vom Tal des Tirich-Gol ableiten und mehr als 10000 Acres (etwa 40km^2) oberhalb des rechten Ufers des Turikho Flusses bewässen. Die trockene Ebene „Kagh Lasht“ (kagh = karg!) oberhalb des linken Ufers zwischen den Flüssen Turikho und Mastuj zu bewässern wird Gegenstand eines weiteren Projektes sein.

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Erosion resistance on nature trails in northern Finland

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Increasing tourism is putting pressure on nature trails in northern Finland, where nature is vulnerable and the climate is severe. Nature trails at tourist destinations are situated in places that have nature attractions and beautiful views. This is often based on the geology of the area. These geo-environments as tourist attractions are sensitive to erosion due to their geologic properties.

The aim of the study is to investigate how and at what rate geologic factors are affecting the resistance to erosion in different geologic environments at tourist destinations in northern Finland. The purpose is to investigate equipment for estimating and monitoring erosion problems, to create a classification of erosion resistance for different types of geo-environments and to make recommendations for planning new nature trails based on these factors.

The bedrock in Finland is part of Fennoscandian Shield, which is the oldest bedrock (1.8-3.1 Ga) in Europe. It consists mainly of quartzite, amphibolites, granulites and granites. In the study area, these rock types have been resistant to erosion and are currently seen in fell areas in Finnish Lapland. The bedrock in the topographic depressions consists mainly of schist, limestone and greenstone (MIKKOLA 1941, LEHTONEN et al. 1998)

Finland was repeatedly covered by continental ice sheets over the last two and half million years. Various Quaternary deposits and glacioerosional features have been formed due to the position in the central area of the ice sheet and the variation in glacial dynamics. Different kinds of till beddings, moraine formations and glaciofluvial deposits were also formed (KUJANSUU 1967, AARIO 1977 AND 1990, HIRVAS1991, JOHANSSON & KUJANSUU 2005)

Methodology

The study area is in northern Finland and consists of 10 geologically variable target areas. From every target area 3-6 sites were chosen. The status of erosion, thickness of mineral soil cover and organic layer were estimated. Soil and stone samples were taken both on the nature trails and beside them and analyzed in the laboratory for different parameters. Dielectricity was measured to determine variations on moisture conditions. Also, non-geological factors, were taken into consideration, such as climatic conditions, precipitation, snow cover, temperature and vegetation type. The type and seasonal use of the nature trails were identified and the amount of visitors was estimated.

The Ylläs target area

One of the target areas is Ylläs, which is situate in western Lapland and is a part of the Ylläs-Pallas National Park. The sites are located on the 12 kilometer long nature trail going around Keskinenlaki, one of the three highest points of the Ylläs fell. The top of Ylläs fell is 718 m above sea level. The bedrock is quartzite, which is a hard and erosion resistant rock type consisting mainly of quartz and lesser amounts of feldspar and mica. The quartzite areas are surrounded by different kind of volcanic stones, mica schist, phyllite and granite.

Based on the stratigraphic record, multiple glacial advances and retreats have been studied in the area (HIRVAS 1991). The last ice flow direction of continental ice sheet was towards the north-northeast. The area was deglaciated about 10,000 years ago (JOHANSSON & KUJANSUU 2005). The main soil type of the area is basal till. On the higher level of Ylläs fell, the till cover is thin or absent. The peak areas are covered by block fields.

The sites are situated in different kinds of geo-environments like overflow channels, gorges and fell slopes at variable elevation levels. The vegetation varies from luxuriant brook side forest to a poor vegetation type consisting mostly of lichen. Also, the thickness of the organic layer varies. Thick organic layer protects mineral soil from erosion.

At the sites situated at a higher elevation level, where the soil cover and the organic layer are thin, the erosion is stronger. There are also lower moisture contents and smaller seasonal variations. The grain size distribution shows that at these sites the material is finer on trail than beside it.

On the steep slope, the erosion was naturally more obvious, but also the direction of the trails in relation to contour lines is important. The trails that gently follow contour lines are in better condition even at the higher elevation levels than the trails located vertically against contour lines at lower elevation levels.

In Ylläs, the rock composition of pebbles is similar at every site. The stone pebbles taken from the trails were smaller in size and mostly more rounded than beside the trails.

Also, the soil moisture has seasonal variation. In early summer, the moisture of the soil beside the trails was higher than on trails, but in autumn the situation was opposite. High water content has an influence on the trails during winter and spring, when frost erodes and heaves the pebbles.

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Distribution, spatial arrangement and internal composition of plateau-like hills in insular accumulative glaciostructural uplands of Latvia

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Analysis of morphology, spatial distribution and arrangement of plateau-like hills is based on data derived from topographic maps of scale 1:10 000, geological maps of scale 1:50,000, aerial images and digital elevation models using GIS tools. In comparison with previous works this allows to define more substantially distribution and morphology of plateau-like hills within insular accumulative-glaciostructural uplands.

Insular accumulative-glaciostructural uplands are isolated large interlobate macroforms with strongly disturbed Pleistocene deposits that form diverse glacial landscape. These uplands can be divided into definite peripherial and central zone. Marginal formations of peripheral zone almost entirely surround the most elevated sabglacial and intraglacial landforms of the central zone. The plateau-like hills are most common and largest formations of this zone. There have a little slightly hypsometric position as composite hilly massifs that locate to ice masses convergence zone during Late Weichselian glaciation. Commonly the plateau-like hills occur in groups forming from 12 sq.km to 820 sq.km large areas. The main topographic features of these landforms are flat-topped surface, rather steep slopes (15 - 40°), which in places are terraced, but commonly incised by gullies.

Detailed studies of spatial distribution, morphological features and internal structure reveals only slight regional differences in arrangement, morphology and composition of plateau-like hills between glacial uplands. Only few plateau-like hills can be encountered in the Alūksne Upland, which is smallest one among the accumulative-glaciostructural type uplands in Latvia. On other hand almost equal quantity, similar morphology and arrangement of these hills occur in Vidzeme and Latgale uplands.

Analyzing areal distribution of these relief forms, as well as, their outer morphologic indications, it is possible to declare, that there are small regional differences in miscellaneous uplands. In Aluksne upland plateau-like hills are represented with a few typical relief forms, on other hand in Vidzeme upland and Latgale upland almost equal quantity of existent forms are both similar and different, that particulary expresses in character of arrangement.

The compact and diffuse areas with variable density of plateau-like hills can be distinguished. The elevations of hill tops and bases vary not only between distinct areas but also inside each area (Fig. 1). The most elevated parts of landforms trend to marginal parts of the area, that accompanied by thickening of glaciolacustrine sediments common in most part of flat-topped surface. The major part of these hills is built up by glaciotectonic folds cored by glacioaquatic sediments and overlapped by deformation till. On the slopes the folded structure are complicated by overthrusts. The glaciotectonic base is overlaid by glaciolacustrine massive, in places varved-like clay or clayey silt with relatively thick (0.5 - 2 m) interbeds of sand and gravel.

It could be suggested that glacioaquatic material composing core of glaciotectonic deformation was deposited during transgression of the Last Weichselian glaciations and later buried by basal till. The structural base of the hills was primarily formed as a result of subglacial glaciotectonic deformation. Later on under conditions of stagnant ice, clay, silty clay and sandy-gravel material were deposited on the top of the glaciostructural base. The deposition of glaciolacustrine sediments occurred during the Gulbene deglaciation phase when marginal formations of the peripherial zone were created.

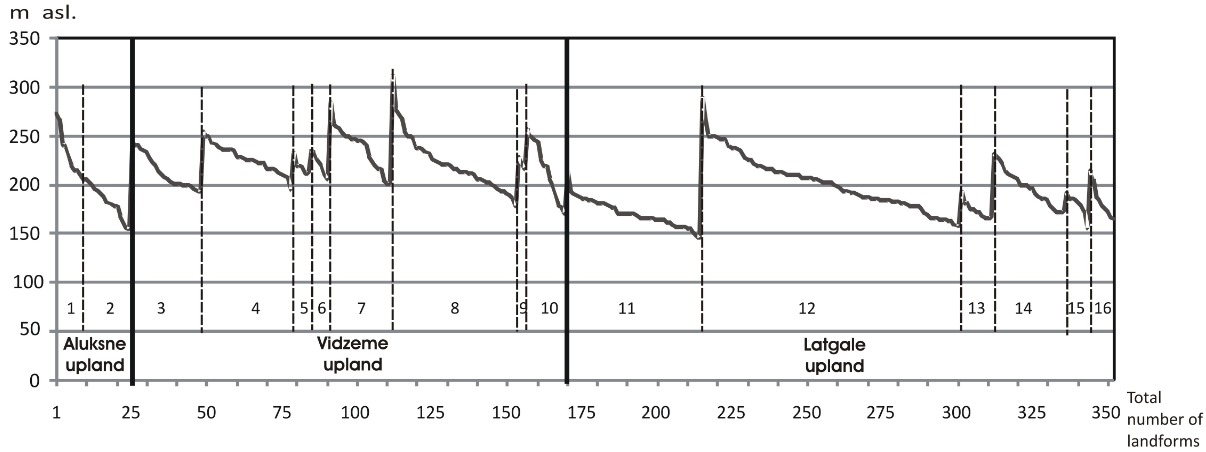

Fig. 1: Hypsometric location of plateau-like hills in insular accumulative -glaciostructural uplands of Latvia (1-16 - plateau-like hills area: 1- Iceniesu; 2– Strautinu; 3- Drustu; 4- Skujenes; 5- Stepelu; 6- Kaibenu; 7- Liezeres; 8- Erglu; 9- Lauteres; 10- Savites; 11-Burzavas; 12- Raznas – Pildas; 13- Gailisu; 14- Aulejas; 15- Osvas; 16- separate landforms).

Analysis of the distribution and spatial arrangement of the plateau-like hills in respect to the composite hilly massifs and the landform complexes, particularly ice marginal formations is carried out to establish event sequence in their formation and relationship with main phases of the decaying of Late Weichselian glaciations in insular accumulative-glaciostructural uplands.

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Zementstein erratics of Greifswalder Oie type: Lithology and fossil content

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Carbonate-cemented tuffites of Paleocene/Eocene age, found as erratic boulders at the southern coast of the Bay of Greifswald and on the Greifswalder Oie, a small island in the Pomeranian Bay (southern Baltic Sea), were already described by DEECKE (1903) as so called Zementstein. These rocks are comparable with calcareous concretions (cementsten) of the Danish Moler (Fur Formation) in North Jutland that represent numerous carbonate-cemented volcanic ash layers in a clayey diatomite (PEDERSEN et al. 2004). Another type of Zementstein erratics is known from NW Germany. They are characterized by sandy-marly-limy rocks, which contain tuffites (HUCKE & VOIGT 1967). However, the Danish Moler type is far more fossil-bearing compared with the Zementstein types in northern Germany.

By now, there are only a few descriptions and monographic characterizations of the flora and fauna as well as the lithology of the Zementstein of Greifswalder Oie type available that can serve as a basis for a comparison with the Danish Moler. During an excursion in October 2009 two different Zementstein varieties were found and sampled on the Greifswalder Oie. The most frequent Zementstein erratics are usually dark grey in colour, and show mainly parallel or cross bedding; subordinate they are unstratified. They are characterized by interbeds of thin, yellowish-brown layers of fine-grained carbonate (calcite and? siderite) and dark layers of up to several centimetres in thickness, which contain calcitic-cemented glass shards. These layers of volcanic ashes are intensively bioturbated, starting from the carbonate layers above. Another variety of Zementstein occurs as concretions in a raft of Tertiary age exposed at the south-eastern coast of the Greifswalder Oie (cf. OBST 2010). These concretions are slight grey to yellowish (when weathered) in colour, and are lentiform embedded in grey clay. They consist of sandstone interbedded by tuffite. The sandstone is calcitic-cemented and intensively bioturbated. The major components are quartz, followed by minor amounts of feldspar and glauconite. The quartz and glauconite grains are often coated with limonite that point to redeposition of these particles. Furthermore, the occurrence of sphaero-siderite can be used as an indicator for a shallow marine environment, because the development of sphaero-siderite is related to the contact of fresh water to brackish water (UFNAR et al. 2004). However, crystallization processes during early diagenesis (MIDDLETON & NELSON 1995) can not be excluded.

Both Zementstein varieties are generally poor in fossils, whereas the loose erratic boulders are more fossil-bearing. The most common fossils are ichnofossils like *Taenidium* (KNAUST 1992), the worm tube *Oiella voigti* (HINZ-SCHALLREUTER & SCHALLREUTER 2000), and faecal pellets (HINZ-SCHALLREUTER & SCHALLREUTER 2000). Additionally, remnants of different macrofossils are reported. These are a cedar-like cone of a conifer (GOTHAN & NAGEL 1922), fragments of a plane tree (SÜSS 1980), a fish scale (HINZ-SCHALLREUTER & SCHALLREUTER 2000), shark teeth (KNAUST 1992, ANSORGE unpubl.), shark vertebras (ANSORGE unpubl.), various fragments of insects, especially wings (ANSORGE 1997, 2000), and probably a residue of a turtle (OBST 2010).

Most of the microfossils are diatoms, which are often arranged in tiers, but are mostly broken. They are represented by pennate and central forms (REICH 2000). For example, typical genera are Paralia, Coscinodiscus and Stephanopyxis. New investigations suggest the occurrence of agglutinated foraminifers and new sponge needles (probably triaene).

It has to be noted that body fossils of the other Zementstein variety (in the raft) are very rare and need further investigations. It can be concluded that the occurrence of different floral and faunal associations implies a deposition at the inner shelf. This is in contrast to the Danish Moler that was deposited at deeper water level.

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New results for the Quaternary stratigraphy of Neumark-North (Geiseltal)

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The results of sedimentological, palynological and malacological examinations of sediments from the central region of the paleo lake basin Neumark-North 2 (NN2) are presented and compared with the situation in the Neumark-North 1 basin (NN1). Both basins evolved in peripheral sinks between lignite diapirs (THOMAE 1990, MANIA et al. 2008). The understratum of the basin sequence was formed in each case from the first Saalian Till (Drenthe stage, Zeitz phase). The limnic layer sequence about 11 m thick of the main profile A in the NN2 basin consists predominantly of lake silt; in the upper part to a lesser degree silt mud, calcareous mud as well as detritus and algae mud formed. In the lowest section of the profile, the lake silt consists mainly of resedimented till. This is followed by a stronger presence of aeolic matter. This development continues to the upper stratum under the influence of the wooded landscape which was open well into the Eemian and was not interrupted until the hazel-yew-lime age (pollen zone 5) with the deposition of more clayey material and the subsequent accumulation of muds. Then, in the transition to the Weichselian glacial period, a clastically dominated sedimentation of silts and sands can again be observed.

The interdisciplinary investigations of the main profile A and the neighbouring profiles concur in indicating that the limnic accumulation took place from the end of the Saalian complex during the Eemian Warm Stage and up to the Weichselian glacial period. The profile reveals variations in the lake water level with a general tendency to lowering and filling up, as well as varying sedimentation rates. The palynological investigations have also shown hiatuses connected with erosion and sediment redeposition.

The comparison of the vegetation development during the warm period in both the NN1 and NN2 basins reveals a continuous agreement from the palynological point of view. The pollen diagrams presented clearly indicate the basic characteristics of the tree succession for the Eemian, namely the different moments of entry of birch – pine – elm – oak – hazel – alder – yew – lime – hornbeam – spruce - fir and then pine and/or birch again. Taking all the profiles discussed into account, both basins show a development of the vegetation which can be followed almost continuously from the late Saalian until the late Eemian. The early Weichselian is reflected only in relicts. The special palyno-stratigraphical features discussed by SEIFERT (1990) and SEIFERT-EULEN (2010) as fundamental deviations from the basic Eemian age tree succession also apply to the NN2 basin in so far as they are really a question of vegetation history.

The freshwater fauna of the NN2 basin indicates a uniform development of the water body during a temperate period cycle with the dominance of *Bithynia tentaculata*, *Gyraulus laevis* and *Valvata piscinalis*, inter alia. Although the frequency of the mollusc specimens declines, especially in the central part of the profile, there are no indices of any intervening glacial phases. The upper section of the profile is characterised by a strong increase in the specimens of *Anisus leucostoma* which foretells the increasing filling up of the lake. The occurrence of terrestrial molluscs is less frequent in accordance with the limnic environs. They are mainly present as open land varieties, e.g. *Pupilla muscorum* and *Vallonia costata*, but also include clearly temperate period varieties, especially *Cepaea* sp. The molluscs in the NN1 basin (MANIA 2000) are similar in principle to the fauna of NN2. The fish species are very similar with *Scardinius erythrophthalmus*, *Tinca tinca*, *Carassius carassius*, *Perca fluviatilis* and *Esox lucius*. It is very striking that, in the area of NN1 and comparable with NN2, there is a relatively high predominance of open land varieties among the land snails as well.

In particular the palyno-stratigraphical but also the malacological coincidence of the NN1 and NN2 basins provides evidence that the deposits date from the same period. Hence in Neumark-North between the Saalian till of the Zeitz phase and the Weichselian glacial period there was only one temperate period, the Eemian. The results of recent luminescence datings also indicate

that the basin fillings are isochronous and must be attributed to the Eemian (KRBETSCHEK, in press).
The main range of the archaeological findings of NN2/2, which is attributed by LAURAT & BRÜHL (2006), LAURAT et al. (2006) and MANIA et al. (2008, 2010) to a pre-Eemian warm period separated from the Eemian by a cold period, accumulated really during the Eemian. Nor was confirmation found of the deposition relationships documented by MANIA et al. according to which the basin sequence of NN2 could have been superimposed on NN1.
In Neumark-North the particular climatic conditions of the Central German dry region during the Eemian period are clearly recognisable. In this sense, the comparison between the Eemian findings for Neumark-North, Gröbern, Grabschütz and Rabutz provide an instructive example of the variability between neighbouring synchronous warm period profiles with reference to specific sites (cf. LITT 1994).

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Late Pleistocene remains of a giant deer (*Megaloceros giganteus*) from the Greifswalder Oie, Pomeranian Bay, NE-Germany

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Occurrences of mammalian fossils, except of mammoth remains, are rare in the Pleistocene of Mecklenburg-Vorpommern. In 2009 mammalian bone fragments – identified as a giant deer's scapula – were found in a highly deformed Pleistocene succession exposed at the active south-eastern cliff of the Greifswalder Oie, a small island situated in the Pomeranian Bay close to the islands of Rügen and Usedom.

The glaciotectonically sheared bone was embedded in fine- to medium-grained yellow-brownish, partly limonitically bound, glacial-fluvial sands. This sand-gravel complex (i1; cf. KNAUST 1995) occurs in between two glacial tills. The older till (m1) at the base of the cliff can be correlated with the Saalian (Warthe) ice advance. The younger till (m2) situated above the sand most likely belongs to a late Weichselian (Brandenburg/Frankfurt) ice advance (OBST 2010). This suggests an early to middle Weichselian age of the scapula remains. Additionally, it has to be noted that greenish-grey to reddish-grey clays are intercalated between the older till (m1) and the sandy deposits (i1) as shown by exposures a few metres towards the north-east. The clay contains brackish-marine foraminifera, e.g. *Haynesina orbiculare* (BRADY, 1881), *Cribroelphidium albiumbilicatum* (WEISS, 1954) and *Cribroelphidium excavatum* (TERQUEM, 1875) typical for the Cyprina clay of Hiddensee and Arkona/Rügen (FRENZEL 1993). A small glacial erratic lump of similar sediments was reported by FRENZEL & ANSORGE (2001) from the Greifswalder Oie, discovered not far away from the bone site. Therefore, a planned radiocarbon dating of the mammal bone remains may help to clarify the stratigraphic position of the surrounding sediments.

The scapula is broken into several, partly deformed pieces and, thus, difficult to classify. Only the typical circular ball and socket joint point to a cervid species. The reconstructed length of the scapula is about 45-50 cm. Its size and the supposed arctic conditions under which the bone bearing sediments were deposited make it most likely that the scapula belongs to a giant deer (*Megaloceros giganteus* BLUMENBACH, 1803). However, a relationship to the European elk (*Alces alces* LINNAEUS, 1758) cannot be excluded for sure.

Pleistocene cervid remains in Mecklenburg-Vorpommern are not often found due to a lack of suitable preservation conditions in the glacial deposits. Occurrences near Gristow, Gützkow, Endingen and Lüdersdorf were published. While the findings of Endingen and Lüdersdorf could be dated (Alleröd), no ages were determined for the findings of Gristow und Gützkow (cf. BENECKE 2000). A few other findings of cervid bones are known but are not well documented. In contrast, numerous Late Pleistocene remains of the giant deer have been well reported and documented in southern Scandinavia by AARIS-SØRENSEN & LILJEGREN (2008).

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Loess-paleosol-sequences in Saxony – A terrestrial archive for paleoenvironmental evolution

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The region of the Saxonian loess area is characterized by a thick loess cover which could be reach a thickness up to 16 m. The loess was predominantly deposited during the Weichselian glaciation and contains several paleosols, paleosol sediments and other sedimentary features. So this area is well suited to reconstruct paleoenvironmental evolution for this part of the European continent.

In former studies HAASE et al. (1970) gave a first overview of the stratigraphic situation. However from this time on few researches has been realized in the Saxonian Loess region. Since three years a new project of Loess research started funded by the DFG. The new results are based on eight well investigated loess sites. We combine all the findings and create a new synthetic standard profil. Comparing the new standard profil with older ones (HAASE et al., 1970) we detect some similarities but also differences. We could complete the findings of HAASE et al. (1970) by the following details:

1. We could add to the Lower Weichselian sediments two in situ and one reworked humic horizons above the Eemian hydromorphic Luvisol.
2. We also think that the so called “Gleinaer pedokomplex” is not the equivalent to the “Lohne soil” (after SEMMEL, 1968) from the western part of Germany. We think that the Geinaer soil is older and characterized by a phase of geomorphic activity (erosion/sedimentation) that finished with a strong gelic Gleysol pedogenesis.
3. In the Upper Weichselian loess sequences we detect a weak brown soil, a strong gelic Gleysol and several weak gelic Gleysols.

A detailed age model of the standard profile is in work. This age model is based on more than 30 optical stimulated luminescence datings (fine quartz).

The aim of our work is to close the lack of knowledge between the well investigated western European loess and the Moravian, Bohemian and Silesian loesses.

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Geopotenzial Deutsche Nordsee – Ein neues Gemeinschaftsprojekt

MICHAEL NAUMANN & GPDN - PROJEKTTEAM

Die Deutsche Nordsee stellt einen einzigartigen Naturraum dar. Kürzlich erfolgte zum Beispiel die Unterschutzstellung des Wattenmeers als Weltnaturerbe von der UNESCO- Kommission. Gleichzeitig handelt es sich bereits heute um einen intensiv genutzten Wirtschaftsraum, der weitere Zukunftsperspektiven für die wirtschaftliche Entwicklung der nördlichen Bundesländer, insbesondere von Niedersachsen bietet.

Das Niedersächsische Wirtschaftsministerium setzt einen Aktionsplan um, durch den die innovative, sichere und Klima schonende Gewinnung, Erzeugung und Speicherung von Energie sowie eine langfristige Versorgungssicherheit gewährleistet werden soll. Dabei steht zunächst der niedersächsische Küsten- und Nordseeraum im Mittelpunkt, der besondere Potenziale bietet. Das Bundesministerium für Wirtschaft und Technologie hat im Rahmen der fünften Nationalen Maritimen Konferenz das vorrangige Ziel deutlich gemacht, die erfolgreiche Entwicklung der maritimen Wirtschaft weiter abzusichern.

Die o. g. Initiativen greifen das Landesamt für Bergbau, Energie und Geologie (LBEG), die Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) und das Bundesamt für Seeschifffahrt und Hydrographie (BSH) mit dem Projekt „Geopotenzial Deutsche Nordsee“ auf.

Ziel des Projektes ist es, bis zum Jahr 2013 Wirtschaft und Wissenschaft grundlegende Geoinformationen über die heute noch weitgehend unbekannte Entstehungsgeschichte und den strukturellen Aufbau des Nordseeraumes zugänglich zu machen. Dieses Wissen ist für die nachhaltige Entwicklung des maritimen Wirtschaftsraumes Nordsee unerlässlich, da Planung und Umsetzung von Maßnahmen in den Bereichen Wirtschaft und Umwelt darauf aufbauen.

Das Vorhaben umfasst sechs Projektmodule (Tab. 1), die parallel und aufeinander aufbauend Geodaten aus der Nordsee gewinnen und aufbereiten. Wesentlich für den Erfolg ist das koordinierte Zusammenwirken der verfügbaren Kräfte. Das umfassende und spezifische Know-how der Projektpartner BGR, LBEG und BSH kann dabei von der wissenschaftlichen Grundlagenermittlung über die Dateninterpretation und Aufbereitung bis zur anwenderbezogenen Produktgestaltung Kompetenz unter einem Dach bereitstellen und bietet daher hervorragende Voraussetzungen zur Umsetzung eines solchen Projektes.

Tab. 1: Die sechs Fachmodule des Vorhabens.

Geopotenzial Deutsche Nordsee	
• Modul A	Geologisches Strukturmodell Nordseeraum
• Modul B	Ablagerungen, Baugrundverhältnisse, mineralische Rohstoffe
• Modul C	Geologische Grundlagen und Meeresspiegelentwicklung
• Modul D	Abschätzung des Erdöl-/ Erdgaspotentials
• Modul E	Speicherkapazitäten im Nordseeraum
• Modul F	Geoinformationssystem Nordsee

Künftig interessante Bereiche für die Energiewirtschaft sollen identifiziert werden, so dass sich Technologieentwicklungen und Kraftwerksplanungen darauf einstellen und Anforderungen des Umweltschutzes rechtzeitig beachtet werden können. Potenziale liegen insbesondere in der Verfügbarkeit der Energierohstoffe, insbesondere Erdöl, Erdgas, aber auch Windenergie sowie der Energiespeicherung und der geografischen Position im Energienetzwerk, die für Pipelines, Leitungstrassen, neue Kraftwerke und die Möglichkeit der CO_2-Speicherung besonders interessant sind.

Im Projektverlauf wird die bestehende Systemplattform Niedersachsens um den Bereich der Nordsee erweitert und durch die in den unterschiedlichen Modulen des Projektes erarbeiteten Datenbestände ergänzt. Auf dieser Plattform ist vorgesehen, alle für das Projekt notwendigen Daten über die Nordsee nach einheitlichen Kriterien zu archivieren und zu integrieren, dies umfasst auch die im Projektverlauf entwickelten 3D-Modelle. Das Informationssystem wird über das Internet einer großen Zahl von Akteuren aus Industrie, Wissenschaft und Forschung bereitgestellt, die dieses Wissen – jederzeit erreichbar - für ihre Projekte nutzen können.

Der europäische Kontext wird in einigen Projektmodulen bereits aufgezeigt. Für die nähere Zukunft ist hier eine internationale Zusammenarbeit mit anderen Anrainerstaaten der Nordsee anzustreben.

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Landslide susceptibility assessment in the Vienna Forest: first geostatistical analyses applied on a new landslide inventory

BETTINA NEUHÄUSER[1] & BIRGIT TERHORST[2]

The study area is situated in the Vienna Forest Flysch Zone in Lower Austria and the Western part of the city of Vienna. The area is at the margin of the eastern Alps and represents an undulating low mountain region where landslides are widespread and frequent. The Flysch bedrock is superimposed by Quaternary periglacial cover beds and loess. Both, petrography of the bedrock as well as soil mechanical properties of the Quaternary sediments control the current slope dynamics (DAMM & TERHORST 2010). Investigations on the contributing factors and causes of landslides in the regional scale are rare and studies of the landslide susceptibility are lacking. Recent investigations concentrate on the slope formation and the actual process dynamic on single slopes (TERHORST & DAMM 2009; TERHORST ET AL.2009). Major scope of this project is the regional assessment and delineation of the landslides susceptibility by means of GIS-based modelling (cf. NEUHÄUSER & TERHORST 2006).

A landslide inventory database has been compiled by integrating historical (GÖTZINGER 1943) and recent sources, i.e. publications of the Federal Geological Survey Austria and actual mapping of the working group. The inventory is homogeneous and geo-referenced and consists so far of 471 landslide events. Among them are some huge events with a size of 0,065km^2, but the major part consists of smaller incidents with an average size between 0.002km^2 and 0.001km^2. Based on this new landslide inventory first geostatistical analyses have been carried out elaborating the spatial distribution and the relationship between the landslide locations and some factors that are assumed to have an impact on the occurrence of slides (so called causative factors).

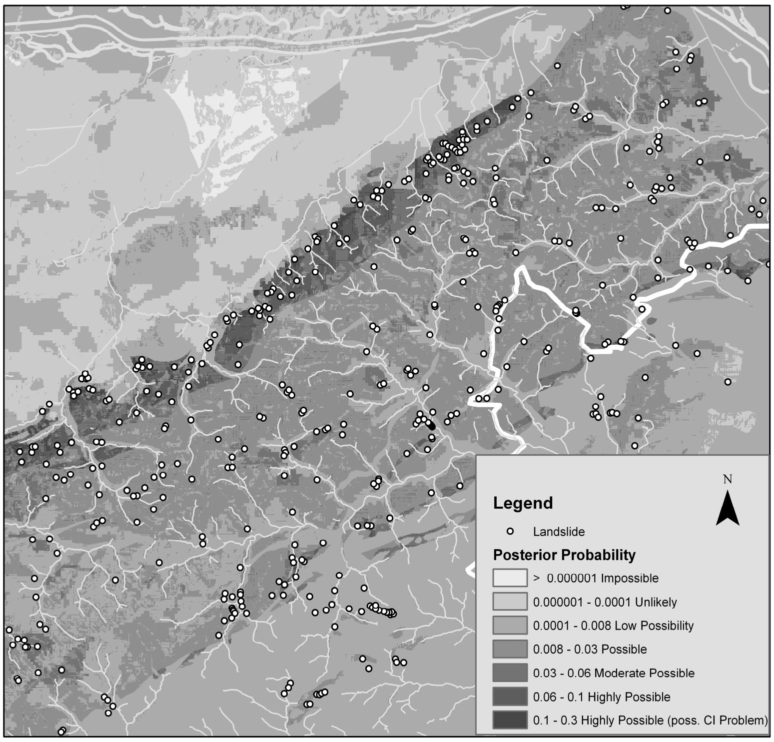

Fig. 1: Posterior probability map.

The distribution of the landslides follows the direction of tectonic main faults and nappe boundaries. Distance analyses have shown that 70% of the landslides are within a distance of 500m. A standard deviational ellipse was calculated confirming the directional distribution of the landslides in the direction of the tectonic lines. Besides of the directional trend analysis a probabilistic/statistical approach, called Weights-of-Evidence (*Wofe*) according to BONHAM-CARTER et al. 1989 was applied. In *Wofe* the quantitative relationship between the cau-sative factors and known land-slides can be analysed. The approach uses Bayesian proba-bility theory. The causative factors are used as input maps and the final product is an output map showing the posterior probability of the occurrence of landslides. By means of pair wise overlay of the landslide locations with each of the causative factors statistical parameters are calculated for each factor class. The classes which are positively correlated could be identified:

- Slope Gradient: In the study area landslides occur on slopes with a gradient from 2° to 37° - a huge range. *Wofe* analysis showed that two ranges of slope gradient are positively correlated with the landslides events: A steep range from 36° to 40° and a flatter range from 8-22°.
- Profile Curvature: The profile curvature has been calculated, that describes the shape of the slope, measured as the rate of change in slope gradient along a given slope length. It is reported as 1/100 of z units. Convex curvatures of 2-3 have the highest positive correlation and can therefore be assumed as indicators of slope instability. Aspect: The role of aspect in morphodynamic processes is controversial discussed. Nevertheless some studies in low mountain areas have described a certain climatic effect driven by aspect. The analysis showed that there is indeed a correlation of slopes with direction North (0°-22°, 337.5°-360°), Northwest (292.5-337.5°) and West (247.5°-292.5°).
- Geology: The investigation of the geological map of Austria (1:200.000) combined with the landslides locations identified some geological classes to have a positive relation to landslides, for instance: Calcareous Flysch "Escarpments" of the Rhenodanumbian Flysch zone.
- Land Use: CORINE landcover data have been used to get information on the actual land use. The major part of the study area is covered with broad-leaved forest. However, the strongest positive correlation was identified in small agricultural areas.
- Tectonics: There are several faults and nappe boundaries in the study area. A distance analyse has been carried out. A significant statistical relationship could be shown within a distance from 0 to 300m from the closest tectonic feature.

On the basis of the previously calculated statistical weights the calculation of the total posterior probability was carried out. It ranges between 0% and 27%. A preliminary susceptibility map is based on topography, geology, tectonics and land use. The analysis has mainly been carried out for the purpose of testing the relationship and usability of the available information to describe the landslide distribution. It is the base for further, more detailed investigations.

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Microfacies analyses of varved lake sediments from Lake Czechowskie (Poland): first results from the last 1.500 year interval

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Varved lake sediments are ideal high-resolution archives for high-resolution palaeoclimatic investigations. New advances in methodology as the combination of micro-facies analyses with µ-XRF element scanning provide very detailed proxy data at annual to sub-annual resolution.
Lake Czechowskie, located ca 80 km southwest of Gdańsk (Poland), recently has been discovered to contain an at least partly finely laminated sediment record (BŁASZKIEWICZ 2005). Within the frame of a bilateral project between the German Research Centre for Geoscience GFZ (Potsdam) and the Polish Academy of Sciences (Toruń) two overlapping core sequences were revealed from Lake Czechowskie in September 2009 for detailed investigations. The core sequences of ca 11.5 m lengths were obtained from the deepest part of the lake basin at 33 m water depth. The basal glacio-fluvial sands are overlain at a sharp transition by fine-grained, pelagic lake sediments that were deposited since the Allerød oscillation (BŁASZKIEWICZ 2005). From the two core sequences a master composite profile has been established by means of defining marker layers at macroscopic and microscopic scales and high-resolution magnetic susceptibility data. The uppermost ca 9 m of the record comprises a continuous succession of calcite varves. This study concentrates on the last 1,500 years with a particular focus on the Medieval Warm Period and the Little Ice Age in order to determine differences in inter-annual and decadal-scale variability between an on average warmer and a rather cold period. Our first results are based on micro-facies analyses on large-scale thin sections and µ-XRF element scanning. Seasonal layer thickness data as well as abrupt changes in sedimentation rates indicate distinct short-term variability during the study interval.
The ultimate aim of the ongoing project is to disentangle both natural climate variations and human impacts in the lake catchment based on an independent and precise varve chronology. The sediment record has the potential to extend existing historical records of past climate variations in Poland (TREPIŃSKA 2010, BRÁZDIL & DOBROVOLNÝ 2010) further back in time.

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Micro- and macrofauna associations of a potential tsunami layer in the Sur-lagoon (Sultanate of Oman, Arabian Peninsula)

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The Sultanate of Oman is situated in the East of the Arabian Peninsula and borders the Oman Sea (Gulf of Oman) as well as the Indian Ocean, respectively. Several active tectonic zones are located offshore: the Owen fracture zone (dextral strike slip fault) to the SE, the Zagros fault-zone (continent-continent collision) to the N and the Makran subduction zone to the NE. With the current project we aim at testing the Sur-lagoon as a geological archive for Quaternary tsunamis deposits.
A devastating tsunami hit the coastline of Pakistan on 28.11.1945 following a 8.1 Mw earthquake on the Makran subduction zone. There are indications that the tsunami had an impact on Oman's coastline as well. However, there is no historical evidence. This can partly be explained by the isolation and state of underdevelopment of the country during this time.
Sur-lagoon is a 12 km^2 large, shallow and microtidal lagoon. Most of the lagoon is intertidal and access is easy during low tide. We collected seven sediment cores at various locations within the lagoon. The deepest core reaches 10 m below the present surface. The sequence is characterized by silty finesand in the lower part (10-6 m) and finesand in the upper part (6–0 m). Within the uppermost meter a distinct shell bed was identified. This clearly indicates an event-layer which can be either storm- or tsunami-generated. We concentrate on the analyses of microfauna-associations (foraminifers and ostracods) within the shell layer as well as in the surrounding strata, supported by sedimentological and macrofauna investigations. We expect to find evidence for the depositional character of the layer by identifying species and state of preservation.

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The Koźmin glacial lake – its origin, age, deposits and palaeoecology

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The Koźmin glacial lake developed in the middle reach of the Warta River valley (central Poland). Glaciolacustrine deposits overlie the Younger Saalian (Warthian) till and are covered with several meters thick fluvial series of the Weichselian (Vistulian) age. The glacial lake occupied the erosional channel existing in the till and underlying thick series of sands and gravels. Investigations were conducted in the Koźmin outcrop of the Lignite Mine ADAMÓW JSC and its surroundings. Although the age of underlying till is clear from petrographic analyses (both indicator erratic counts and the grain long axis azimuth measurements), the exact age of glaciolacustrine deposits is still under debate. They widely spread under the Warta River valley deposits: their width is about 2 kilometers in the north, and about 4 kilometers in the south (Figure 1). Unfortunately there is no precise information about the meridional length of the lake, although the suspected extend should not be less than 5 km.

In the investigated area the Warta river valley uses the Adamów graben, one of the tectonic structures of central Poland, active during Paleogene and Neogene. Subsidence during Quaternary favored accumulation of thick sediment series.

The glaciolacustrine deposits available for investigations represent an accumulation in the proximal part of the sedimentary basin. Bottom part of the glaciolacustrine succession is dominated by fine sand and silt of ripple cross-lamination, overlain by silts with massive structure. In the middle part fine sand, silty-sand and silt of ripple, wavy, and horizontal lamination predominate. In places massive clay and horizontally laminated silt are present. The uppermost deposits are represented by ripple laminated fine sand and silty-sand with interlayers of silt with horizontal lamination or massive structure. There is an apparent cyclicity within the series caused by seasonal changes in material supply to the lake.

There are numerous deformations in the finest-grained deposits. Load casts and faults predominate. Some deformations occur in tabular layers, and are interpreted as seismites. There are also deformations connected with redeposition of sediments along the lake basin slope. The glaciolacustrine deposits have also been investigated using palynological analysis. Eleven local pollen zones, connected with changes in terms of deposition, have been identified. Unfortunately, because of great admixture of redeposited pollen grains, dating is impossible. The variability of pollen assemblages indicates the changes in hydrological and thermal conditions only. Nevertheless cold climatic conditions during accumulation were recognized. The pollen analysis was also used to determine the age of organic material, laying in the higher position then the top of glaciolacustrine series too. The Eemian age of these deposits was confirmed.

Cladocera remains were preserved in the glaciolacustrine deposits from Koźmin. The taxa and frequency of Cladocera were very low. Four development phases of Cladocera have been distinguished. These phases were separated by periods which were characterized by the ***absence of Cladocera remains***. The most common species were those with broad ecological tolerance. In the older phases planctonic forms appeared, but towards the top, littoral forms dominated. The upper part of the section didn't contain cladocerans.

TL dating of glaciolacustrine and glacial deposits was performed in four profiles where a total of over forty samples were dated. Additionally, in one of the profiles, twelve samples of glaciolacustrine deposits were dated with the OSL method. For the eroded glacial till, two TL dates were obtained: 149.5 ± 22.4 ka BP (base) and 119.7 ± 18.0 ka BP (top). The results for glaciolacustrine deposits range from 175.4 ± 26.3 ka BP to 82.9 ± 12.4 ka BP, but most of them are between 110 and 85 ka BP. The OSL dates fall within a range from 106.9 ± 5.5 ka BP to 69.5 ± 4.8 ka BP (excluding two clearly too young dates). The dates obtained with OSL datings are slightly younger than the ones obtained using TL method. According to geological records and results of the pollen analysis, especially of the Eemian deposits, most of the TL and all OSL dates seem to be too young.

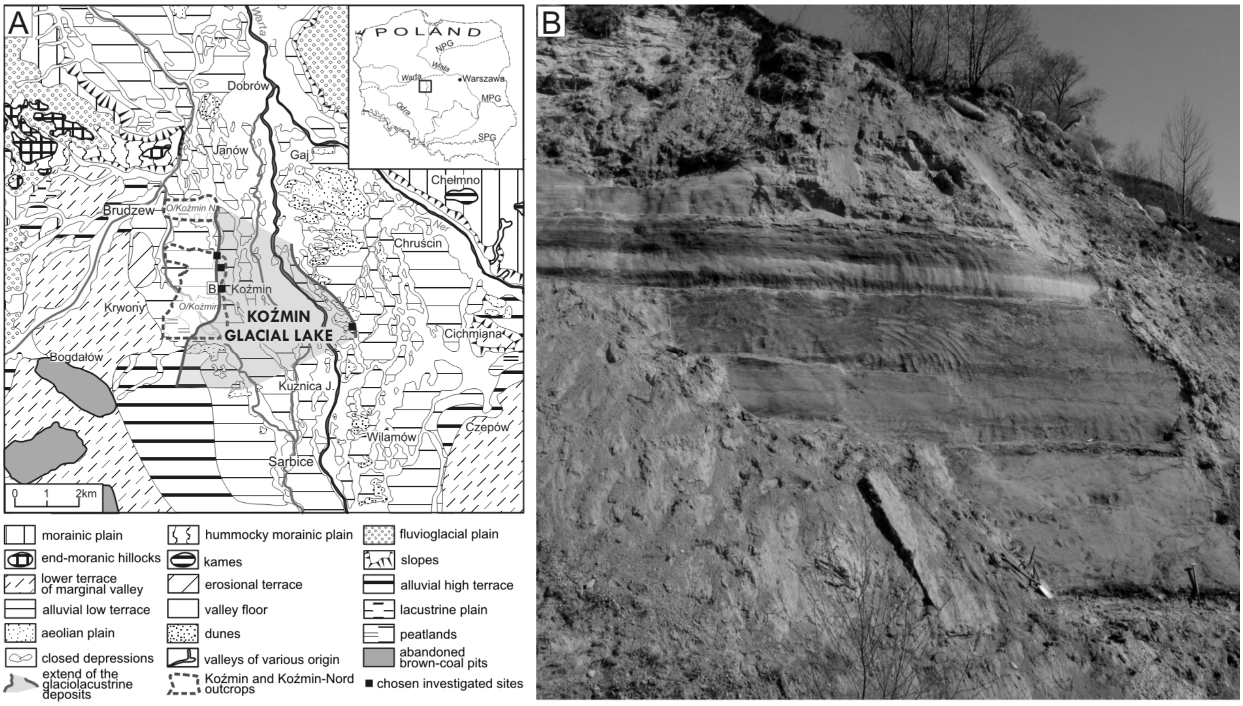

Fig. 1: A – Geomorphological map of the study area. Ice sheet limits of: SPG – South Polish Glaciations (Elsterian), MPG –Middle Polish Glaciations (Saalian), LGM – North Polish Glaciation (Vistulian); B – Glaciolacustrine deposits of the Koźmin glacial lake *Photo by J. Petera-Zganiacz*).

The Koźmin glacial lake developed in glacial channel eroded during the Wartanian glaciations, and existing during decline of that period. It functioned as an extraglacial, periodically interflow lake. In the cold climate with slightly fluctuating temperatures, environmental conditions in the lake were good enough for existing of Cladocera, represented mainly by species with wide ecological tolerance. Tectonic activity was possible during deposition what is suggested by occurrence of seismites. In the layers with seismites there are no Cladocera remains.

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An integrated reconstruction of the Saalian glaciation in the Netherlands and NW Germany

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In MIS 6, around 170,000-150,000 years ago, large ice masses last covered The Netherlands and NW Germany (Saalian Drenthe Substage). It left many geomorphological features in the landscape, e.g. push moraines, sandurs and glacial basins. Throughout the 20th century extensive research has been done on this geomorphological assemblage and the sequence of glacial events, resulting in glaciation phase models (e.g. VAN DEN BERG & BEETS, 1987; EHLERS, 1990; RAPPOL, 1991; KLOSTERMANN 1992; SKUPIN et al., 1993). However, the various phase models each appear biased to specific features, subregions and types-of-data. Besides, new data and insights have risen since the construction of these models, starting to link proglacial with glacial features (e.g. BUSSCHERS et al., 2008; WINSEMANN et al., 2009).
Our research newly reconstructed the sequence of events during the Saalian, unifying the evidence in NW Germany with that in the Netherlands. We collected geological-geomorphological evidence (literature inventory) and new high-resolution elevation data in a inventory GIS. The GIS stores our newly constructed phase model, as well as earlier phase models. Our preferred reconstruction recognises four phases towards maximum ice-sheet extent, and a complex multi-phased deglaciation stage (ending with the Warthe Substage).
We present overview maps and will outline the elements of 'classic' knowledge and additional new lines of reasoning. We reviewed conceptual models of the phasing of events and related glaciological processes during the glaciation, responsible for the eventual ice-margin landscape. Improved structuring of data and insight regarding the phasing of the glaciation, contributes to better understanding of the glacial morphology and geology of the area and the processes that are involved. Besides new insight in the configuration of proglacial and deglaciation river and lake systems, it provides valuable data overview supporting regional quaternary geological studies (e.g. Province of Drenthe, Bregman, this conference).

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Future prospects for the development of geotourism in Northern Finland and North-Western Russia

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At present, tourism is considered to be the fastest growing industry worldwide. In Finland, the use of geology and geological sites to promote tourism and as a producer of further information is rather new and therefore rare. In the Pyhä-Luosto National Park, the Geological Survey of Finland and Metsähallitus, Natural Heritage Services Lapland have already worked for several years with the clear aim of spreading knowledge about geological heritage to the public, the tourism sector, and to education institutes. The Pyhä-Luosto National Park (est. 1938) contains geological monuments and sites with special scientific importance in Precambrian sedimentology, Pleistocene glacial geology, geomorphology along with aesthetic value.

Concurrent with geological work, geologically valuable natural sites have been mapped. As a result of the mapping work, a geologic map has been published for people interested in nature. On the map, geological sites in the area are shown and in the guidebook an explanation is given of its development and effect on the existing nature and landscape. The data compiled during the mapping process has also been used to revamp the national park's nature trails. Twelve info boards have been added to the trails, explaining the origins of the landscape and the related geologic time scales, from the ancient bedrock to the present day geological processes. Safari companies organizing guided tours in the wilderness have also included geology into their programs. The influence can be seen in increased number of visitors in geological sites and routes. In 2009, the National Park was visited by approximately 128,000 people.

The Programme Kolarctic European Neighbourhood and Partnership Instrument cross-border co-operation ENPI CBC is one of the EU's new financing instruments that is going to be implemented on the EU's external borders. In the Kolarctic ENPI program document, the tourism and experience industries are mentioned to be growing sectors in the North Calotte. Also in the program priorities, the unspoiled natural environment is seen to be a major factor in attracting tourism to the Programme area. According the Kolarctic ENPI Action Plan 2010, in tourism it is important to gain from other regions' experiences, to build and to market joint products, to build competence and improve the quality of the products and services. Based on those facts, it can be concluded that developing geotourism by means of a joint co-operation project is in accordance with the regional strategy of the Barents area.

In the Kola Peninsula, the main activities include the analyzing of the geological heritage; preparation of a brochure and uniform signing of 10 geological demonstration sites for education and nature tourism in the target area; creating a geologic outdoor map of the Khibiny mountains; marketing geological heritage and of increasing geological knowledge; evaluation of regional nature values; and mapping and popularisation of nature targets. The Khibiny massif is considered as a primary object of geotourism due to its unique mineralogy and history of development since the 1920s, easy access and infrastructure (it is close to the Kirovsk and Apatity town with hotels, medical services, food and Khibiny souvenirs shops). The second promising area for geotourism is Monchegorsk with Cu, Ni, Co, Cr and PGE deposits.

Geologic exhibitions, geologic lessons for tourists and the production of educational and information materials for schools will be examples of the future cooperation. The information on the sites will be published on the Internet and can be downloaded onto mobile devices for use on personal hikes or guided tours. A joint objective is to link Pyhä-Luosto National Park and the surrounding tourist area to the international Geopark network.

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Landscape development in an rural area between 1000 and 1500 AD using the example of the DFG-project „Abandonment site Wouezk near Penkun“, Mecklenburg-Western Pomerania

AXEL POLLEX & MANUELA SCHULT

The project investigates the social, technical and ecological changes during the German colonisation of Eastern Central Europe during tue Middle Ages (between 1000-1500AD). It is an interdisciplinary cooperation between archaeology, anthropology, archaeometry, archaeozoology and archaeobotany.
Aim of the palaeoecological part of the investigations is to reconstruct by means of micro- and macrofossil analysis the vegetation development in the direct and broader surroundings of the Wouezk settlement with an emphasis on land use.
Are there constant factors in land use and crops? How did the changes affect the land and its vegetation? Is there a correlation between land use, vegetation history, erosion history or even palaeoclimate?
The first results of the archaeobotanical investigation show a composition of the crops in the 13. century:

- Secale dominant (similar like in slavic settlements),
- Hordeum less frequent and less abundant and the absence of Panicum (in contrast to slavic settlements).

The first palynological results give the following conclusions:

- the landscape had more water bodies during the investigation time,
- the region has a long settlement period (with a strong impact on the landscape during Neolithic/Late Bronze Age and Slavic Periode),
- in the 13th century there is a decreasing in woodlands and increasing in land use,
- there were different kinds of land use (pasture, field, grazed forest),
- land use existed in small area (spatial resolution),
- land use was dynamical in space.

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Geological structure and distribution of aeolian relief in South Lithuania

VIOLETA PUKELYTĖ

In Lithuania aeolian deposits cover about 2.61% of the territory and the areas of continental dunes prevail over the coastal ones. The most typical and homogenous areas of the aeolian relief stretches in South Lithuania e.g. Latežeris, Randamonys, Dubas, Katra, Musteika, Marcinkonys, Lynežeris, Palkabalis, Varėna, Barčiai and Rūdninkai.

The widespread aeolian deposits, mainly formed by the re-deposition of the glaciolacustrine sediments and somewhat less by alluvial ones, have been analysed. Aeolian areas have been taken for correlative analysis of morphological parameters and comparison of results obtained. The following parameters of dunes e.g. altitude of the foot and summit, relative height, length of the main ridge, azimuth of perpendicular of the main ridge, amount of the ridge spurs and orientation of the dune, have been used. On the grounds of prevalence of maximum, minimum and average values of above mentioned parameters, peculiarities of correlation bonds among the parameters in all areas, connection with gravitation field and neotectonic structures, also of material of composition and texture studies of aeolian sand the following conclusions have been done.

The formations of the aeolian areas in South Lithuania were not simultaneous. Investigated massifs have been formed by the re-deposition of the glaciolacustrine sand under the influence of the different directions of the wind and change of ground water depth. The oldest massifs e.g. Rūdninkai, Barčiai, Varėna, Dubas and Katra have been formed during the initial stage of the dune's formation. Late the aeolian massifs of Marcinkonys, Musteika and Latežeris have been formed.

Aeolian processes have been influenced and controlled by the tectonic processes, geological structure of the territory, peculiarities of the sub-Quaternary surface and palaeosurface of Quaternary deposits. In South Lithuania aeolian sedimentation took place within subregional Veisiejai-Šalčininkėliai Elevation. Tectonically uprising areas represent the most favorable places for the aeolian sedimentation as it has been inferred on a basis of collected data. Also, the morphology of aeolian relief has been influenced by the rate of tectonic movements markedly. In particular, +0.73 coefficient of correlation has been established between residual altitudes of the crystalline basement and relative amplitudes of the aeolian hills, and +0.70 correlation has been obtained between the former and length of axis of aeolian hills. The similar close correlation has been stated for neotectonic structures. Fault tectonic controlled aeolian sedimentation too. The limits of individual aeolian fields coincide with the faults defined in the crystalline basement and the sub-Quaternary cover often. Frequently, distributions of the aeolian fields are coincident with the neotectonically active linear zones.

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Secondary carbonate precipitates in glacial sediments: origin, age and palaeoenvironmental significance

MARIS RATTAS

The calcium carbonate cements hosted within the glaciofluvial outwash deposits has been studied from twenty sequences in Estonia and Latvia. Mostly these outwash sediments are associated with marginal glaciofluvial forms, end moraines, eskers and drumlins deposited during the Late Weichselian deglacial stages about 16.5-11.5 ka BP. The cemented masses occur as the laterally continuous layers or as entire piles or patches, either at the contact between the two sedimentary facies within outwash deposits or between the sand and gravel and the overlaying till layer, or along the glaciotectonic deformation structures.

In coarser, matrix-free facies of gravel, the cement occurs as a calcareous crust with variable thickness (up to few mm) around the clasts. In matrix-rich sandy facies the cement is distributed in the matrix filling almost overall intergranular pores and also intruded into clasts microfractures. Micro-morphologically the cement consists of sparitic (up to 200 μm) and micritic (<4 μm) angular equant to rhombohedron calcite crystals or needle-fiber calcite. The needle-fiber calcite is arranged either as randomly oriented acicular meshes or as subparallel rods perpendicular to the grain surface. Multilayered cement and dissolution traces on the surface of calcite crystals suggest episodes of cement precipitation alternating with periods of dissolution. The cements are interpreted as having formed in water-saturated conditions based on their continuous and isopachous character.

The formation and development of calcite cement in outwash sequences is attributed to carbonate precipitation from calcite-rich waters either close to the ice margin or somewhat later in periglacial conditions where meltwater fluxes and groundwater circulation were controlled by water-driving pressures, textural changes and boundaries of sediment facies, and barriers to water flow resulted by permafrost or partly frozen sediments. The isotopic composition shows that solute-bearing waters were enriched in light isotopes, probably somewhat mixed with meteoric and surface waters and quite much affected with atmospheric and biotic factors.

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Glacial deposits in Anatolia: indicators for Quaternary paleoclimate phange

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Today's climate of the Eastern Mediterranean region is influenced by three main atmospheric systems: the main middle to high latitude westerlies, the mid-latitude subtropical high-pressure systems, and the monsoon climate (AKÇAR & SCHLÜCHTER, 2005). The spatial and magnitudinal changes in these different atmospheric patterns in the past resulted in changes in this region's climate. One of the sensitive places to these changes in the region is Anatolia, which is situated between 36°-42°N and 26°-45°E. As a consequence, the geological record of paleoglaciers of the Anatolian mountains merits special attention in the quantification of Quaternary paleoclimate change. The reconstruction of ice volume fluctuations of continental ice sheets and mountain glaciers is one of the key tools used in this quantification. Surface exposure dating is a method used to place glacier fluctuations and moraine sequences into a chronological frame.
Glacial deposits are located in the Black Sea, the Taurus and Eastern Anatolian Montains, Uludağ and on isolated extinct volcanic cones in the interior, such as Mount Erciyes, Süphan and Ararat (ÇINER, 2004; AKÇAR & SCHLÜCHTER, 2005 and references therein). First studies on glacial geology in Anatolia have started in the late 19th century with observations on the presence of glaciers and glacial deposits (AKÇAR & SCHLÜCHTER, 2005 and references therein). Despite this early start, the chronology of these deposits remained open until early 2000's when the first pioneering surface exposure dating studies commenced (AKÇAR et al., 2007a among others).
Cosmogenic ^{10}Be, ^{26}Al and ^{36}Cl surface exposure ages demonstrate that the last local maximum glaciation occurred: no later than around 20 ka in Uludağ (ZAHNO et al., 2010), 21 ka in Mount Erciyes (SARIKAYA et al., 2009), 20 ka Mount Sandıras (SARIKAYA et al., 2008); and between around 24 and 18 ka in the Dedegöl Mts. (ZAHNO et al., 2009), 22 – 18 ka in the Eastern Black Sea Mountains (AKÇAR ET AL., 2007a; 2008). This seems to be synchronous with the last maximum glaciation occurred in the European Alps, Central Apennines (Italy) and the Greek Mountains during the global Last Glacial Maximum (21±2 ka) within Marine Isotope Stage-2.
Subsequent glacier oscillations were dated to the Lateglacial: at around 16 ka in Mount Sandıras (SARIKAYA ET AL., 2008), 15 ka in Mount Erciyes (SARIKAYA ET AL., 2009); between around 16 and 15 ka in Uludağ (ZAHNO ET AL., 2010). In the Eastern Black Sea Mts., the Late Glacial advance was probably restricted to the tributary valleys, and the timing of this advance is still unknown, however this advance continued until around 16 ka (AKÇAR ET AL., 2007a; 2008). This evidence suggests an oscillating glacier recession in Anatolia during Termination-1. Published surface exposure ages related to the Lateglacial Gschnitz and Egesen moraines in the European Alps are in good agreement with Anatolia's. This implies the parallel occurrence of major climatic shifts on millennial time-scale in the European Alps and Anatolia during MIS-2.
During Younger Dryas, the glacial valleys in SW Anatolia (Mt. Sandıras, Dedegöl Mountains) and in central Anatolia (Mt. Erciyes) were already ice-free (SARIKAYA et al., 2008, 2009; ZAHNO et al., 2009), whereas Younger Dryas occurred between around 13 ka and 11 ka in the southern Black Sea coast (AKÇAR et al., 2007A; 2008; ZAHNO et al., 2010). After the deglaciation of the valleys in the Eastern Black Sea Mountains, rock glaciers and snow-avalanche ridges have been active processes during the Holocene. ^{10}Be exposure ages from these ridges show that these events occurred during the Holocene and are therefore not linked to glacier fluctuations (AKÇAR ET AL., 2007b). Little Ice Age (LIA) moraines appear to be absent in Anatolia. Terrestrial geological records in Anatolia with regard to the Younger Dryas and the LIA cooling still remain to be studied in detail. Huge and active rock glaciers in the cirque areas may be related to the LIA cooling; absolute dates, however, are still absent. Dry and cold climatic conditions during the LIA could explain the absence of glacier advance, as the conditions were not conducive for the build-up of ice. This idea is also supported by the freezing events in the Bosporus during the last 2 ka (YAVUZ ET AL., 2007).

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The impact of the bedrock on the surface topography in the cross-border area of Sokółka-Grodno

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The Polish Geological Institute – National Research Institute conducts a lot of international projects. One of them is cross bordering cooperation in mapping.

In July 2009 we obtained a grant from the Ministry of Environment and started to elaborate a new Polish – Belarussian transborder map in 1 to 250,000 scale. It is a geological map which consists of two maps: the geological map of the surface i.e. a map of quaternary sediments and the bedrocks map i.e. a map without quaternary sediments, as well as of a few cross-sections and the book of glossaries.

The research area on the Polish territory is the neighborhood of Sokółka and on the Belarussian territory is the neighborhood of Grodno. The archival material was researched and site works performed. The data from 12 sheets of the Detailed Geological Map of Poland in 1 to 50,000 scale were compared. The data from deep boreholes of the Central Geological Database was taken into consideration as well.

For the Belarusian area maps, cross-sections and boreholes data from the Belarussian Research Geological Exploration Institute, Institute for Nature Management and the Geophysical Expedition of Republican Unitary Enterprise "Belgeologija" were examined. The first stage included elaborating a scheme of the bedrocks landform features. It is diverse and dynamic especially on the Belarussian territory.

The second stage was elaborating the composition of the stratography of the under-quaternary deposites – (the occurrance of) Creda, Paleogen and Neogen. It turned out that Creda deposites occur in places. It is connected with the tectonic processes. Next DT2 model in 1 to 50,000 scale was analyzed and the morfolineaments were marked. They may reflect tectonic discontinuances, scaliness of the bedrock and the line diversity of the litology. The density of lineaments indicates that the bedrock is shallow (low) and zone of tectonic and glacitectonic distortion. The faults could have had an impact on creating postglacial forms.

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Late Glacial palaeoenvironmental changes in North Estonia

LEILI SAARSE & LEELI AMON

Plant macrofossils, AMS radiocarbon dates, grain-size distribution, loss-on-ignition and magnetic susceptibility from Lake Udriku were used to adjust the ice recession and chronostratigraphy of Late Glacial sediments in North Estonia. Udriku is a small and shallow lake (23.7 ha in area and 6.8 m deep) at an altitude of 95.1 m a.s.l. on the NW slope of the Pandivere Upland (59°22´17´´N, 25°55´50´´E). Sediment stratigraphy can roughly be described as silt, overlain by silty gyttja, gyttja and peat. On the basis of loss-on-ignition and grain-size distribution five lithological units have been identified, covering three main climatic periods: Allerød, Younger Dryas and early Holocene. Silt fraction dominated in the Late Glacial sediments. Organic matter content was low, varying between 1% and 10%, and carbonate content was less than 2%. The average sedimentation rate was 0.69 mm yr^{-1} during the Allerød interstadial but decreased to 0.45 mm yr^{-1} during the Younger Dryas stadial. The most distinct change in magnetic susceptibility occurred at the glaciolacustrine/limnic sediment transition, referring to a change in the sediment source during the isolation event at about 13,700 cal yr BP.

Calibrated radiocarbon ages from terrestrial macroremains were in correct stratigraphic order. The AMS ^{14}C date from the basal laminated silt (13,750±85 cal yr BP, Poz-30430) matches with the Allerød age and corresponds to the OSL date (13,700 yr BP) of sand from the kame field nearby (RAUKAS & STANKOWSKI 2005). The AMS radiocarbon dates of 10,590±60 (12,590 cal yr BP) and 10,060±60 (11,780 cal yr BP) give evidence of deposition during the Younger Dryas.

The macrofossil assemblage of L. Udriku minerogenic sediments consists of 25 plant species and genera, showing the local vegetation development from Late Glacial pioneer communities to the early Holocene. Five macrofossil zones have been distinguished and interpreted as follows. The basal part (MA-1) of the macrofossil diagram was relatively poor in taxa, indicating periglacial conditions with almost bare ground close to widespread occurrence of dead ice and permafrost. The vegetation succession started with the predomination of *Salix polaris* that in MA-2 zone was replaced by *Dryas octopetala*. The diversity of plant macrofossils increased significantly in the warmer episode of the Allerød (GI-1a, LOWE et al. 2008) during which *Dryas octopetala*, *Ranunculus* sect *Batrachium* and *Nitella* oospores reached their maximum. *Nitella* is considered as an oligotraphent genus which occurs in the small lake on silt, poor in organic matter (TOBOLSKI & AMMANN 2000). Among aquatics *Potamogeton filiformis* was found, a taxa which needs a minimum July temperature of about 8 °C (GAILLARD & BIRKS 2007). In the Allerød warmer episode (MA-3) also ephippia of *Daphnia*, a limnic cladoceran, occurred in the largest numbers compared to the rest of the sediment section.

The abundance and diversity of aquatic biota declined abruptly at the Allerød–Younger Dryas lithostratigraphic limit as relatively cool climate inhibited spread of aquatic plants and animals (MA-4). *Selaginella selaginoides*, a heliophilous, alpine to subalpine species appeared referring to open habitats. *Dryas octopetala* and *Ranunculus* sect *Batrachium* almost disappeared. The macrofossil finds consisted of a few species of different herbs and a few *Nitella* oospores. At 12,300 cal yr BP *Dryas octopetala* appeared once again, confirming harsh tundra-like conditions. The concentration of macrofossils in the early part of the Younger Dryas is lower than the later part. In this whole data set of macrofossils *Betula nana* was not found.

The transition from Younger Dryas to Holocene is distinct and characterized by clear shift in plant community. *Dryas octopetala* disappeared almost completely, while *Ranunculus* sect *Batrachium* re-appeared together with different species of *Potamogeton* (MA-5). Mean summer temperature could have been above 9 °C, referring to the modern range limit of *Potamogeton perfoliatus* at the Arctic tree-line (BENNIKE et al. 2004). The absence of tree remains suggests that trees were not locally present or, more likely, were not growing near the studied lake.

Proxy data indicate several environmental changes, first of all in the sediment composition and vegetation response to cooler and warmer episodes, and confirm that the study area has been free of ice by 13,800 cal yr BP. At that time the Udriku basin was a sheltered bay of the Baltic Ice Lake, which finally isolated about 13,700 cal yr BP.

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GIS-based modeling of debris flow processes in an Alpine catchment, Antholz valley, Italy

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Debris flows are frequent natural hazards in mountain regions, which seriously can threat human lives and economic values. In the European Alps the occurrence of debris flows might even increase with respect to climate change, including permafrost degradation, glacier retreat and variable precipitation patterns (MAIR et al. 2008). Thus, detailed understanding of process parameters and spatial distribution of debris flows is necessary to take appropriate protection measures for risk assessment. In this context, numerical models have been developed and applied successfully for simulation and prediction of debris-flow hazards and related process areas (cf. DAMM AND FELDERER 2008). In our study a GIS-based model is applied in an alpine catchment to address the following questions:

- Where are potential initiating areas of debris flows?
- How much material can be mobilized?
- What is the influence of topography and precipitation?

The study area is located in the Antholz valley in the eastern Alps of northern Italy. The investigated catchment of the Klammbach creek comprises 6.5 km^2 and is divided into two sub-catchments. Geologically it is dominated by metamorphic rock and altitudes range between 1,310 and 3,270 m. In summer 2005 a debris flow of more than 100,000 m^3 occurred, originating from a steep, sparsely vegetated debris cone in the western part of the catchment. According to regional study (DAMM AND LANGER 2006, DAMM 2007) the lower permafrost boundary in this area has risen by 250 m since about 1950.

In a first step, geomorphological mapping was performed, several channel cross-sections were measured and sediment samples were taken during field survey. Using mapping results and aerial images, a geomorphological map was created. In further steps, results from the field work, the geomorphological map and existing digital data sets, including a digital elevation model with 2.5 m resolution, are used to derive input data for the modeling of debris flow processes. The model framework 'r.debrisflow' based on GRASS GIS (MERGILI 2008) is applied, as it is capable of simulating the potential spatial patterns of debris flow deposition, as well as their initiation and movement. Furthermore it is freely available and open-source software and can thus be improved and extended. 'r.debrisflow' couples several modules for hydraulic, slope stability, sediment transport and debris flow run-out modeling, which are combined differently in 6 simulation modes. In a first step, model parameters are calibrated using the run-out only mode with known parameters of the 2005 debris flow. Finally, the full mode will be used to evaluate the debris-flow potential of the whole catchment.

First results from the geomorphological mapping reveal numerous surface forms, like levees, debris flow lobes or scars that indicate past and recent debris flow activity in the area. In both sub-catchments, there are large areas of unconsolidated, sparsely or not vegetated sediments, surrounded by high rock walls, which conduct precipitation rapidly into the debris. The two sub-catchments, however, have different topographic characteristics, which can be analyzed with the model in more detail. In a next step, the potential starting areas of future debris flows shall be identified and the potential amount of mobilized material shall be estimated by the model.

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Interstadial peat-sediment deposit in Petäjäselkä, Northern Finland

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Inter-till stratified sediment deposit with intervening organic layer was found from the Petäjäselkä area, northern Finland. Petäjäselkä is located in the Central Finnish Lapland about 150 km north from the Arctic Circle. A percussion drilling program for till geochemical exploration was carried out in the area in 2005 and the organic material was found in two of the drilling holes. In 2008 both sampling sites were re-sampled using percussion drilling with plastic tubes 3.7 cm in diameter.

The sampling sites situate in a mire area. The thickness of Holocene peat cover is 2-3 m. Under that there is a 1.5-3 m thick till unit composed mainly of sandy or silty matrix with some thin sandy layers. The stratigraphy is followed by the one-meter thick stratified sandy and/or gravelly deposit that includes intervening organic peat layer (thickness 1-15 cm). Pollen assemblage of the peat is Pinus-Betula dominated. Under the stratified sediments occur silty till with the thickness more than 3 m.

Samples were taken for dating both from the peat (radiocarbon C-14) and the stratified sediments under and below (Optical Stimulated Luminescence OSL). C-14 dating was done in the Poznań Radiocarbon Laboratory, Poland and OSL dating in the Dating laboratory of the University of Helsinki, Finland. C-14 age for the peat is 35,300 ± 600 BP and the OSL ages for the sand under the peat are 72.6 ± 21.3 ka and 58.1 ± 17.0 ka. Instead, the age of the sand above the peat is 31.8 ± 5.6 ka.

The dating results prove that the inter-till stratified deposit with intervening peat layer is representing the Middle Weichselian interstadial. The Middle Weichselian interstadial deposits from the central and southern Lapland have also been described by HELMENS ET AL. (2007), MÄKINEN (2005), SARALA (2005, 2008) and SARALA ET AL. (2010). These observations clearly prove that northern Finland has been ice-free at least once during the Middle Weichselian period.

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Distribution patterns of Pleistocene periglacial slope deposits exposed along a gas pipeline ditch through the Rhenish Massif

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The folded mountains of the Rhenish Massif, located at the Western boundary of Germany, were built during the Carboniferous, and consist predominantly of Devonian slate and graywacke. A minor part of the area is covered by Devonian quartzite and limestone. Under the warm and humid conditions of the Upper Mesozoic and Tertiary, intensive weathering of the Devonian rocks took place, leading to a peneplain covered by thick kaolinitic soils. Below these soils saprolite was formed, reaching a thickness of up to 150 metres. During the cold periods of the Pleistocene, the Rhenish Massif was subject to periglacial conditions, although it was not glaciated at any time. Under these climatic conditions and contemporaneous tectonic uplift, the rivers Rhine and Moselle incised deeply into the basement rocks, and their tributaries progressively dissected the peneplain. Meanwhile, the pre-Pleistocene soils were extensively removed by denudation and gelifluction. Several layers of Pleistocene Periglacial Slope Deposits (PPSD) were formed, covering the Mesozoic-Tertiary Saprolite. The upper part of the saprolite was also incorporated into the formation of the PPSD.
The German classification system distinguishes four types of PPSD:

- The Basal Layer (BL) consists only of debris of the underlying rock and in most places lies directly on top of the rock. It occurs in almost every relief position with a thickness varying in a wide range.
- The Intermediate Layer (IL) follows on top of the BL. It is usually rich in loess and only present in positions which favour loess accumulation and preservation.
- The Upper Layer (UL) contains rock debris and loess. It has a remarkably steady thickness of 50 ± 20 cm.
- The Top Layer (TL) mainly consists of rock debris and is restricted to particularly resistant rock types in higher regions.

During the Holocene, for several thousand years no significant geomorphological processes occurred until in historical time deforestation and agricultural use by man led to favorable conditions for extensive erosion. As a result, today, the PPSD are partly eroded or covered by colluviums in many places.
In 1999 a gas pipeline was built, crossing the Rhenish Massif from NW to SE. The pipeline ditch with a depth of 2.5 m offered a good view on the partly saprolized rock, PPSD, and colluviums. We used this situation to observe the influence of relief and underlying rock on thickness and properties of the PPSD. Along 20 sections of overall 19 km in length, the thickness of the layers was measured.
We found that the distribution and thickness of the colluviums and PPSD, except the UL, is decisively governed by the paleorelief. The BL is found almost everywhere. Its thickness increases in paleodepressions up to several meters. The IL only occurs in paleotroughs, while the UL is found in all positions. Where it has not been eroded, it shows an almost constant thickness of about 50 cm. Colluviums are widespread, too. Their thickness increases distinctly in paleotroughs.
By filling up paleodepressions the PPSD and colluviums had a smoothing effect on the landscape, so that many paleotroughs are not visible anymore today.
Generally, concave slope sections show a substantial increase of sediment thickness. The deposits within them may differ in terms of thickness and vertical composition. Whereas in some dells the BL are thicker than along the surrounding slope, in other dells they were thinned out or completely removed by erosion. Mostly, an IL follows above the BL. Only in some W-exposed dells no IL are involved in the composition of the dell fillings. The reason for this the

luv-lee-effect with regard to the loess deposition: Due to predominant westwinds, more loess was deposited on the E-exposed slopes than on the W-exposed slopes, so that the IL (which are characterized by a great loess content) are more frequent along E-exposed slopes. In contrast to the concave positions described above, the vertical sequence of convex slope sections only consists of UL above BL, both being comparatively thin. In some places the rock is only covered by the UL, which may be also interrupted by rock outcrops.

The soils that developed in the PPSD on saprolite are primarily characterized by waterlogging, so that the most frequent soils in areas with UL above BL above saprolite are Planosols. The rain water which can easily infiltrate the UL accumulates above the BL that is composed only of clayey saprolite which completely lost its structure and was heavily condensed by the gelifluction process during its genesis. In places where an IL is present, distinct clay cutans are developed therein. In this case, the rain water also passes rapidly the UL, but is then slowed down by the IL and finally again accumulates above the BL. This process is documented by strong redoximorphic features in the BL and weaker ones in the IL. In contrast to the hydromorphic soils in PPSD on saprolite, cambisols predominate among the soils in PPSD on fresh rock.

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Stratigraphy of Late Quaternary river terraces at the Lech – Danube confluence

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The study area is situated at the Lech – Danube confluence in the German Alpine Foreland (Fig. 1). The valleys of both rivers are characterized by flights of Quaternary river terraces. The oldest and highest Pleistocene terrace remnants are the different *Deckenschotter* levels. They are followed by *Hochterrassen* (Upper Terraces), which are related to the Riss glacial (PENCK & BRÜCKNER 1909). *Niederterrassen* (Lower Terraces) of Würmian age are common in valleys of the Alpine Foreland, whereas they are rarely morphologically present in the study area (Fig. 2). Instead, Holocene terraces take up widespread areas of the valley floors of both rivers. While the *Rainer Hochterrasse* at the Lech – Danube confluence was in the focus of research (e.g. GRAUL 1943, SCHAEFER 1966, KILIAN & LÖSCHER 1979, TILLMANNS et al. 1982, FIEBIG & PREUSSER 2003), the Late Quaternary valley bottom in the study area was examined only by SCHREIBER (1985). Furthermore an unpublished geological map of the northern part of the study area exists (GROTTENTHALER, unpublished).

The morphological features in the study area were surveyed by field mapping and high resolution Digital Elevation Models (LIDAR data, 2 x 2 m resolution) from the OFFICE FOR SURVEYING AND GEOINFORMATION (Munich). The fluvial deposits of the river terraces were investigated in numerous outcrops at the Lech – Danube confluence. The chronology of fluvial dynamics is provided by radiocarbon and luminescence dating. Also, pedological observations, archaeological data and historical maps were taken into account.

In the Danube valley slightly downstream the Lech mouth a Lower Terrace is preserved. This terrace is composed of sandy gravels and exhibits a thin cover of floodplain deposits. Plant remains from the base of a paludal infill of the marginal depression (*Randsenke*) yielded an age of 9,960 ± 60 ^{14}C BP (11,220 – 11,610 cal BP). Insofar, the Lower Terrace most likely was formed in the Younger Dryas or earlier, as the paludification of the channel fill is younger than the fluvial formation of the terrace.Two pine trunks, dated to 9,290 ± 60 (10,270 – 10,660 cal BP) and 9,360 ± 70 ^{14}C BP (10,400 – 10,740 cal BP), give evidence for a Preboreal accumulation of the early Holocene terrace *(qha)* upstream the confluence. A further terrace remnant of at least Preboreal age is preserved in the Lech valley.

In the study area, the Atlantic period is not represented by coarse clastic river deposits. In several outcrops up to three fossil black floodplain soils could be found in floodplain sediments overlying Preboreal terrace gravels. In one outcrop a piece of wood between two black soils yielded an age of 5,090 ± 40 ^{14}C BP (5,740 – 5,920 cal BP). Floodplain sediments containing fossil black soils are partially conserved beneath Subboreal gravel deposits. Therefore, the black soils developed between the late Preboreal and the early Subboreal.

The Subboreal terrace (*qhm*) is the most widespread one in the valley floors of the investigated area. Infills of several channels were dated by OSL to 5 to 3 ka BP. For discussion of the luminescence ages see SCHIELEIN & LOMAX (in prep.). At the base of the gravel body several ^{14}C ages around 4,000 ^{14}C BP (4,400 – 4,960 cal BP) prove the Subboreal age of the terrace. In addition, Roman settlements and streets on the surface give evidence of a pre-Roman deposition of the terrace.The youngest valley floor was formed during the Subatlantic period. It can be subdivided in up to six terraces (*qhj*), which accompany the recent courses of Lech and Danube.

The Danube terraces show the typical morphology of a meandering river, whereas the morphology of the Lech terraces predominantly relates to an anabranching river. Downstream of the Lech – Danube confluence Subatlantic terrace morphology is a transitional one. The Subatlantic terraces have been differentiated by differences in their surface elevation, morphological unconformities and partly by the degree of soil development. According to radiocarbon dating of organic material, OSL dating of fluvial sands, archaeological data and historical maps the Subatlantic terraces were formed between 2,770 ± 50 ^{14}C BP (2,760 – 2,980 cal BP) and the 19th century AD (Fig. 2).

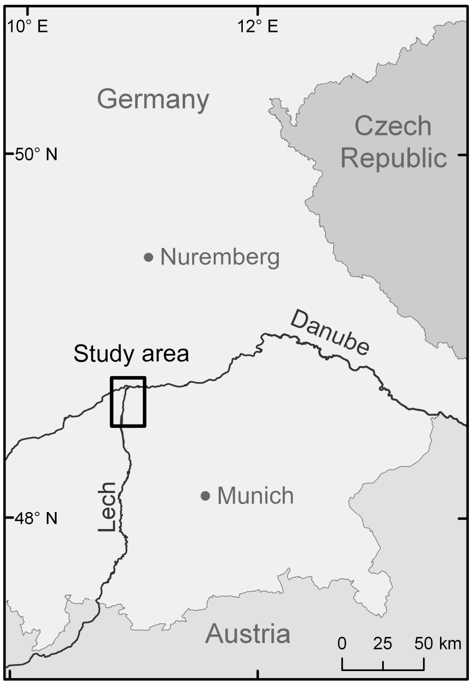

Fig. 1: Location of study area.

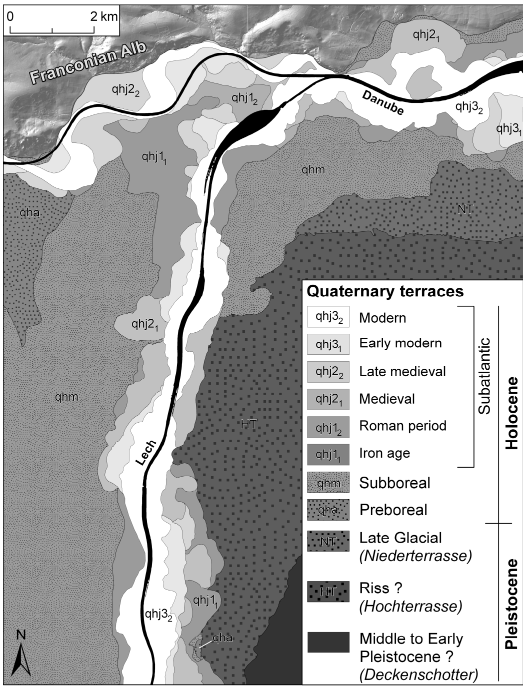

Fig. 2: Geology at the Lech–Danube confluence.

The poster presents some results of field mapping, several representative outcrops and schematic transverse valley profiles. Furthermore the age of the terraces will be discussed. *The study was funded by the Bavarian Environmental Agency. The authors would like to thank G. Doppler, E. Kroemer and B. Gesslein for helpful comments and discussions in the field as well as F. Preusser and M. Fiebig for support of OSL dating.*

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Switzerland at the Last Glacial Maximum (LGM) – A new map (2009) by swisstopo 1:500 000

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Map-sheet No. 9 of the Atlas of Switzerland (1970) showing the area of the country at the Last Glacial Maximum by Eduard Imhof und Heinrich Jäckli has been sold out for many years. This simple fact and new data on the geometry of the inner-alpine LGM glaciers, mainly by Florineth (2000) and Kelly (2004), initiated the idea to produce a new map of the LGM in Switzerland. This idea was the beginning of a hard job which has kept us busy for almost 10 years. The new map 1:500,000 is available now through book- and map-stores and can be downloaded at www.swisstopo.ch.

What information is new on this map? These are the following reconstructions:

(1) The ice cover on the highest and central parts of the Jura Mountains is more extensive and more important than previously thought. The main data in support of this reconstruction is excellent mapping evidence to the northwest of the High Jura in France.

(2) The Highlands of the Napf in the central Swiss Midlands with a max. elevation of 1408 m has been covered with small, however well defined valley glaciers. This has not been recognised on the previous map. The local LGM valley glaciation of the Napf is supported by the existence of nivation areas and small glaciers in the adjoining hills.

(3) Detailed mapping of trimlines in the High Alps between the Engadine Valley to the east and the Mont Blanc area to the west shows the existence during LGM time of well defined ice dome areas in the Upper Engadine, in the Surselva and in the Upper Rhone Valley (including the ice plateau in the Zermatt area).

(4) All four such ice accumulations are situated to the south of the main orographic divide of the Alps with interesting implications on atmospheric paleocirculation patterns. As a result of this configuration ice flow was from south to north along certain transfluences accross the the High Alps. – The huge outlet glacier from the Mattertal (draining the ice plateau in the upper valley of Zermatt) to the main valley of the Wallis was so important that the ice from the upper Rhone valley was blocked-off at Brig-Visp and diverted directly to the south accross Simplon pass (causing a complex divergent transfluent ice flow regime in the Brig-Visp area). With such a reconstruction of the paleo iceflow in the Rhone valley it is possible now for the first time to explain the distribution of erratic indicator lithologies in the western Swiss Midlands.

(5) The glaciers in southern Switzerland display narrow valley glacier morphology, quite different from earlier reconstructions. This morphology may reflect glaciers with very high mass turnover (compared to the glaciers in South Westland of New Zealand's South Island) as a result of the main track of precipitation to the Alps from the south. The positions of the LGM ice domes coincide with the centers of foehn controlled precipitation today.

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Development of top soil on Quaternary inland dunes – How important are microorganisms?

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After the retreat of the Ice Age glaciers sand dunes developed in Europe from aeolian sand deposits forming initial ecosystems. Nowadays, the "European sand belt" in the northern European Lowlands extends from Britain to the Polish–Russian border and beyond and covers several tens of thousands of square kilometres (KOSTER 2009). Sand dunes are considered as nutrient-poor and water limited ecosystems. Many open and mobile sand dunes have however been stabilized after transformation into pine forests during the last century. These mobile sand dunes are unique model systems for the better understanding of soil formation processes in initial ecosystems. Therefore, we studied the initial development stages in the former military training areas in Lieberose (Figure 1) and Groß Oßnig in Brandenburg, North-East Germany.
The first millimeters of the initial surfaces of sand dunes are covered with biological soil crusts (BSC), composed of cyanobacteria (Figure 2), green algae, mosses and lichens. They are an important initial factor for the soil development as they prevent aeolian sand transport and stabilize the substrate. BSC provide nitrogen fixation, accumulate the first soil organic matter and influence the hydrological processes (FISCHER et al. 2010a, 2010b). They furthermore promote surface run-off subject to grain size distribution, porosity and water retention capabilities.
The development of BSC types depends on abiotic factors such as climate, parent material, relief, sorting of the particles and grain size composition, availability of nutrients, precipitation and on anthropogenic disturbance.
Three types of BSC were defined for both study sites: (i) cyanobacterial and green algae crusts on the soil surface with no vegetation (crust type 1). Here the sand particles were stabilized at their contact areas by accumulated organic matter, filamentous cyanobacteria and green algae. (ii) cyanobacteria and green algae between sparse vegetation cover e. g. with *Corynephorus canescens* (crust type 2). In this case filamentous cyanobacteria and algae are present in the pores and enmeshed sand particles. (iii) BSCs with few mosses between dense vegetation (crust type 3). Here the crust type is composed of filamentous algae, cyanobacteria and mosses. The pore space is completely filled with the microorganisms.
To compare the different crust types, the amount of chlorophyll as well as organic matter content were determined, and the structure of the crust was investigated using optical and scanning electron microscopy.
In addition, we characterized the water regime of the crusts using water infiltration, and repellency tests were carried out using the ethanol/water microinfiltrometer method to determine the repellency indices (HALLETT & YOUNG, 1999).

Tab. 1 shows the carbon and nitrogen contents, C/N ratios and chlorophyll α content. At Lieberose (L) the carbon content increase from crust 1 to crust 2. At crust 3 the carbon content is slightly lower, however, the total amount of accumulated organic matter increased due to increasing crust thickness. At Groß Oßnig (GO) the carbon and nitrogen content and C/N ratios are similar for each crust type, but at both sites chlorophyll α increases from crust 1 to 3. In the initial stages of crust development the water repellency indices increased, but the appearance of mosses resulted in decreasing repellency index values.

Fig. 1: Study site at Lieberose, Brandenburg.

Fig. 2: SEM micrograph of crust L2 with filamentous cyanobacteria on the sand grains.

Tab. 1: Carbon and nitrogen contents, C/N ratios, and chlorophyll α contents of the crusts 1-3 at Lieberose (L) and at Groß Oßnig (GO).

	C	N	C/N	Chlorophyll α
	mg/g	mg/g		µg/cm²
Crust L1	1.95	0.20	9.75	1.38
Crust L2	7.43	0.45	16.51	2.45
Crust L3	6.45	0.45	14.33	2.73
Crust GO1	0.37	0.03	12.33	9.23
Crust GO2	0.36	0.03	12.00	9.74
Crust GO3	0.39	0.03	13.00	25.37

Most likely, microbial extracellular polymeric substances (EPS) influence surface polarity and, thus, wettability of the crust. Biological soil crusts are an important factor for the development of soil on quaternary sandy substrate in the initial stages. Their main functions for soil genesis include the stabilization of the dunes, the accumulation of soil organic matter and – depending on the crust types – the influence on the water regime in the soil.

This project is part of the Transregional Collaborative Research Centre 38 "Structures and processes of the initial ecosystem development phase in an artificial water catchment" and is funded by the German Research Council (Deutsche Forschungsgemeinschaft DFG).

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New geological maps (GK 25) of the Altmark based on archive documents and fieldworks (example: geological map 3135 Leppin)

LJUBA STOTTMEISTER

The aim of geological survey in the Altmark is to fill the gaps of the geological mapping and to make available the modern geological information about the northern part of Sachsen-Anhalt to a wide circle of user. The 1990th gave the mapping of the so called "white spots" (not mapped regions) special emphasis, especially the area around the border to Niedersachsen. Those projects required a great deal of fieldwork. Four new geological maps at a scale 1:25,000 (GK 25) were published since 1996 – three of them as editions with additional Explanatory Notes. Two more GK 25 maps are in process.

Contemporary the geological survey concentrates on the revision and publishing of archives mapping documents. The partial over 50 years old manuscript maps will be completed and will be made topical by a minimum of fieldwork, by the help of evaluation air photos and under consideration of all given archives data (reports, drill holes, construction projects, labor analysis) and also be adapted to modern topography. Graphic programs make possible the preparing of the revised maps, the legends, the thickness columns and the geological cross sections, so that their layout is ready for publishing. The new maps will be transformed in the digital GK 25 additionally.

The map sheet 3135 Leppin is the second from about nine manuscript maps from the northern Altmark, which are cultivated this way (the western following sheet 3134 Arendsee was published in 1998 as edition with additional Explanatory Notes). This area was mapped by B. Marcinkowski in the years 1965-1966. There are descriptions of 998 handmade drill holes until a depth of 2m, which are distributed very irregular in the area.

With geomorphologic mapping, inspection of geological exposures and 283 handmade drill holes it was possible to surmount the unsteadiness (resulting from the manuscript maps) within 18 days in the premises in the year 2009. In the result the map representation partial needed to be revised. The descriptions of the past drill holes were scrutinized and the designation of the equivalent sediments were adapted to actual lithological and stratigraphical terms. A new geological legend was drawn up consequently. Besides the graph was transfered to an actual topographical base.

The paper "Geologische Schnitte" (geological cross sections) – presenting a selection of 10 cuts based of about 450 boreholes from LAGB-data-bank – was designed to illustrate the bedding conditions in the underground. The mostly flat boreholes for an examination of deposits of springs, construction grounds, clay, gravel and iron ore are priority bound to 12 small spaces in the area. Merely 28 boreholes are deeper than 100m, 8 of them were used for searching mineral oil. The deepest borehole for mineral oil was stopped by a depth of 4745 in the "Unterrotliegend". An essential contribution for the reconstruction of the quaternary base surface and the course of the over 250m deep quaternary channel provided the seismic profiles from the time of the search for mineral oil.

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What is the age of "Eemian" marine outcrops at the southern coast of the Baltic Sea?

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Due to their fauna characterizing them as marine sediments, several sandy layers found in outcrops and drillings in Mecklenburg-Vorpommern (e.g. Klein Lehmhagen, Schwaan, Bad Doberan) are assigned as marine deposits of the Eemian interglacial period (STEINICH 1995, FRENZEL & ANSORGE 2002). However, recent luminescence (OSL) datings of transgressional sandy layers in the clay-pit of Klein Lehmhagen near Grimmen yield Late Pleistocene ages. Since OSL dates the last exposure of sediments to sunlight, this demonstrates that these sands were not deposited in the Eemian interglacial but in MIS 2. The question arises if marine shells showing saline water conditions were formed synsedimentarily and thus indicate a short marine transgression during that period, or if they were reworked from older deposits and deposited by glaciofluvial processes. This question will be answered with ^{14}C datings. Furthermore, it is intended to extend OSL datings to other "Eemian" marine deposits as e.g. in Schwaan, in order to highlight the chronology of these deposits in the southern Baltic area.

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The influence of subglacial processes on the luminescence of basal sediment

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Natural luminescence data from basal sediment from Haut Glacier d'Arolla, Switzerland has revived speculation that erosion and/or sediment transport in the subglacial environment may constitute effective luminescence resetting mechanisms. The plausibility of these resetting mechanisms rests on the presumption that luminescence signals can be reset if sediment grains are exposed to sufficient stress. The ice-bedrock contact zone of active glacial systems and the shear zones of active fault systems have been cited as environments where shearing has the potential to reset luminescence; however, laboratory studies that have investigated the effects of shearing on luminescence have produced conflicting results. We present the first results from a laboratory-based project that aims to determine the efficacy of resetting in the subglacial environment by shearing sediment under conditions representative of the ice-bedrock contact zone of active glacial systems. Preliminary luminescence data will be shown from an initial experiment that aims to quantify the effect of shearing on the luminescence of quartz. Homogenous medium-sand was obtained for the experiment from relict dune systems that possess substantial natural luminescence (we anticipate that glacial sediments with a wider range of grain sizes will be used in later experiments). Shearing was conducted using a state-of-the-art ring-shear apparatus using an imposed normal stress of 50 kPa at a shearing rate of 1.44 m/day for a distance of up to 12 m, with samples for luminescence analyses taken from the shearing zone at pre-defined intervals. It is anticipated that further experiments using a range of imposed normal stresses and further analyses of changes in the luminescence and surface microtexture of grains in specific grain-size fractions will elucidate and quantify the specific nature of the resetting mechanism.

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Lakes and human activity in Mecklenburg-Vorpommern during the past 6000 years

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While the development of lakes in Mecklenburg-Vorpommern during the early Holocene was primarily determined by internal processes and climate, humans increasingly influenced lake ecosystems after the spread of agriculture at 6000 cal. BP. We studied human effects on nine small lakes and one large lake across Mecklenburg- Vorpommern (fig. 1). The lakes are situated in the different landscape compartments of Mecklenburg-Vorpommern, including ground moraines, outwash plains, glacial basins and terminal moraines and thus may reflect different developments in these different compartments. To arrive at comparable results we selected lakes with a similar morphometry (close to circular shape, one central lake basin) and size (10-50 ha). Mostly the lakes have no inlet or outflow. Three lake profiles are AMS ^{14}C dated. The land-use history was studied using pollen analysis. For improved interpretation a surface sample data set including 45 lakes in the area was established. Proxies used to study lake development are magnetic susceptibility, loss on ignition, grain size and basic geochemical analysis.

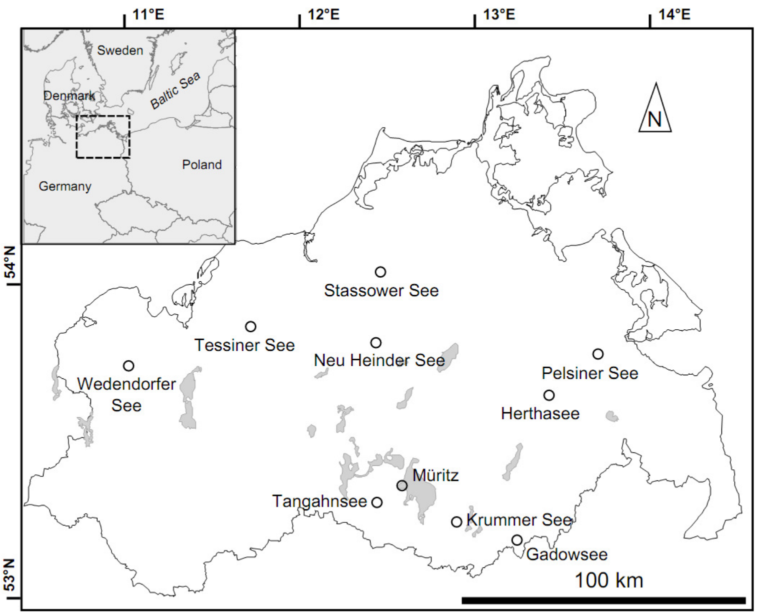

Fig. 1: Location of investigated lakes.

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Geomorphological mapping as prerequisite for landslide susceptibility modeling of Pleistocene sediments along the coast of Jasmund/Rügen

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The cliff of Jasmund peninsula (Rügen Island, Germany) is composed of soft, intensely fractured Cretaceous chalk rocks and Pleistocene glacial deposits consisting of till, clay, and sand (STEINICH, 1972). Both stratigraphic successions have undergone strong glacial deformations during the Late Weichselian. Results of these glaciotectonic processes are tight folding and shearing of the Pleistocene deposits, and thrusting accompanied by folding of the Cretaceous chalky limestones. The entire lithostratigraphic sequence was uplifted and segmented into thrust-bounded structural complexes during the last glacial ice advances, and subsequently capped and discordantly overlain by the youngest glacial sediments.
Recently, the public interest of the coastal cliff stability significantly increased due to spectacular large-volume cliff failures and landslides that occurred over the last few years; one of which was the landslide in Lohme in the year 2005. During this event about 100,000 m^3 of Pleistocence till and sand were mobilized and several houses had to be evacuated (OBST and SCHÜTZE 2006). Not only the infrastructure but also visitors of the National Park Jasmund might be endangered by cliff collapses and sliding masses. Because little was known about the distribution of shallow, topographically controlled landslides on Jasmund, a detailed geomorphological survey at the scale 1: 5,000 was conducted in a pilot study area along the north-eastern coast of the peninsula. The mapping was prerequisite for landslide susceptibility modelling presented in GÜNTHER and THIEL (2009). Eighty slides with main scarps ranging from 10 to 160 metres were identified, most of them being dormant or subactive; only twelve are active. However, most of the active slides are advancing or retrogressive landslides, indicating reactivations of apparently stabilized areas.
The landslide inventory has been continued not only for the south-eastern coast of Jasmund but also along other steep cliff section. All results are incorporated in the GIS-based landslide register of the State Geological Survey Mecklenburg-Vorpommern to develop innovative concepts for coastal protection and new coastal zone management approaches.

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StymphaCore – Reconstructing the environmental history of the Northern Peloponnesus, Greece

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The interdisciplinary research project "StymphaCore" aims to understand the relationship between the climate and the historical record, as well as the natural versus human-induced environmental change on the Northern Peloponnesus. To answer these questions, two study areas, Lake Stymfalia (22°27' E / 37°51' N) and the Prokopos Lagoon (21°23' E / 38° 8' N), were selected for high resolution comparative analyses. In a first field campaign in March 2010, several lake sediment cores were recovered at both sites using a piston coring device on a floating platform. The planned sediment analyses include the combination of geochemical (i.a., XRF-scanning, CNS) and geophysical methods (i.a., Magnetic Susceptibility). High-resolution AMS ^{14}C dating is used to establish detailed time series of the climate variables (samples have been submitted but the dates are not yet available).

Known from the ancient Heracles myth of the Zeus' son slaying the Stymphalian birds, the mountainous landscape of Stymphalos, including the lake, the ancient Greek town, a river and a mountain by the same name, is an ideal site to study the environmental history of the area by combining the climate archive of lake sediments with the historical and archaeological record. Settlement activity is known from least the 5th century BC and was specified by Pausanias in his "Description of Greece" (ca. 160–175 AD) A 15.54 m long sediment core (STY1) was retrieved, with the first lithological characterization of the mainly clayey sediments suggesting that the core spans the entire Holocene and parts of the Late Glacial.

In contrast, the Prokopos Lagoon is separated from the Ionian Sea by a ca. 1.5 km wide, arboreous dune ridge and shielded to the North by the carbonate cliff of Cape Araxos. At this site, emphasis is placed on (1) reconstructing the paleo-climate, (2) establishing paleogeographic scenarios including sea level fluctuations and (3) disentangling the human-environment interaction. Along a transect 3 sediment cores of up to 4 m length each were retrieved. First results indicate a predominance of dark, shell- and organic-rich sand which is sporadically dissected by gyttja or peat layers. Additional information about environmental changes will be derived from recent and historical maps, from ancient travel reports and from the archeological record of the Mycenaean fortress Teichos Dymaion located on Cape Araxos. Human activity is known to have occurred in this area since the end of the Neolithic.

Focusing on the balance between sustainability and exploitation, important questions of the StymphaCore project are: How did the different cultures i.a. Myceneans, Classic Greeks and Romans, manage the water resources? And how sustainable was the agricultural land use?

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Relative sea-level change in northwest Europe and the southern North Sea during the Holocene – Determination of isostatic and tectonic subsidence in the German Bight based on observational and model results

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A thorough understanding of the causes and effects of differential relative sea-level (RSL) rise in the southern North Sea region since the end of the Last Glacial Maximum is important to help predict future morphological development along the intensively utilised northwest European coastal zone. In this study, a comprehensive observational database of Holocene RSL index points deriving mainly from dated basal peat layers from northwest Europe (Belgium, the Netherlands, northwest Germany) and the southern North Sea (mainly German sector) has been compiled in order to compare and reassess the data collected from the different countries/regions and by different workers on a common time–depth scale. RSL-rise varies in magnitude and form between these regions, revealing a complex pattern of differential crustal movement which is attributed mainly to the variable effects of tectonic and isostatic subsidence. It clearly contains a non-linear, glacio- and/or hydro-isostatic subsidence component, which is only small on the Belgian coastal plain but increases significantly to a value of ca. 7.5 m relative to Belgium since 8 cal. kyr BP along the northwest German coast (VINK et al., 2007), and a value of >15 m since 10 cal. kyr BP in the German Bight. The subsidence is at least in part related to the post-glacial collapse of the so-called peripheral forebulge which developed around the Fennoscandian centre of ice loading during the Last Glacial Maximum, but may also be associated with water and sediment loading of the North Sea Basin. Differential isostatic subsidence between the analysed areas can only be traced to ca. 4 cal. kyr BP, after which RSL curves overlap (i.e. by then, isostatic subsidence within the entire analysed region had either evened out or become negligible). The RSL data have been compared to geodynamic Earth models in order to infer the radial viscosity structure of the Earth's mantle underneath NW Europe (lithosphere thickness, upper and lower mantle viscosity), and conversely to provide predicted RSL values with area-wide coverage (i.e. also in regions where we have no or few observational data). Modelled RSL data have been corrected for hydro-isostatic effects and suggest that the zone of maximum forebulge glacio-isostatic subsidence runs in a relatively narrow, WNW-ESE trending band connecting the German federal state of Lower Saxony with the Dogger Bank area in the southern North Sea.

Analysis of a new comprehensive dataset of RSL index points from the German Bight shows that (neo)tectonic subsidence has occurred in a direction approximately perpendicular to that of glacio-isostatic subsidence during the last 10 cal. kyr (i.e. in a NW-SE direction within the band of maximum isostatic subsidence). The linear tectonic subsidence component along the northwest German coast is assumed to be very small at ≤ 0.05 m/kyr (roughly estimated from the present-day depth of submerged Eemian sea-level highstand deposits, and supported by the results of levelling activities carried out from 1928 to 1931 and from 1949 to 1955).

Observational and modelled RSL data from the German Bight show that linear (neo) tectonic subsidence increases to ca. 0.37 m/kyr in the outer reaches of the German North Sea sector and to ca. 0.53 m/kyr in the Dogger Bank area. This is the first study in which present-day offshore tectonic subsidence rates in the German Bight have been roughly estimated, which may be of interest for companies dealing with commercial activities such as the installation of pipelines, offshore wind parks, cable lines, etc.

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Evolution of Middle Pleistocene Glacial Lake Leine (NW Germany): challenges on the way to reconstruct lake-level history and palaeogeography

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The blocking of the Leine valley by the Saalian Drenthe Ice Sheet led to the formation of a large glacial lake, referred to as "Glacial Lake Leine". At the initial stage, the lake level was approximately 110m a.s.l. followed by a rose of 100m to a highstand of ~200m a.s.l. (Winsemann et al., 2007). Major unsolved questions concern the lake-level history and the fluvial response to temporal lake formation and drainage.

In this study we use a multidisciplinary approach to reconstruct the lake-level history and palaeogeography of the glacial Lake Leine. The data set includes information from geological maps (scale: 1:25 000), outcrop sections, wells, high-resolution shear-wave seismics and digital elevation models (DEM). All data will be compiled in a Geographic Information System (ArcGIS).

The lowermost fill of Upper Leine Valley consists of fluvial and lake deposits (Early to Middle Pleistocene age), overlain by fine-grained, glaciolacustrine deposits of presumably Saalian age. Coarse-grained glaciolacustrine ice-marginal deposits are exposed at Freden and Bornhausen. Extraordinary up to 45m thick, fine-grained, glaciolacustrine deposits occur in the area around Northeim and Nörten-Hardenberg, possibly indicating sediment supply through an overspill channel from Glacial Lake Weser. The glacigenic valley-fill deposits are overlain by fluvial deposits and loess.

In order to reconstruct the extension, volume and lake-level history of glacial Lake Leine we want to identify:

- *Overspill channels*
- *Shoreline features*, such as wave-cut benches and beaches
- the distribution and architecture of *glaciolacustrine, ice-marginal* and *lake-bottom sediments*
- *Fluvial deltas*, which topset-foreset contacts can be used as water-plane indicators.

The traditional interpretation of the Pleistocene sedimentation history of the Upper Leine Valley is based on a climate-driven fluvial incision model, assuming a successive deposition/incision of the River Leine during the Pleistocene (e.g. Rohde, 1994).

Nevertheless an overall geological model is missing, which can explain the significant discrepancies concerning elevation and composition of the terrace deposits. We hypothesize, that the supposed terrace levels partly represent fluvial deltas, which were shed into glacial Lake Leine.

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Response of a proglacial delta to rapid high-amplitude lake level change: integrating geomorphology, sedimentology and shear wave seismics

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In this paper we will present the stratigraphic evolution, internal facies architecture and geomorphology of the Middle Pleistocene Emme delta, controlled by rapid high-amplitude lake-level change. The Emme delta was deposited on the northern margin of glacial Lake Weser, located in north-west Germany. Rates of lake-level rise were probably larger than 50 mm/yr and rates of lake-level fall 30-50 m within a few days or weeks, due to opening of lake outlets.

We employ digital elevation models, sedimentology and shear wave seismic to improve earlier reconstructions and investigate the influence of rapid base-level change on delta development. Shear-wave seismic data resolve architectural elements in the range of metres and bridge the common gap between outcrop and conventional compression wave seismic data.

The radial delta complex is about 2 km long, 1.8 km wide and up to 70 m thick, overlying a concave, up to 13° steep dipping ramp surface. It has a stepped profile and consists of vertically and laterally stacked delta lobes, caused by lobe switching during base-level change. During lake-level rise, vertically stacked (Gilbert-type) delta systems formed. The decrease in thickness and lateral extent indicates a rapid upslope shift of depocentres.

A high rate and magnitude of lake-level fall (50 m) promoted the development of a single incised valley and the deposition of forced regressive coarse-grained delta lobes in front of the valley. The incised valley was filled during decreasing rates of lake-level fall and low base-level, because the alluvial gradient was larger than the emergent lake profile. Attached sand-rich forced regressive aprons formed during lower magnitudes of lake-level falls in the range of 30-35 m. Valley incision occurred, but was limited to the uppermost portion of the delta, controlled by the steep slope. The incised valley related to the final lake drainage is associated with long-wavelength (60-90 m) bedforms at the downslope end, attributed to the formation of standing waves as a result of a hydraulic jump. Estimated palaeoflow depth during standing wave formation was ~ 9-14 m and flow velocity 10-12 m /s.

Since subsidence, waves or tides did not play a major role, the Emme delta can be used as an analogue-based predictive stratigraphical and sedimentological model for steep glacigenc deltas controlled by rapid base-level change and help to better understand the facies distribution and 3D geometry of these depositional systems.

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