EUG XI

Symposium EVO6

The Late Quaternary Glacial and Environmental History in the Eurasian North - Land Areas, Shelf Seas and the Adjacent Deep Arctic Ocean (QUEEN)

Convenors

J. Thiede
Christian Hjort

Tuesday PM Session

EVO6 : TUpm25 : F1
Environments and their Late Quaternary History in the Eurasian Shelf Seas and the Adjacent Deep Arctic Ocean (QUEEN): An Introduction

Jörn Thiede (jthiede@awi-bremerhaven.de)[1] & **Julian A. Dowdeswell**[2]
[1] Alfred-Wegener-Institute for Polar and Marine Research, Columbusstrasse, D-27568 Bremerhaven, Germany
[2] Bristol Glaciology Center, School of Geographical Sciences, University of Bristol, UK

The deep Arctic Ocean and the adjacent shelf sea environments have changed rapidly and frequently during the Late Quaternary because of the paleoclimatic alternations of Glacials and Interglacials, of eustatic and isostatic sea level fluctuations, the growth and destruction of large ice-sheets over NW Eurasia. Little was known about these changes until during the past decade a substantial number of bilateral projects between western and Russian research institutions was established which are now cooperating in the ESF program QUEEN (Quaternary Environments of the Eurasian North) and which provide a wealth of new data. For the first time these projects have been able to define the eastern boundary of the Weichselian ice sheets over NW Eurasia and the wide shelf seas between the Northern Europe/ Siberia and the deep Arctic Ocean.Depending upon the former extent of these ice sheets the Barents, Kara and Laptev seas have developped widely different seafloor morphologies with submarine permafrost underlying wide stretches of the Laptev Sea. The ice complexes presently exposed and under rapid destruction in central northern Siberia and along its shores towards the Arctic Ocean are probably the best expression for the extreme environments which have developped in this area during the Quaternary. Sediment cores from the Arctic shelfs allow to reconstruct the history of sea level rise and inundation of the shelf seas after the last glacial maximum. The stratification of dominantly terrigenous sediment cover of the deep eastern basins and of Lomonossov Ridge of the Arctic ocean reflect the changing properties of a sea ice cover which existed for the past few hundred thousands of years at least. Pulses of the influx of coarse ice-rafted terrigenous debris document times and localities of dynamic changes of the ice sheets over NW Eurasia and North America-Greenland, the ice-rafting event towards the end of O-isotope stage 6 being the most important one. However, large uncertainties still exist about stratigraphies and extent of deposits documenting the last interglacial when shallow embayments reached much further inland than during the Holocene. Collections of QUEEN papers can be found in recent volumes of BOREAS (vol. 28, 1999) and GLOBAL AND PLANTARY CHANGE (in press).

EVO6 : TUpm26 : F1
Modelling and Observations of Sediment and Iceberg Flux to the Arctic Ocean during the Late Weichselian

Julian Dowdeswell (j.a.dowdeswell@bristol.ac.uk) & **Martin Siegert** (m.j.siegert@bristol.ac.uk)
Bristol Glaciology Centre, University of Bristol, Bristol, UK

A numerical model of the Eurasian Ice Sheet is used to predict the flux of sediments delivered to the Arctic Ocean and Barents/Svalbard margin during the Late Weichselian. The model predictions are tested against the dated geological record from the western margin of the ice sheet. Glacial sediments are delivered mainly from fast-flowing ice streams within the Late Weichselian ice sheet. These ice streams flow in bedrock troughs in the Barents Sea (e.g. St. Anna Trough, Franz Victoria Trough, Bear Island Trough). The model also predicts iceberg and meltwater flux to the ice-sheet margin. Observations of the modern ice caps in Svalbard and the Russian Arctic archipelagos (e.g. Severnaya Zemlya), using satellite synthetic aperture radar (SAR) interferometry and airborne ice-penetrating radar, are used to measure the flux of icebergs produced from these large ice caps today, providing a benchmark against which model predictions of past iceberg flux can be compared.

EVO6 : TUpm27 : F1
Three-Dimensional Seismic Images of Quaternary Glacial Deposits, South-Western Barents Shelf

Karin Andreassen (karina@ibg.uit.no)[1], **Bjarne Rafaelsen**[1], **Luppo Kuilman**[2], **Morten Midtbo**[1], **Erland Lebesby**[1] & **Kai Hogstad**[3]
[1] Department of Geology, University of Tromso, N-9037 Tromso, Norway
[2] Norsk Hydro ASA, Oslo, Norway
[3] Norsk Hydro ASA, Harstad, Norway

In the south-western Barents Sea several types of sub- and pro-glacial features are inferred from 3D-seismic data within the glacigenic sediments that overly the consolidated bedrock. The close spacing of 3D lines and the powerful computer work station interpretation techniques have allowed a detailed 3D mapping of the observed features. Several generations of glacial grooves observed on four different paleo surfaces are interpreted to reflect flow patterns of paleo glaciers. The grooves are 3 to 9 m deep, 20 to 180 m wide, and 0.5 to 20 km long. All four surfaces show a main lineation pattern of grooves trending N-S, suggesting that the dominant ice flow was moving north across the Barents shelf at least four times during the last 0.8 Ma. Imbricated thrust sheets involving the whole section of up to 120 m of glacigenic sediments are interpreted to be formed by thrusting of sediments in front of a glacier. The most extensive of these features suggest an ice-movement from east to west, and are probably formed during the last glacial maximum. Other, less extensive imbrication structures, which seem to suggest an ice-direction towards the east, are probably formed during a later deglaciation phase. A lobate-shaped ridge complex on the sea floor, interpreted to be an end-/push- moraine, suggests that the last ice movement locally was from west to east. Whereas the morphology of the buried seismic horizons is characterised by different generations of sub-parallel grooves, the sea floor is dominated by more variably oriented iceberg plough marks from the deglaciation phase of the last Barents Sea ice sheet. Despite relatively low seismic frequencies and hence low vertical resolution of seismic profiles, time slices and sub-horizontal time maps are of high spatial resolution, providing detailed images of different stages of buried Quaternary glacial geomorphology.

EVO6 : TUpm28 : F1
Preliminary Results from OSL Dating Supports "High" Sedimentation Rates on the Lomonosov Ridge, Central Arctic Ocean

Martin Jakobsson (martin.jakobsson@unh.edu)[1], **Andrew Murray** (andrew.murray@risoe.dk)[2], **Jan Backman** (jan.backman@geo.su.se)[3] & **Reidar Løvlie** (reidar.lovlie@ifjf.uib.no)[4]
[1] Center for Coastal and Ocean Mapping, Univeristy of New Hampshire, Chase Ocean Engineering lab, 24 Colovos Road, Durham, 03824 New Hampshire, USA
[2] The Nordic Laboratory for Luminescence Dating, Department of Earth Sciences, University of Aarhus, Risø National Laboratory, DK-4000 Roskilde, Denmark
[3] Department of Geology and Geochemistry, Stockholm University, 106 91 Stockholm, Sweden
[4] Institute of Solid Earth Physics, University of Bergen, Allégt. 41, N-5007, Bergen, Norway

The study of past climates relies on the accuracy of the age models used. The establishment of accurate age-depth relationships for sediment cores retrieved from the Arctic Ocean is associated with great difficulties and uncertainties, and there is much debate about how to derive a reliable chronology. Indeed, the chronology of Arctic Ocean sediments may be regarded as the Achilles heel of Arctic paleoenvironmental reconstructions. For example, on the crest of the Lomonosov Ridge the geophysical data indicate undisturbed sedimentation presumed to be favorable to studies of the Arctic paleoenvironment. Using cores from this area, sedimentation rates have been proposed, ranging from mm/1000 years (typical for deep-sea red clay facies) to several cm/1000 years (average modern deep-sea sediments). This one order of magnitude uncertainty in chronology is clearly unsatisfactory.

A new approach to constrain the Pleistocene chronology of Arctic Ocean sediments has been suggested by Jakobsson et al. (2000). They argue that variations in manganese concentration and sediment color with depth provide a proxy for glacial-interglacial variability. This approach was used to correlate Arctic deep-sea cores to low latitude $\delta^{18}O$ glacial-interglacial cyclicity, thereby permitting the construction of an age model. Their model yields a sedimentation rate curve with two distinct intervals, each rather linear in character. The first interval from MIS 1 to 4 shows an average sedimentation rate of 2.8 cm/ka, whereas the second interval, from MIS 5 to the Brunhes/Matuyama boundary, shows an average rate of 0.5 cm/ka. In order to test this age model further, OSL dating has been carried out on core 96/24-1sel, raised from 980 m water depth on the Lomonosov Ridge in the central Arctic Ocean. The preliminary results from two of the three OSL dated samples from this core support the interpretation that the sedimentation rate in the central Arctic Ocean is of the order of cm/1000 years. The sample from the stratigraphic position identified as MIS 5.5 (205-210 cm) yielded an age of 106 ±7 ka and the sample from MIS 5.1 (175-180 cm) yielded 87 ±6 ka. The third sample was taken from a location in the core with a high input of IRD (70-75 cm). The OSL date of this sample is far too old for its stratigraphic location in the core, which most probably is a result of the dominantly ice rafted sediment and insufficient bleaching.

Jakobsson M, Løvlie R, Al-Hanbali H, Arnold E, Backman J & Morth M, *Geology*, **28**, 23-26, (2000).

EVO6 : TUpm29 : F1
Moisture Supply for the Growth of Northern Eurasian Ice Sheets- Evidence from Late Quaternary Arctic Marine Sediment Cores

Robert F. Spielhagen (rspielhagen@geomar.de) & **Niels Nørgaard-Pedersen** (nnoergaard@geomar.de)
GEOMAR Research Center, Wischhofstr. 1-3, D-24148 Kiel, Germany

During the last years evidence has accumulated that the Late Quaternary ice sheet history in Northern Eurasia was more complex than previously anticipated. Extensive field studies of ice marginal features on land and in the shelf seas, combined with the application of improved dating techniques, have demonstrated that maximum Weichselian ice sheet extension did not exist during the global last glacial maximum (ca. 20.000 years B.P.), but rather during Middle or Early Weichselian interstadials (see Svendsen et al. (1999) for a synthesis). Ice sheet growth in areas of (presently) low precipitation must have been supported by moisture supply from the adjacent Arctic and sub-Arctic seas. We will present records from sediment cores obtained from theses areas to demonstrate that large open water areas existed in the northern Nordic Seas and in the eastern Arctic Ocean during the the last two glacial phases which must have represented an important moisture source. Based on high-resolution stratigraphies, we used high abundances of planktic organisms and/or biogenic carbonate in the analyzed sediment cores to determine intervals when the sea ice cover must have been strongly reduced due to a strong inflow of temperate Atlantic Water into the Arctic. Such inflow events were strong especially in the last glacial maximum, the late Early Weichselian and the Middle Weichselian interstadial, the penultimate glacial maximum, the early penultimate glacial, and (somewhat weaker) several other times during these glacials. We argue that there was a strong interrelationship between the history of Atlantic Water advection to the North and the ice sheet build-up in Northern Eurasia.

Svendsen JI, and 13 others, *Boreas*, **28**, 234-242, (1999).

EVO6 : TUpm32 : F1
The Last Glacial Environment in the Unglaciated Arctic Shelf Land– New Evidence from the Laptev Sea Coast

Andrei V. Sher (asher@orc.ru)[1],
Svetlana A. Kuzmina (skuz@orc.ru)[1],
Tatyana V. Kuznetsova (tatkuz@orc.ru)[1],
Leopold D. Sulerzhitsky (suler@geo.tv-sign.ru)[2],
Lutz Schirrmeister (lschirrmeister@awi-potsdam.de)[3],
Christine Siegert (csiegert@awi-potsdam.de)[3],
Andrei A. Andreev (aandreev@awi-potsdam.de)[3],
Pieter Meiert Grootes (pgrootes@leibniz.uni-kiel.de)[4],
Frank Kienast (fkienast@awi-potsdam.de)[3] &
Hans-Wolfgang Hubberten (hubbert@awi-potsdam.de)[3]
[1] Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, 33 Leninsky Prospect, 117071 Moscow, Russia
[2] Geological Institute, Russian Academy of Sciences, 7 Pyzhevsky Pereulok, 109017 Moscow, Russia
[3] Alfred Wegener Institute for Polar and Marine Research, Telegrafenberg A43, 14473 Potsdam, Germany
[4] Leibnitz Laboratory, Max-Eyth-Str., 11, 24118 Kiel, Germany

The East Siberian Arctic Shelf Land (ESASL) occupied a huge territory of modern shallow shelf seas during the Weichselian sea-level fall. Reconstructions of the ESASL environment are still controversial and range from polar desert to wet tundra or even taiga. The shelf land was not glaciated, but the syncryogenic terrestrial sedimentation resulted in the continuous accumulation of extremely ice-rich silty deposit called “Ice Complex” (IC).

The Russian-German co-operative work at the south-east of the Laptev Sea coast in 1998-2000 yielded new multidisciplinary evidence of terrestrial life on the ESASL. The most important information comes from the 40-m high Mamontovy Khayata cliff (Bykovsky Peninsula). Numerous AMS ^{14}C dates, dozens of sediment, pollen, plant and insect macrofossil samples, hundreds of mammalian bones provided unparalleled paleoenvironmental record for the last 50 ka, making this site the best studied IC section in Siberia. Analysis of 4000 insect fossils, many of them being very sensitive indicators of the past environment (Kuzmina et al., this volume), corroborated by the other components of multidisciplinary data, allows to suggest a new concept of the last glacial environment of the ESASL.

During the whole documented period (50 to 12.5 ka, non-calibrated ^{14}C ages) the southern part of the ESASL was covered by grass-dominated vegetation. Although water was the main depositional agent of the IC, the environment was rather xeric than mesic, which is evidenced by a significant share of xerophilic insects and plants. Two periods of prominent aridity and summer temperature higher than present have been recognised from the presence of steppe insects - 48-35 ka and 18-12.5 ka. The period of 25 to 18 ka was marked by lower summer temperature, but the environment was still rather dry, which is evidenced by the abundance of xerophilic plant macrofossils. Dominance of grass and various herb pollen alongwith the high amount of *Selaginella* spores suggests a parallel with the modern Wrangel Island environment. The period of 35 to 25 ka presents a smooth transition from the arid/hot summer stage to the arid/cool stage. Permafrost evidence indicates constantly very low mean annual temperature, so extremely cold winters can be assumed for the whole period. These conclusions are strongly supported by fossil mammal evidence (Kuznetsova et al, this volume), indicating permanent occupation of the ESASL by grazing mammals, such as mammoth, horse, and bison, from the limits of ^{14}C dating to about 12.5 ka.

Thus, this huge land mass responded to the global climatic trends in a peculiar way. Extreme continentality of the ESASL is the main key to understand its history. The pasture ecosystem, having no complete modern analogue, existed here during the most of the last glacial, only slightly deteriorating during the time, which can be correlated with the LGM.

EVO6 : TUpm33 : F1
Detailed X-Ray Quantification of Mineral Assemblages and Derived Mass Flux Rates in Eurasian Continental Slope Sediments

Christoph Vogt (cvogt@uni-bremen.de)
Geosciences/ FB Geowissenschaften, Universität Bremen, Klagenfurter Str, 28259 Bremen, Germany

In this presentation Late Weichselian to Holocene changes in sediment mineralogy are utilized to reconstruct the riverine terrestrial input into the Eurasian Shelf Seas. A paleoceanographic reconstruction of source material, sedimentation and sediment transport can only be based on differences between the source regions. Luckily, the source regions for the Eurasian Arctic Ocean, the Barents, Kara and Laptev Sea show these differences in mineralogy. Clay minerals are extremely well suited to determine ocean current transport and the riverine input of the large Siberian river and sea ice transport. The inner Kara and Western Laptev Sea exhibit a very important marker mineralogy. The clay mineral assemblage is dominated by smectites and montmorillonites from the erosion of the Putorana Siberian Flood Basalts and tuffites. The material is transported to both shelf regions by the Yenisei and Khathanga river systems, respectively. Contrarily, the Eastern Laptev Sea shows an illite/mica and chlorite dominated clay mineral assemblage. The determination of the clay minerals from the clay fraction is extremely variable depending on the laboratory routine. Unfortunately, separation of the clay fraction and further laboratory processing make it extremely difficult to recalculate the content of a particular clay mineral in the bulk sediment. Hence, sedimentation and accumulation rates of a distinct clay mineral contain variable and large systematical errors and determination of clay minerals are performed rather in a qualitative than quantitative manner. Here, detailed records of bulk fraction mineralogy will be reported by means of a novel and well tested quantification software. In particular, quantification of the clay minerals from the bulk sediment is emphasized due to their importance for paleoceanographic reconstruction. Mass flux rates can be estimated. In sediment cores from the Laptev Sea continental slope distinct changes in clay mineral assemblages in the bulk fraction are indicative of the early flooding of the Western Laptev Sea and/ or the Kara Sea and the late flooding of the eastern Laptev Sea during the last glacial to Holocene transgression. The recognition of high amounts of smectites and montmorillonites (the expandable phyllosilicates) with western Laptev Sea/ Kara Sea provenance in the Laptev Sea slope sediments during the very early Termination I implies early redistribution of the material from the inner shelfs during the early deglacation between 15,000 and 13,500 radiocarbon years. If the material derived from the Kara Sea no ice sheet could have persisted in the Eastern Kara Sea. The existence and extent of this ice sheet is currently strongly under discussion, e.g. in the QUEEN community. The high contents of mica in upper Termination I sediment. might be related to the flooding of the Eastern Laptev Sea.

EVO6 : TUpm34 : F1
Glaciation and Reorganization of Asia’s Network of Drainage: The GRAND Project

Nat Rutter (nat.rutter@ualberta.ca)
Department of Earth & Atmospheric Sciences, University of Alberta, Edmonton, Alberta, T6G 2E3, Canada

The GRAND Project (Glaciation and Reorganization of Asia’s Network of Drainage) was established to study the extent and timing of late Quaternary glaciation in Asia (Siberia, the Himalayas, and Tibet) and to evaluate the impact that this ice had on the continent’s hydrological system. In addition, because of the importance of continental freshwaters on ocean circulation and, in turn, on global climate, it is critical to know how Asia’s glaciers influenced runoff to the oceans. Damming by ice sheets may have forced much of Asia’s runoff to seek new routes southward through the Aral, Caspian, Black and Mediterranean Seas and not the Arctic Ocean. Runoff into the Indian Ocean from more extensive ice cover in Tibet and the Himalayas also varied during the late Quaternary.

A major thrust of GRAND activity is focussing on the extent and timing of glaciation in High Asia (Himalayas and Tibet). The record in China provides an expecially long and good paleoclimatic proxy for change and reflects both orbital controls on climate and other more regional influences such as the uplift of the Tibetan Plateau. Global ocean circulation is impacted by differences in rainfall and by freshwater infusions from melting glaciers in the Himalayas. Data is coming from coupled atmosphere-ice sheet modelling, which includes radiative models and the role that topography plays; this is being integrated into a global circulation model (GCM).

Lowland spillways across the region south of the glacial boundary have been identified. Some of these large-scale paleodrainages connect to the Aral-Caspian-Black Sea system and others to large modern river valleys such as the Lena, Tunguska, Yenisei, Ob, and Irtysh, which in part relate to former ice sheets across northern Siberia. Still other systems connect various intermontane basins of the Tien Shan, Altai, Sayan, and other mountain regions; many of these display evidence of late Pleistocene catastrophic flooding that probably was associated with ice-dammed lake bursts.

The extensive efforts of our sister organization, the ESF QUEEN Project, have shown that Late Weichselian glaciation in western Siberia was not nearly as extensive as some had previously suggested, and that north-flowing rivers were not dammed by this glaciation. GRAND acivities, including studies of the absolute age, genesis, and paleofauna and paleoflora in thermokarst depressions, cryogenic structure of frozen deposits, and isotope and chemical composition of ice, confirm that Late Weichselian glaciation did not occur on the Arctic Ocean shelf and coastal lowlands, and that Asia’s rivers continued to drain into the Arctic Ocean during the last glaciation. Offshore cores and seismic records in the Arctic Ocean basin, in combination with continental records, also suggest a somewhat limited extent of Late Weichselian ice, but indicate that earlier glaciation was more extensive and probably dammed and diverted the flow of Siberian rivers.

EVO6 : TUpm35 : F1
High Resolution Organic Carbon and Biomarker Data from the Northern Fram Strait/ Yermak-Plateau during the Last Glacial/ Interglacial Cycle

Daniel Birgel (dbirgel@awi-bremerhaven.de), **Kirsten Fahl** & **Ruediger Stein**
Alfred Wegener Institute for Polar and Marine Research, Columbusstrasse, 27568 Bremerhaven, Germany e-mail: dbirgel@awi-bremerhaven.de

During the RV “Polarstern” expedition ARK-XIII/2 (1997) several gravity cores were recovered from the western Yermak Plateau to study the palaeoclimate and palaeoceanic circulation patterns and their variability during the last glacial/interglacial cycle. In this context, detailed organic-geochemical investigations were performed. In order to distinguish between marine and terrigenous sources of the organic matter organic geochemical bulk parameters (TOC,C/N) and biomarkers (n-alkanes, alkenones, sterols and fatty acids) were determined. In this study, we concentrate on one gravity core (PS2837-5) which has a well-documented stratigraphy throughout the last 35 ^{14}Cka. Furthermore, this core is characterized by very high sedimentation rates up to 25 cm/kyr, allowing a high-resolution reconstruction of palaeoenvironment.

Quantity and composition of organic carbon in the sedimentary record of core PS 2837-5 are mainly controlled by the variability of sea-ice cover, Atlantic-water inflow and primary productivity. At the beginning of Oxygen Isotope Stage 2, TOC contents show maximum values, which correlate well with high C/N ratios and high concentrations of long-chain n-alkanes, indicating a terrigenous character of the organic matter. In addition, high concentrations of short-chain n-alkanes, sterols and short fatty acids occur. These may suggest an increased primary productivity due to reduced sea ice-cover, triggered by warm Atlantic-water inflow. During the Last Glacial Maximum, minimum TOC values and lowest biomarker concentrations were determined. In this time period Atlantic-water inflow decreased and sea ice-cover increased, causing low productivity. The initial break-up of the svalbard ice-sheet is suggested from increased accumulation rates of terrigenous organic matter (TOM), indicated by high C/N ratios and highest long-chain n-alkane concentrations. During Termination I we observed high concentrations of sterols, indicating an increased Atlantic Water inflow. In the uppermost part of the core we observed a constant input of TOM, accompanied by marine biomarkers dominated by sterols and n-alkanes.

EVO6 : TUpm36 : F1
Variability of Siberian River Runoff during the Holocene Inferred from Faunal and Oxygen Isotopic Analyses

Henning A. Bauch (hbauch@geomar.de)[1],
Thomas Mueller-Lupp[1] & **Yelena I. Polyakova**[2]
[1] GEOMAR, Wischhofstrasse 1-3, 24148 Kiel, Germany
[2] Department of Geography, Moscow State University, Moscow, Russia

Investigating Arctic shelf hydrography and sea-ice regime seems of crucial importance to understand Arctic Ocean processes. However, a good evaluation of the various processes involved require long records. Records that go back in time hundreds or thousands of years can be provided only by paleoclimatic archives. Given the variability on subdecadal, and on centennial to millennial timescales, the dispersal and fate of riverine water discharge and its role on the ice regime as well as on water mass properties is a central issue in the understanding of Holocene climate change in the Arctic marginal seas, the Arctic Ocean, and beyond. Based on micropaleontolgical and geochemical studies, such temporal changes in Arctic shelf salinity are recorded in shelf sediments from the Siberian margin. We have applied diatom assemblage studies and oxygen isotopic analyses to study centennial changes in river runoff (salinity) and sea-ice regime in the Laptev Sea for the past 9000 cal. yrs. Both proxy methods proof to be reliable tools to investigate thoses changes on the Laptev Sea shelf that were related to the gradual southward retreat of the riverine sources induced by the flooding of the shelf during the Boreal transgression.

On the basis of surface sediments, the shelf region outside the strong influence of riverine waters is characterized by a dominance in sea-ice diatoms and other marine species. Their numbers increase steeply within the area of drifting pack ice. In contrast, the marginal zones near the riverine freshwater sources, where exceedingly low salinities prevail, are dominated by freshwater diatoms. Using the good correlation between freshwater diatoms in the surface sediments and average summer salinities allowed for a reconstruction of the surface water salinity during the Holocene. The temporal distribution of the diatom assemblage also reflect ecological changes which may be strongly influenced by changes in hydrology, nutrients, and sea-ice conditions.

In a second approach, salinity changes in the shelf bottom waters were reconstructed for the last 8500 cal. yrs. using stable oxygen isotopes in benthic foraminifera and on bivalves to unveil submillenial and subdecadal variability, respectively. Oxygen isotope ratios measured on calcareous fossil groups seem less affected by ecological parameter, thus rendering this method crucial for the interpretation of past variations in riverine discharge. The data indicate that salinity range was about 1.5 psu, which is comparable to modern observations. The variability, however, reveals a strong recurrence period of a 1000 years. Using AMS radiocarbon-dated bivalves, detailed sampling profiles on the submillimeter-scale give insight into the seasonal salinity variability for different time slice. This latter method seems particulary promising because it allows a direct comparison of past conditions with data from the Laptev Sea compiled from extensive monitoring over the last 50 years.

EVO6 : TUpm37 : F1
Deglaciation and Palaeoclimate of the Andfjord-Vågsfjord Area, North Norway

Tore O. Vorren (tore.vorren@ibg.uit.no) &
Liv Plassen (liv@ibg.uit.no)
Department of Geology, University of Tromsø, N-9037 Tromsø, Norway

Based on earlier and newly retrieved seismic and core data the deglaciation history and palaeoclimate from 22 to 9.5 ^{14}C ka BP in the Andfjord-Vågsfjord area is reviewed. Eight main glacial events are recorded: The Egga-I (before 22 ^{14}C ka BP), the Bjerka, the Egga-II (before 14.6 ^{14}C ka BP), the Flesen (14.5 ^{14}C ka BP), the D (13.8-13.2 ^{14}C ka BP), the Skarpnes (12.2 ^{14}C ka BP), the Tromsø-Lyngen (10.7-10.3 ^{14}C ka BP) and the Stordal (10.0-9.5 ^{14}C ka BP). The onset of the deglaciation occurred about 14.6 ^{14}C ka BP when most of the western part of the Fennoscandian and Barents Sea Ice Sheets receded from the outer continental shelf. The delivery and melting of icebergs to the Norwegian-Greenland Sea caused the first regional low oxygen isotope event. Atlantic water intruded the area 13.2 ^{14}C ka BP, and an atmospheric warming commenced 12.9/12.8 ^{14}C ka BP. A marked glacial recession occurred before the Skarpnes event. During Allerød time the glaciers retreated to the fjord heads or even farther inland. The Fennoscandian outlet glaciers reached their Younger Dryas outer limit after 10.7 ^{14}C ka BP and retreated from this position before about 10.3 ^{14}C ka BP.

EVO6 : TUpm38 : F1
Late Quaternary Glaciomarine Sedimentation in the Barents Sea

Ivar Murdmaa (murdma@sio.rssi.ru),
Elena Ivanova, **Mikhail Levitan**,
Tatyana Khusid, **Mikhail Belousov** &
Bourtman Maria
Shirshov Institute of Oceanology RAS, 36 Nakhimovsky Prosp., 117851 Moscow, Russia

The multidisciplinary study of about 30 sediment cores from the Barents Sea reveals a step-by-step history of glaciomarine sedimentation beginning from the Last Glacial Maximum (LGM) through deglciation to the Holocene. The glaciomarine sedimentation comprises the following: frontal marine moraine formation at the glacier edge, iceberg and sea ice rafting of coarse debris (IRD), reworking of moraine deposits by gravity flows, and deposition of extremely fine-grained glacier meltwater load ("glacier milk"). Glacier bottom exaration and debris from nunataks serve as coarse material sources, whereas fine-grained material likely accumulates in the glacier ice from eolian dust. The independent deposition mechanisms of IRD and fine-grained suspended matter lead to bimodal grain size distribution of glaciomarine sediments. First glaciomarine deposits represented by sandy silty clay with gravel and pebbles (diamicton) overlay bottom moraine of the grounded Barents Sea ice sheet. Initial destruction of the ice sheet resulted in deposition of fine-grained meltwater load mixed with iceberg-rafted debris and of marine moraine, partially reworked by gravity flows. The glacier meltwater discharge became a dominant sediment source after ice sheets retreated from the shelf, and iceberg calving decreased. Downslope nepheloid density flows, induced by brine formation on shoals, resulted in deposition of laminated sequences. High-density suspension flows formed homogeneous clay beds at slope bases. The contribution of glaciomarine sedimentation decreased sharply at the Pleistocene-Holocene boundary. However, glacier meltwater discharge from archipelagoes is still a major fine-grained sediment source even today, and ice rafting continued to play an important role in the Holocene sedimentation. Therefore, we suggest a decreasing trend of glaciomarine sedimentation on the Barents Sea shelf from early deglaciation, likely about 15-13 ^{14}C ka BP, through late deglaciation (13-10 ^{14}C ka BP) to Holocene.

Tuesday PO Session

EVO6 : TUpo01 : PO
Environmental Protection in the Arctic Regions of Russia

Eduard Buhgalter
(e_bukhgalter@nv.vniigaz.gazprom.ru) &
Aleksandr Baranov
(e_bukhgalter@nv.vniigaz.gazprom.ru)
OOO VNIIGAZ, Pos. Razvilka, Leninsky District,Moscow, Region, 142717, Russia

By the beginning of industrial development Central Yamal had not been practically studied with regard to its hydrological regime. To fulfill this task the large-scale hydrological survey including the adjacent scientific fields (landscape science, geomorphology, etc.) was conducted under the Yamal research program during the period between 1991and 1999. The results of this study were used as a basis for simulating hydrological regime of rivers of the Bovanenkov GCF. The two- layer model of flood flows of river-beds and river-plains, developed in computer center of Academy of Russia, was the most effective and useful.

The application of this model made it possible to analyze different aspects of man-caused impact on the current ecological and hydrological situation of the Bovanenkov field and to tackle the hydrological problems such as:

1. Providing the field development project with design hydrological parameters for choosing an optimal option of the construction and safety operation of infrastructure facilities (motor roads, construction sites, settlements, etc.); 2. Evaluating a possible damage to aquatic environment during the field development; 3. Development of monitoring system for controlling aquatic environment both at normal operation of facilities and emergency situation; 4. Predicting hydrological situations.

EVO6 : TUpo02 : PO
Ecological Expert Appraisal of Gas Complex Facilities in the Arctic Regions of Russia

Eduard Buhgalter
(e_bukhgalter@nv.vniigaz.gazprom.ru),
Aleksandr Baranov
(e_bukhgalter@nv.vniigaz.gazprom.ru) &
Boris Budnikov
(e_bukhgalter@nv.vniigaz.gazprom.ru)
OOO VNIIGAZ, Pos. Razvilka, Leninsky District,Moscow, Region, 142717, Russia

All the gas complex facilities in accordance with the Federal Law undergo ecological expert appraisal at the pre-investing stage (feasibility study) and at the field facility construction design. In the gas industry, starting from the year 1994, which does not contradict to the above-mentioned Law, the industry's ecological expert appraisal was introduced, preceding the State Appraisal.

The paper deals in detail with the industry's ecological appraisal organisation principles, and on the example of field facility construction design in Arctic regions of Russia (north part of Tumen region) its specific features are underscored:

1) assessment, with a view to ecological restrictions, of site selection for facilities construction (well clusters, gas and gas condensate conditioning units etc.), pipelines routes, taking account of specific hydrologic conditions of the Arctic territories;

2) the necessity of submitting soil maps,; relief maps; monitoring network location maps (charts) etc. in the design;

3) development of legal aspects of Gazprom activity in the industrial development of Arcric regions with a view: - to the existence Nenets, Khants and other small North nationalities as ethnic entities, programs of employment of the indigenous population (deer-raising, fur farming etc.), mechanism of determining of the entitlement payment amount and its distribution among the indigenous population for the whole period of the field development; - to rules of protection of ocean water usage regions.

EVO6 : TUpo03 : PO
3.5 kHz Echosounding of the Eastern Part of the Kara Sea: First Implications for the Paleoenvironment

Klaus Dittmers (kdittmers@awi-bremerhaven.de), **Frank Niessen** & **Rüdiger Stein**
Alfred Wegener Institute for Polar and Marine Research, Gildemeisterstr.4, Bremerhaven, 27568, Germany

Within the scope of SIRRO (Siberian River Run off) an expedition of RV Akademic Boris Petrov was carried out in the Kara Sea during August and September 2000. The aim of the study is characterisation and quantification of terrigenous sediment primarily supplied by Ob and Yenesei rivers. In the eastern part of the Kara Sea shelf (78°N, 70°E, 70°N, 85°E) 3.5 kHz high-resolution echosounding profiles were recorded using 4 tow-vehicle mounted transducers as acoustic source and receiving unit. The main objective is the identification and characterisation of sediment echo types in conjunction with geophysical and sedimentological investigations of the collected gravity cores. The nature of echo types is a reflection of sedimentary processes and thus exhibits variation of sedimentary environments in space and time.

A prominent reflector at a depth range of 10 to 40 m below sea floor could be traced through the whole area where the acoustic penetration was sufficient enough, indicating the possible base of the Holocene. Underneath this reflector little information was obtained. North of 72°N several sediment-filled paleoriver channels were identified. Channel depths were up to 20 m. All paleochannels are situated in the extension of the Yenesei River and are most likely related to it. In this area the sediment thickness above the main reflector averages to 10 m. Profiles in the area of the mouth of Yenesei River show high mud accumulation up to 40 m thickness and widespread abundance of shallow gas. The existence of filled paleoriver channels suggests a similar history of the Kara Sea shelf as that described for the Laptev Sea (Kleiber & Niessen, 1999). These channels must have been eroded during sea-level lowstand (glaciation-deglaciation) and were probably filled during the Holocene. River erosion on the exposed shelf of the Eastern Kara Sea during the last glacial period implies continuous river transport across the shelf and non-existence of an ice cap in the area of river channels.

Kleiber, H.P. & Niessen, F., In: Kassens, H., Bauch, H.A., Dmitrenko, I., Eicken, H., Hubberten, H.-W., Melles, M., Thiede, J. & Timokhov, L. (eds): *Land-Ocean Systems in the Siberian Artic: Dynamics and History.* Springer-Verlag, Berlin, 657-665 (1999).

EVO6 : TUpo04 : PO
Pleistocene-Holocene Migration of the Polar Front in the Arctic Region

Sergey A. Gusskov (gusskov@uiggm.nsc.ru)
630090, Institute of Petroleum Geology SB RAS, Koptyuga Av., 3, Novosibirsk, Russia

The type of the hydromasses circulation between the Atlantic and Arctic Oceans is the relevant factor in progression of the Quaternary seas in arctic section of Eurasia.

The type of the bottom watermass and the extent of penetration of the Atlantic hydromasses into the Arctic control the Atlantic fauna migration to this region, because Atlantic fauna (fauna of the Boreal-Atlantic zoogeographical province) reach into Arctic with the warm branch of the Gulf Stream (Norway Stream). It is especially clearly revealed by the analysis of the zoogeographical distribution of foraminifer complexes in the Pleistocene -Holocene of Eurasian section of the Arctic. Total number of taxons and systematic diversity of the coeval complexes decrease from West to East, as well as the number of specimens of most species. The quantity warm-water species decreases the same direction. New taxons (species, genera) appear first on the West and then on the East. Monotype and polytype foraminifer genera are persistent, but in the West the total quantity of both is larger, and the larger is species number presents the quantity of species of polytypic genera there.

Taking into consideration that the Atlantic biota in the Qateternary period is an important portion of Arctic marine communities, such factors as the type of bottom watermass and the extent of penetration of Atlantic hydromass to the Arctic may be assumed to control the formation of Arctic complexes.

The modern boundary between the Boreal-Atlantic and Arctic provinces is in the Barents Sea. Its position corresponds to that of the Polar Front. Polar Front is the area in the ocean or sea where gradients of one or more characteristics of a sea water (temperature, salinity, density etc.) have maximum values. The Polar Front is well recognizable by a number of bionomical signs (rise of biodiversity, value of biomass etc.). Within the limits of the Polar Front, there was encountered bionomical group of benthonic foraminifera, which is characteristic only of this province. The succession of bionomical groups of benthonic foraminifera in Quateternary section of the Arctic region gives the idea of the scale and direction of the Polar Front migration.

Maximum migration of the Polar Front to the east was established for the Ob time (Holsteinian). At this time the Polar Front reached 80° eastern longitude.

In Kazantsevo (Eemian) and Karginsk (middle Weichselian) time the Polar Front occupied more western position in the Kara Sea. In Holocene the Polar Front advanced to the east only to 40° eastern longitude.

This research was supported by the Grant of the Russian Foundation for Basic Research (project 00-05-65445)

EVO6 : TUpo05 : PO
Deglacial to Holocene Paleoenvironments of the Barents Sea

Elena V. Ivanova (eivanova@geo.sio.rssi.ru)[1], **Jean-Claude Duplessy** (jean-claude.duplessy@lsce.cnrs-gif.fr)[2], **Ivar Murdmaa** (murdma@sio,rssi,ru)[1] & **Martine Paterne** (martine.paterne@lsce.cnrs-gif.fr)[2]
[1] Shirshov Institute of Oceanology RAS, 36 Nakhimovsky Prosp., 117851 Moscow, Russia
[2] LSCE, Laboratoire mixte CNRS-CEA, Parc du CNRS, 91198 Gif-sur-Yvette Cedex, France

Foraminiferal assemblages, grain-size variations, oxygen and carbon isotopes in planktic and benthic foraminifera were studied from four sediments cores along the north-south transect across the central Barents Sea. The Holocene time-scale of the cores is based on AMS C-14 dates performed on bivalves . We distinguish three major phases in the Late Weichselian to Holocene history of the Barents Sea separated from each other by dramatic environmental changes. A proximal glaciomarine environment reflects the initial phase of ice sheet destruction due to climate warming and sea level rise. Detachment of the ice sheet from the sea bottom led to extensive iceberg calving and formation of small freshened marine basins in shelf depressions. This is confirmed by the occurrence of extant foraminferal species and by rather high paleosalinity of pore waters. The late phase of deglaciation started after the ice sheets retreated from the shelf. It was characterized by distal glaciomarine environment formed under the influence of abundant meltwater discharge, whereas iceberg calving decreased. Foraminiferal assemblages indicate that subsurface Atlantic water episodically penetrated into the shelf depressions via Franz Victoria and Bear Island troughs under the almost permanent sea ice cover. The transition from the Late Weichselian to Holocene was marked by the development of marine conditions with important contribution of glaciomarine sedimentation in the earliest Holocene and by an increase in surface water productivity owing to the appearance of ice-free seasons. As a result, the abundance and species diversity of foraminifera increased. The evolution of Holocene environments was controlled both by warming during the early Holocene and cooling in the late Holocene, as well as by changes in Atlantic water penetration into the Barents Sea. In the northern part of the sea, near Franz Josef Land, the northward shift of the winter sea ice margin and maximum Atlantic water influx occurred during the climatic optimum, 7.6 to 6.8 ka BP. This led to the longest ice free season promoting food supply for benthic foraminiferal fauna. In the central part, however, the most favorable environment for foraminiferal assemblages established several hudreds of years earlier, about 8.6 ka and lasted up to about 6.2 ka when the deterioration started.

EVO6 : TUpo06 : PO
Palynomorphs in the Southeastern Kara Sea (Sibirian Arctic, Russia) and Paleoenvironmental Changes during Holocene Times

Matthias Kraus (mkraus@awi-bremerhaven.de), **Jens Matthiessen** (jmatthiessen@awi-bremerhaven.de), **Kirsten Fahl** (kfahl@awi-bremerhaven.de) & **Ruediger Stein** (rstein@awi-bremerhaven.de)
Alfred-Wegener Institute for Polar and Marine Research, Columbusstrasse, 27568 Bremerhaven, Germany

Within the scope of the joint German-Russian research project “Siberian River Run-Off” (SIRRO) sediment cores from the inner Kara Sea are studied for their palynomorph contents (pollen, dinoflagellate cysts, green algae). Major goal of the aquatic palynomorph analysis is to reconstruct local changes in sea-surface conditions and freshwater discharge from the large Siberian rivers Ob and Yenisei since the last deglaciation. Furthermore, these records will be compared with the pollen spectra from the same samples, that reflect regional changes in land vegetation and climate to unravel leads and/or lags between the terrestrial and marine environments. These data will be supplemented by sedimentological and organic-geochemical parameters to reconstruct temporal and spatial paleoenvironmental evolution in the southeastern Kara Sea. Here, we present preliminary results of Core BP99-04 (collected with RV “Akademik Boris Petrov” in 1999) which is located in the outer Yenisei estuary. AMS ^{14}C dating revealed high sedimentation rates on the order of 40 to 150 cm/ka allowing submillenial scale reconstruction of the entire Holocene.

The ratio of freshwater to marine palynomorphs reflect changes in paleohydrological conditions. The occurrence and increase of dinoflagellate cysts can be interpreted in terms of rising sea level leading to ingression of marine waters in the early Holocene. Common freshwater algae occurring throughout the Holocene indicate a persistent influence of river discharge at the core location. Dinoflagellate cyst assemblages are generally dominated by cold water taxa suggesting an extensive sea-ice cover and a relatively short summer season with somewhat increased sea-surface temperatures. The occurerence of Atlantic water taxa in the mid-Holocene is related to an increased inflow of relatively warm Barents Sea water leading to slightly increased local sea-surface temperatures. A distinct decrease of freshwater palynomorphs (green algae) in the late Holocene might be associated with a climatic cooling. Possibly, the extent of sea-ice cover increased and hence production of green algae was reduced. The pollen spectra shows a general increase of tree pollen (mainly of pine) up to the late Holocene, whereas herb pollen decreased. However, the pollen input is low suggesting that pine is probably overrepresented in relation to herbs because of long-distance transport of pine in open landscapes. Therefore, the spectra could be interpreted as a climate deterioration and a retreat of forest vegetation in the late Holocene previously described from a number of terrestrial pollen sequences in Siberia. In the mid-Holocene, grains of pollen taxa were found, which could indicate an enhanced peat accumulation due to warmer environmental conditions and increased precipitation. The good correspondence of the dinoflagellate cyst and the pollen records may indicate a climate warming on land and in the sea during the mid-Holocene.

EVO6 : TUpo07 : PO
The Application of Bivalve Stable Isotope Profiles as Modern and Paleoenvironmetal Indicators in the Laptev Sea/Siberian Arctic

Thomas Mueller-Lupp (tmueller-lupp@geomar.de)[1], **Helmut Erlenkeuser**[2], **Henning A. Bauch**[3] & **Ekatarina Taldenkova**[4]
[1] GEOMAR Research Center for Marine Geoscience, Wischhofstr.1-3, 24148 Kiel, Germany
[2] Leibniz Laboratory for Radiometric Dating and Stable Isotope Research, Kiel University, Germany
[3] Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
[4] Department of Geography, Moscow State University, Russia

Stable oxygen and carbon isotopic profiles from the recent bivalves in the Laptev Sea were investigated in order to reconstruct the short-term environmental changes in the strongly coupled land-shelf system of the Laptev Sea. The detailed dissection of shell valves along the axis of

maximum growth provides an isotopic record of environmental and physiological changes during the life of these bivalves. The oxygen isotopic profiles of the bivalves exhibit amplitude cycles interpreted as recording annual ecological cycles. Regarding the well-known relationship between the carbonat $\delta^{18}O$, temperature, and the isotopic composition of water, it is possible to identify phases of more negative (lighter) $\delta^{18}O$ values indicating summer and more positive (heavier) $\delta^{18}O$ values indicating winter and early spring. Because all recent bivalves were collected alive, calendar years may be directly compared by counting the annual cycles backwards from the margin. The $\delta^{18}O$ and $\delta^{13}C$ cycles from growing profiles of the bivalves indicate a correspondence to seasonal hydrographic changes and can be compared with synoptical data from previous years. The main forcing factor of the $\delta^{18}O$ cycles of the shell carbonate is the variability of the isotopic composition of the bottom water. Measurements of $\delta^{18}O$ in surface and bottom waters of the Laptev Sea show a linear relation of salinity and water $\delta^{18}O$ with a coefficient of 0.54 ‰/salinity. The effect of water temperature on the $\delta^{18}O$ of calcite precipitation is about -0.25 ‰/°K and thus less important for the annual variability because temperature data from seafloor and bottom water measurements show an annual variability of 0.3-0.5°K. Carbon isotope profiles from all specimens show decreasing records during spring, associated with the river break-up and seasonal phytoplankton productivity. Trends towards lighter $\delta^{13}C$ values through ontogeny suggest the effects of metabolic changes from a juvenile into a mature adult. Given the seasonal cycles in recent bivalves, stable isotope profiles of fossil, AMS-dated, and well-preserved bivalve shells from the sediment cores may be used to determine the temporal variability of hydrographic settings and their changes during the transgressional history of the Laptev Sea.

EVO6 : TUpo08 : PO
Holocene Environmental Change in Northern Yakutia Based on Pollen Evidence from the Laptev Sea Shelf

Olga D. Naidna (naidina@inl.msk.ru)[1] &
Henning A. Bauch (hbauch@geoamr.de)[2]
[1] Institute of the Lithosphere of Marginal Seas, Russian Academy of Sciences, Moscow 109180, Russia, Russia
[2] GEOMAR, Wischhofstrasse 1-3, 24148 Kiel, Germany

Palynological analyses of radiocarbon-dated marine sediment sequences from the eastern Laptev Sea covering the past 9.4 cal. ka give the first information of high- Arctic climate-related vegetational changes and shelf sedimentation processes. The fluctuation in the pollen and spore record gives reliable evidence of a changing environment during the Holocene which can be related to variations in the transport mechanisms of Lena and Yana rivers draining into the shelf sea and the atmospheric circulation. The good accordance of climatically crucial spectra, such as arboreal pollen, with palynological records on land gives clear evidence that Laptev Sea sediments can provide useful information of Arctic environmental change.

Palynological investigations show that until about 7.5 cal. ka, dominance of sedge and mosse in the pollen record reflect a cold, wet climate which could characterize the development of sedge-bog landscapes. From 7.5 to 5.5 cal. ka, vegetation was progressively dominated by conifers, indicating the northward expansion of the treeline and warming which started in the early mid-Holocene. The overall assemblages are similar to each other, with Pinus pumila dominating the arboreal pollen and Poaceae and Cyperaceae the herbaceous flora. The increase of xeriphytic grass, Chenopodiaceae and Caryophyllaceae pollen, may indicate a reduced humidity within the coastal biotops. Favorable climatic conditions of 5.5-2.7 cal. ka interval represent the time of highest numbers of arboreal pollen. Between 2.7 cal. ka to present, the abundance of long-distance transported conifers of Pinus pumila decreased, with the increase in herbs and mosses. A slight increase in Cyperaceae also notable as well as a peak in Poaceae. This trend suggests progressive cooling with a decrease in the precipitation.

The obtained major trends in the shelf pollen data are in good chronological accordance with terrestrial Holocene pollen records. Thus, the fluctuation in the pollen and spore marine record from the Laptev Sea give clear evidence of a changing environment during the Holocene.

EVO6 : TUpo09 : PO
Connecting Deep Brines from the Fennoscandian Shield with the Baltic Sea through Strontium Isotopes

Philippe Négrel (p.negrel@brgm.fr)[1],
Jo'l Casanova (j.casanova@brgm.fr)[1] &
Runar Blomqvist (runar.blomqvist@gsf.fi)[2]
[1] BRGM, BP 6009, 45060, Orléans Cedex 2, France
[2] 2- GTK, FIN-02400, Espoo, Finland

The Baltic Sea is a northern European intracontinental sea covering 415,000 km2 with a drainage basin four times larger. It can be regarded as one of the major world estuarine system. The water balance of the present day Baltic is mainly controlled by fresh water inputs from rivers as well as communication with open ocean and, to a lesser extend by precipitation and evaporation. As a result of these exchange processes between continental waters and open ocean, the Baltic is brackish with salinities typically less than one third that of seawater.

A simple two-component mixing explain the behaviour of Sr in the Baltic Sea (Andersson et al., 1992). Conversely to Sr contents that decrease with decreasing salinity, the $^{87}Sr/^{86}Sr$ ratios display an increase from the open ocean towards the lowermost salinity of the Baltic. This can be directly related to the $^{87}Sr/^{86}Sr$ ratios of the river dissolved load because running waters draining the crystalline shield are characterised by low Sr contents and high $^{87}Sr/^{86}Sr$ ratios (>0.725). Vertical profiles in the Baltic evidence a decrease of the $^{87}Sr/^{86}Sr$ ratio with increasing depth. The $^{87}Sr/^{86}Sr$ Baltic signature at 200 m depth mimics that of the open ocean. This reflects the stratification of the Baltic Sea and the higher residence time at depth.

A recent paper focused on Sr isotopes in Äspö groundwaters (Peterman & Wallin, 1999), argues for two water sources. One is a local recharge through fracture zones where the water picks up their Sr isotope signature. The other one is deeper, saline and may represents the extreme result of long term water-rock interaction. Here, we present two different mixing trends ($^{87}Sr/^{86}Sr$ ratio vs. 1/Sr) between Äspö groundwaters and the Baltic. The first mixing trend relies the Atlantic Ocean to the fennoscandian rivers through the various dilution levels of the Baltic. The second one corresponds to a simple linear relationship through Äspö groundwaters. As a result of this relationship, most of the groundwater samples from Äspö agree with a binary mixing between a Baltic end-member and a highly Sr concentrated fluid. As specific feature, we observe that the Baltic end-member determined by this relationship, disagree with the present day signature of the seawater near the Äspö Island. The value given by the linear relationship is assumed to represent the value of the palaeo Baltic (i.e. before the last glacial maximum). Moreover, few points corresponding to Sr-rich fluids, plot below the groundwater relationship and suggest the occurrence of at least another brine end-member. The Äspö site can thus be regarded as a complex hydrosystem with at least three end-members (Baltic Sea, brine(s), and meteoric water). The occurrence of several brines at depth is discussed in the light of other deep groundwaters from the Fennoscandian.

Andersson, PS, Wasserburg, GJ & Ingri, J, *Earth and Planet. Sci. Lett*, **113**, 459-472, (1992).
Peterman, ZE & Wallin, B, *App. Geochem*, **14**, 939-951, (1999).

EVO6 : TUpo10 : PO
Changes in Hydrography and Sea Ice Conditions on Siberian Arctic Shelves during the Holocene

Yelena I. Polyakova
(yi@polyakova.geogr.msu.su)[1] &
Henning A. Bauch (hbauch@geoamr.de)[2]
[1] Geography Department, Lomonosov Moscow State University, Moscow, Russia
[2] GEOMAR, Wischhofstrasse 1-3, 24148 Kiel, Germany

Our reconstructions of short-term changes of riverine runoff and their influence on the hydrography and sea ice conditions in the Laptev Sea during the Holocene are based on diatom distribution patterns and the detailed chronostratigraphy of two sediment cores from northeast of the Lena delta.

In order to establish modern proxy tools for paleoenvironmental reconstructions, surface sediment diatom assemblages were studied in the Laptev Sea and the Kara Sea shelves influenced by the great Siberian rivers. A comparison between the freshwater diatoms and surface summer salinity reveals an overall good correlation between relative abundance of freshwater diatoms low surface salinity due to riverine runoff. Extremely high concentration of diatom valves, dominantly freshwater species, in the surface sediments from the Ob and Yenisey estuaries corresponds to an average summer salinity ranging between 2 and 5. The established linkage between relative abundance of freshwater diatoms in the surface sediment assemblages and surface water salinity as well as distributional patterns of sea-ice diatoms and mean interannual location of winter polynya within the inner Laptev and Kara Seas were used for reconstructing salinity fluctuations and sea-ice regime during the Holocene. Accordingly, the paleoenvironmental history of the Laptev Sea could be reconstructed as follows: Due to gradual sea-level rise under the Holocene transgression the studied area was flooded by 9.0 ka BP when sea level raised up to the modern isobath of about 32 m. The time span 9.0-8.6 ka BP was characterized by "alavanche-like precipitation" of riverine diatoms under a salinity between 5 and 2 psu. During the time interval 8.6-7.5 ka BP water salinity in the investigation area increased up to 8-10 due to the southward migration of the Lena River. Surface water salinity gradually increased up to 14 and more bewtween 7.5 and 5.0 ka BP, thus indicating the onset of modern hydrographical condition. Since 5.6 ka the study area was mainly under the influence of drift ice. A southward shift of drift ice edge and associated winter flaw polynya is noticeable for the time interval 5.2-3.2 ka. During the last 2.8 ka the study area remained under the pack-ice conditions and a dominantly riverine influence.

EVO6 : TUpo11 : PO
Paleoenvironmental Changes on the Eastern Laptev Sea Shelf during the Holocene: Evidence from Fossil Assemblages

Ekaterina E. Taldenkova (etaldenkova@mail.ru)[1],
Henning A. Bauch (hbauch@geoamr.de)[2],
A. Yu. Stepanova[1], **A. G. Ovsipyan**[1] &
S. S. Dem'yanenkov[1]
[1] Moscow State University, Moscow, Russia, Russia
[2] GEOMAR, Wischhofstrasse 1-3, 24148 Kiel, Germany

The Holocene sediment sequence was studied in two marine cores from the Eastern Lena and Yana-Lena paleovalleys recovered from the water depths of 45 and 51 m, respectively. Both more than 5 m long cores date back to ca 11 ka. Most part of the sediment sections were accumulated during a short time span of 1 to 2 kyr, thus confirming the previously established pattern of the Holocene sea-level rise with rapid accumulation of sediments in the Early Holocene and sharp decrease in sedimentation rates at ca 5-6 ka.

Downcore investigations of the cores have shown that fossil assemblages of molluscs, ostracodes and foraminifers display a continuous record with certain distinct changes in their composition. Three main assemblages have been distinguished. The lowermost assemblages give strong evidence for considerable freshwater input being dominated by species tolerating brackish waters - *Portlandia arctica cf. aestuariorum* and *Cyrtodaria kurriana* among molluscs and *Heterocyprideis sorbyana*, *Loxoconcha sp.* and *Leptocythere sp.* among ostracodes. Presence of *Cyrtodaria kurriana* and *Acrybia islandica* is a good indicator of nearshore environment, since these species are usually restricted to the depths less than 10 m. Another evidence for the proximity of coastline is extreme abundance of plant debris. Samples from the core located in the Yana-Lena delta, especially the basal ones, are enriched in planktic foraminifers *Neogloboquadrina pachyderma*, *Globigerina bulloides*, *T. quinqueloba* that were probably re-deposited from the older marine beds on the coast of the New Siberian Islands or the sea floor.The overlying transitional assemblages of molluscs are dominated by *Portlandia arctica* with small admixture of other species. Ostracodal assemblages are dominated by the typical marine arctic species *Acanthocythereis dunelmensis*, *Semicytherura complanata*, *Paracyprideis pseudopunctillata* though contain abundant brackishwater species *Leptocythere sp.* and *Loxoconcha sp*. Foraminiferal assemblage in the Eastern Lena paleovalley is dominated by brackishwater tolerating species *Elphidium asklundi* and *Buccella frigida*, though also include normal marine species as *Elphidium clavatum* and *Gordiospira arctica* are also present in the assemblage. The upper assemblages are the most taxonomically diverse. They contain different species that were not found in the underlying strata. Molluscan assemblages of both cores are dominated by *Leionucula bellotii* and seem to be similar to the modern bottom biocoenosis *Leionucula bellotii* that generally

follows location of the polynya in the region. Ostracodal assemblages are dominated by typical marine arctic species *Acanthycereis dunelmensis* and *Semicytherura complanata*. In general, foraminiferal assemblages of both cores exhibit more marine conditions compared to the underlying assemblages. They contain agglutinated species (*Trochammina inflata*, *Ammotium casis*) and normal-marine species *Elphidium clavatum*, *Cribrononion incertus*. Sedimentological data on the core from the Eastern Lena paleovalley give evidence for a sharp change in sedimentation conditions between 150-160 cm which are manifested by a sharp step-like increase in sand content as well as amount of plant debris. Thus, sedimentological and paleontological evidence reveals increasing marine influence upward in the sequence. Composition of fossil assemblages suggests that in the Early Holocene (ca 11 ka) the coastline was located close to the isobaths 45-50 m.

EVO6 : TUpo12 : PO
LGM Ice-Marginal Landscapes on Taymyr, Siberia

Helena Alexanderson
(helena.alexanderson@geol.lu.se),
Christian Hjort (christian.hjort@geol.lu.se) &
Per Möller (per.moller@geol.lu.se)
Dept of Quaternary Geology, Lund University, Sölvegatan 13, SE-223 62 Lund, Sweden

Although a thicker ice sheet from the Kara Sea inundated much of the Taymyr Peninsula early during the Weichselian, only a thin ice sheet advanced onto the lowlands of north-western Taymyr during the Last Glacial Maximum (c. 20 ka BP). It was probably of the surging type, not much more than 300 m thick at the present coast, but nonetheless reached c. 100 km inland before stagnating. In the Lower Taymyr River basin, its maximum extent coincided with the North Taymyr ice-marginal zone (NTZ), originally formed by older Weichselian glaciations. The geomorphology and sedimentology of the partly palimpsest NTZ have been studied both in the field and by satellite image analysis. The LGM segment is often distinguishable from older parts through its 'fresh' appearance and a multitude of landslides revealing remnant glacial ice close to the present surface.

Most material entrained in the ice sheet was concentrated in its marginal parts and when stagnation began this debris soon formed an isolating layer protecting the ice from further melting. Below the central parts of the ice sheet, which melted quicker due to the lower debris content, there are few traces of overriding. Thus, information on the nature of the ice sheet is mainly found at its former margin. Depending on different topographical conditions along the ice front, the appearance of the ice-marginal zone varies between areas. Basically, three different types of LGM ice-marginal landscapes can be identified along the NTZ: 1) In the White Lake area the ice front terminated against a limestone cuesta, in an upslope position. The landscape here is characterised by kame hummocks, moraine ridges and numerous slumps exposing the buried ice. Unconsolidated Cretaceous sediments were deformed or translocated and are found on top of remnant glacial ice. Sandur plains and both frontal- and lateral glaciofluvial terraces document subaerial drainage. 2) South-east of Barometric Lake, the ice front abutted against an older (early-middle Weichselian) ice-marginal ridge. Previously deposited glacial sediments there were deformed and tilted. Hummocks and ridges form parallel linear patterns along the LGM margin, but some of these may be of older age. 3) West of Barometric Lake there were no obstacles for the ice, which could here advance over open, flat land, depositing a parabolic lobe-shaped ridge composed of glacigenic material and remnant ice.

This interaction of the LGM ice front with both bedrock- and older ice-marginal features sometimes makes it difficult to delimit it in the field. Thus, radiocarbon- and OSL-dating and the generally shallow depth to the remnant glacial ice are crucial age-indicators.

EVO6 : TUpo13 : PO
Vegetation and Climate Changes in the Laptev Sea Region during the Late Quaternary by Pollen Data

Andreij Andreev (aandreev@awi-potsdam.de)[1],
Elena Yu. Novenko[2], **Lutz Schirrmeister**
(lschirrmeister@awi-potsdam.de)[1],
Christine Siegert (csiegert@awi-potsdam.de)[1] &
Hans-Wolfgang Hubberten
(hubbert@awi-potsdam.de)[1]
[1] Alfred Wegener Institute, Telegrafenberg A 43, D-14473 Potsdam, Germany
[2] Institute of Geography, RAS, Staromonetny 29, 109017 Moscow, Russia

New pollen, ^{14}C, optical-luminescence, and U/Th data from the Bykovsky Peninsula and Bol'shoy Lyakhovsky Island document paleoenvironment of the Laptev Sea region since the Pre-Eemian time. Grass-sedge tundra dominated 200,000 yr BP around the Lyakhovsky site. Absence of typical cryoxerophitic taxa and high pollen concentration indicates relatively warm and wet climate. This interval may correspond with an interstadial at the end of Tazovsky (Saale) stage. Noticeable amounts of redeposited pollen and presence of cryoxerophitic taxa are characteristic for the Early Weichselian deposits dated to > 50,000 yr BP in both sites. Grass-sedge communities with few other herbs dominated the vegetation. Climate was rather cold and dry in both sites, but colder on the Lyakhovsky Island. Sedge and grass pollen dominated pollen spectra dated to 52,000-48,000 yr BP in both localities, but other herbs also increased their participation in the vegetation. Climate was cold, but relatively wet during this interval corresponded with beginning of Kargin interstadial. Sedge and grass with Caryophyllaceae, Asteraceae, Cichoriaceae dominated around the Bykovsky site 48,000-32,000 yr BP. Presence of *Artemisia* pollen reflect steppic biomes. Willow, dwarf birch and Ericales pollen reflects that climate was relatively warm and wet during this interval, corresponded with the Middle Kargin. Decrease of sedge content in spectra and increase of Cichoriaceae and *Selaginella rupestris* occurred 26,000 yr BP. Scarce grasses communities with some Asteraceae, Cichoriaceae and *Selaginella* dominated on Bykovsky during the LGM. Climate was very dry and cold. Increase of Cyperaceae and Ericales contents reflects wetter and warmer climate ca 15,000-13,000 yr BP. Increase of *Encalypta* amounts in these samples indicate disturbed soils on the Bykovsky Peninsula. Increase of pollen concentration and presence of shrub pollen, reflecting an amelioration of climate, is characteristic of the Lyakhovsky records dated to Allerød. Decrease of pollen concentration, disappearance of willow and dwarf birch, reflecting deterioration of climate is noticeable in the Younger Dryas samples. The Late Glacial/Holocene transition is noticeable in both sites by appearance of tree, shrub, and Ericales pollen. The highest pollen concentration and tree pollen content in the deposits, dated from 9000 to 4500 yr BP, reflects that climate was most favorable during this time. Decrease of amounts of tree pollen reflects deterioration of climate after 4200 yr BP. Climate and vegetation became similar to the modern ones since that time. High concentration of alga colonies (*Pediastrum* and *Botryococcus*) in many samples from the Bykovsky site shows that sedimentation there was probably always in shallow water environment. The concentration of alga is significantly lower in the Lyakhovsky deposits, reflecting colder and dryer climate there, but they also presented in many samples. Their presence reflects subaquatic character of investigated Ice Complex sediments.

EVO6 : TUpo14 : PO
Some Notes to Reconstruction of the Last Maximal Glaciation of the Putorana Plateau

Oleg Antonov (bolshiyanov@aari.nw.ru),
Dmitriy Bolshiyanov (bolshiyanov@aari.nw.ru),
Grigoriy Fedorov (fedorov@otto.nw.ru) &
Maksim Pavlov (bolshiyanov@aari.nw.ru)
St. Petersburg, Vasilievskiy Island, Bering str.,38, Russia

Presented is the last paleoenvironmental reconstruction of the western part of Putorana Plateau based on the results of drilling of Lama Lake sediments carried out in 1993 and 1997 in the framework of Russian-German expedition. Sediment records cover the time-span from Oldest Dryas to the present and show the glaciation in Oldest Dryas (up to 13000 yr BP) and cooling in Younger Dryas (11000-10300 yr BP). The study of landforms and Quaternary deposits in adjacent areas 1997, 1999 and 2000 and the preceding works of other scientists confirm that last maximal glaciation was characterized by ice caps along the north-western face of Putorana Plateau (Kharaelakh and Ondodomi Mountains) and active valley and large outlet glaciers within Great Putorana Lakes region (Lakes Lama, Glubokoye, Keta and others). The age of this glaciation is estimated as Sartan (Late Weichselian). Small valley glaciers existed in the depressions of Talikit, Neralakh and Bogatyr Lakes in the interior of the plateau at the altitude of 500-1200 m. One of the main problems with these glaciers is whether they had the same Sartan age or were younger and can be related to Younger Dryas or Holocene cooling. The contemporary Talikit Lake is located northward Lama Lake within the isolated depression at 530 m a.s.l. The age of lacustrine sediments of the 2,5 m terrace was determined by AMS^{14}C dating as 10100±70. This demonstrates the total melting of the Talikit glacier, possibly, already in Allerod. Thus, the nearest outlet glaciers such as Mikchangda ,which marginal part did reach the Lama Lake (45 m a.s.l.) could have disappeared a little earlier. The age of marginal landforms of one of the outlet glacier lobes will be determined by AMS^{14}C due to the finding of small fragments of stalks in till in the Propadayuschaya River valley. The field work of AARI-CAGRE expedition in the Keta Lake area in 2000 discovered some local marginal landforms corresponding to stages of glaciers retreating within the valleys of Tokingda, Tonel and Yuzhny Ikendekit rivers. Most of them were connected with ice-dammed basins. The thickness of sediments in these basins is up to 30 m. The lacustrine silt and clay are widespread along Glubokoye and Gudke Lakes and described in some sites near Keta Lake (Tokingda River). The top of this clay is as high as 75-104 m.a.s.l. Further laboratory investigation must determine the origin (postglacial or interglacial) of this sediments.

EVO6 : TUpo15 : PO
Sea Level and Glaciations of Taimyr Peninsula in Late Neopleistocene

Dmitriy Bolshiyanov (bolshiyanov@aari.nw.ru) &
Grigoriy Fedorov (fedorov@otto.nw.ru)
St. Petersburg, Vasilievskiy Island, Bering str.,38, Russia

The authors suggest new interpretation of paleogeography of Neopleistocene of Taimyr Peninsula that differs from the traditional one, most comprehensively described in "The Anthropogene Period of Taimyr Peninsula" (1982, in Russian). Every year new data are acquired in Taimyr, which cannot be explained by the ruling hypothesis of ice sheet. This led us to re-consider the evidence acquired. As a result, the following is stated. 1. Sea basin penetrated the modern land of Taimyr Peninsula in Kazantsevo, in Early Zyrian and in Karginskoe times. Only in Sartan time the sea notably degraded. 2. The maximum of Early Zyrian glaciation was likely between 90.000 and 80.000 years BP, and the sea level dropped correspondingly, but not lower than now. Valley and outlet glaciers reached the sea. 3. In Sartan time the sea level was much, about 50 meters lower than present, and numerous local passive glaciers developed on land.

EVO6 : TUpo16 : PO
Valdaian (Weichselian) Glaciations in the Arkhangelsk Region, North-Western Russia

Igor Demidov[1], **Eiliv Larsen**
(eiliv.larsen@ngu.no)[2], **Kurt H. Kjær**[3],
Michael Houmark-Nielsen[4], **Astrid Lysa**[2],
Svend Funder[3], **Jan K. Nielsen**[3] &
Kari Grøsfjeld[2]
[1] Russian Ac. Sciences, Inst. Geology, Pushkinskaya street 11, Petrozavodsk 185610, Russia
[2] Geological Survey of Norway, Leiv Eirikssonsvei 39, N-7491 Trondheim, Norway
[3] Geological Museum, Univ. Copenhagen, Øster Voldgade 5-7, DK 1350 Copenhagen, Denmark
[4] Geological inst., Univ. Copenhagen, Øster Voldgade 10, DK 1350 Copenhagen, Denmark

In the Arkhangelsk region, the Late Valdaian Scandinavian ice sheet formed distinct lobes adapted to Pre-Valdaian topographic lows. The western part of the territory was occupied by the Karelian flow, the central part by the Belomorian flow, and the north-eastern part by the Kuloi-Mezen flow. The ice margin extended approximately N-S from the north shore of the Kanin Peninsula across a hilly-morainic relief in the Cape Konushinskaya Korga area and farther south toward the Lower Mezen River. Probably, the southern part of the Mezen Bay was ice free. The ice margin then probably intersected Mezen near the Pyoza river mouth and extended along the Kimzha river, generating a thick zone of hilly-morainic relief which is

connected with the marginal formations of the Pinega ice tongue on the river Yezhuga (a tributary to Pinega) and the river Kimzha interfluve. The Pyoza river basin was not covered by ice in Late Valdaian time but traces of cryogenesis imply severe environments. The southern boundary of the Pinega ice tongue reached the area of the village Verkola in the south, and covered the Ezhuga river basin in the east. The Dvina ice tongue crossed the rivers Severnaya Dvina and Vaga near the villages Cherevkovo and Ust-Padenga and formed a series of sistinct end moraines. In the Vaga valley the last glacial maximum was attained about 17 ka BP according to OSL dates. The ice front of the Karelian ice flow rimmed the Melovian and Nyandoma uplands and continued southwestward to the lake Beloe and Kubenskoe area in the Vologda region.

The existence of a Scandinavian ice sheet in the Arkhangelsk area and in Karelia in Early-Middle Valdaian time is not supported by geological data. In Middle Valdaian time the Kara-Barents ice sheet reached the Lower Pyoza river and the northern part of the Kuloi plateau. In Early-Middle Valdaian time a glaciation from the east and south-east (from Timan ridge?) reached the Pyoza river and the southern part of the Mezen Bay. Probably the southern front of this glaciation dammed the Mezen river near the village Tsenogora and was controlled by the Vashka-Mezen interfluve with an altitude of 250 m. a.s.l.

EVO6 : TUpo17 : PO
The Maximum Extent of the Saalian and Weichselian Glaciations in Eurasia

Eurasian Ice sheets project members EU Contr. No. ENV4-CT97-0563
(john.svendsen@smr.uib.no)
University of Bergen, Centre for Studies of the Environment and Resources, Allégt. 41, N-5007 Bergen, Norway

The maximum extent of the Weichselian glaciations in the Russian Arctic occurred around 90,000 years ago (Early Weichselian), when the Barents-Kara Ice Sheet expanded onto the Russian continent and blocked the northbound drainage towards the Arctic Ocean. During the Middle Weichselian, about 50-60,000 years ago, the Barents and Kara Sea region was affected by another major glaciation. At this time also the Scandinavian Ice Sheet grew to a considerable size over the Baltic region. During the LGM, about 20,000 years ago, the Scandinavian Ice Sheet attained its maximum position .At this time our results indicates that the Barents-Kara Ice Sheet embraced a much smaller area over the Russian Arctic than shown by most earlier reconstructions. According to our compilation the southern margin was located on the continental shelf in the South East Barents Sea and in the Kara Sea to the east of Novaya Zemlya. The ice sheet probably reached the North West coast of the Taymyr Peninsula, but Severnaya Semlya remained ice free.

We present a map showing a three-dimensional reconstruction of the Eurasian ice sheets for the Last Glacial Maximum (20 ka). In addition we present a map were the maximum ice sheet limits have been inferred for the Middle Weichselian (50 ka), Early Weichselian (90 ka) and Saalian (??) glaciations. The map reconstructions are results obtained by the European Community project Eurasian Ice Sheets (Contr. No. ENV4-CT97-0563). The inferred ice sheet extensions in the Eurasian Arctic are based on field investigations in northern Russia and geomorphological mapping. The estimated ice thickness during the LGM is based on glaciological modeling.

EVO6 : TUpo18 : PO
The Evolution of Lakes of Taimyr Peninsula and Global Environmental Changes in Late Neopleistocene and Holocene

Grigoriy Fedorov (fedorov@otto.nw.ru) &
Bolshiynov Dmitriy (bolshiyanov@aari.nw.ru)
St. Petersburg, Vasilievskiy Island, Berring str.,38, Russia

The authors have elaborated an original paleolimnologic classification of lakes of Taimyr Peninsula. 1. The lakes have been divided into four main types, which differ by landscape topology, hydrologic regime, hydrobiologic parameters, sedimentation environment and, finally, by genesis and evolution. 2. The formation and evolution of lakes of each type is controlled by one of principal processes governing the change of environment in Late Neopleistocene and Holocene. 3. The duration of life of the lakes of each type is determined by the duration of action of landscape-forming process and is related to one of the cycles of the Earth's evolution. 4. The genesis of the depressions of similar type lakes may be different, as the classification deals not with geomorphologic but with limnologic objects. 5. Within each type, a more detailed classification is suggested to account for the genesis of lake depression and local landscape units. 6. The first type includes the lakes in the areas of modern uplifts, which appeared at the tectonic activization in the end of Middle and the beginning of Late Neopleistocene, with the inherited uplifted throughout Late Neopleistocene and Holocene (e.g., Levinson-Lessing and Schel Lakes). 7. The second type includes large lakes of accumulative flatlands, which relate to changes in landscape that occurred at the margin of Early Zyrian and Karga times (e.g., Portnyagino, Kungosalakh and Labaz Lakes). 8. The third type includes the lakes on accumulative watersheds, which relate to changes in landscape that occurred at the margin of Pleistocene to Holocene (e.g., Barometricheskiye, Ryazanskoye and Rusanova Lakes). 9. The fourth type includes the lakes located at the bottoms of modern river valleys or related to the modern sea shoreline. Such lakes must have existed throughout Late Pleistocene, but the processes controlling them are very rapid, so now there is no such lakes older than Holocene.

EVO6 : TUpo19 : PO
Eemian Marine Sediments and Faunas in the Arkhangelsk Region, Russia

Svend Funder (svf@savik.geomus.ku.dk)[1],
Kari Grøsfjeld (kari.grosfjeld@ngu.no)[2],
Jan Kresten Nielsen
(jankn@savik.geomus.ku.dk)[1] &
Marit Solveig Seidenkrantz (geolmss@aau.dk)[3]
[1] Geological Museum, Ostervoldgade 5-7, DK-1350 Copenhagen K, Denmark
[2] Geological Survey of Norway, Leiv Eirikssons vei 39 (Lade), N-7491 Trondheim, Norway
[3] Geological Institute, Århus University, DK-8000 Århus C, Denmark

During the Eemian a marine transgression invaded northern Russia and formed a shallow shelf sea up to 400 km inland from the present coast. In the Arkhangelsk region exposures in riverbanks and coastal cliffs at 20 localities in the Vaga, Severnaya Dvina, Pinega, Kuloi, Mezen, and Pyoza river basins and on the Kanin peninsula show that the marine sediments are wedged between till beds and fluvial deposits. They usually display a normal transgressive-regressive cycle, reflecting rise of relative sea level, while one site (Pyoza) contains a composite deglacial cycle (regressive-transgressive-regressive). The faunas in the normal-cycle sediments contain boreal species, which presently don't penetrate into this region, but have their limit along the Murman coast or even further to the southwest. This shows that during the period of sea level rise Atlantic water with summer sea surface temperatures higher than 8°C penetrated much further into the Barents Sea-Kara Sea region than during the Holocene, and oceanic salinity was attained even at the basin's margins. After this, isostatic uplift took over and forced regression ended the marine record. This suggests that the marine sediments date in the early Eemian period of very rapid sea level rise at c. 128-130 ka. (McCulloch & Esat, 2000). This is supported by pollen analyses at some sites, showing that regression began before the Carpinus zone. After this, nearshore sediments with brackish faunas (lower S. Dvina, Pyoza) may reflect a transition to hydrographical conditions similar to the present White Sea during forced regression (Funder et al., in press). Earlier studies have indicated a succession of transgressions in the area, but the sediments at all localities can be fitted into the pattern of one sea level cycle. The only trace of older faunas is at the Abramovsky coast where a reworked fauna with Cyrtodaria angusta gives evidence of a much earlier transgression.

Funder, S, Demidov, I & Yelovicheva, Y, *Global and Planetary Change*, (in press).
McCulloch, MT & Esat, T, *Chemical Geology*, **169**, 107-129, (2000).

EVO6 : TUpo20 : PO
Records of Weichselian Lake Sediment Sequences in Northern Russia

Mona Henriksen (mona.henriksen@geol.uib.no)[1],
Jan Mangerud (jan.mangerud@geol.uib.no)[1],
Aage Paus (aage.paus@bot.uib.no)[1] &
John Inge Svendsen (john.svendsen@smr.uib.no)[2]
[1] Dep. of Gelogy, University of Bergen, Allegaten 41, N-5007 Bergen, Norway
[2] Centre for Studies of the Environment and Resources, HIB, University of Bergen, N-5020 Bergen, Norway

To obtain a long record covering most of the last glacial period in the European part of northern Russia, lake drilling was carried out in Lake Yamozero (65*01´N, 50*14´E), located outside the Weichselian/Valdaian glacial limit (Mangerud et al. 1999). The c. 28 km^2 large and 1-3 m deep lake is situated at 212 m a.s.l. on the Timan Ridge between the Pechora and Mezen river basins. Sediment thickness is least 34 m. Cores were collected from the winter ice by using a heavy geotechnical (UGB-50) drilling equipment yielding one meter long core segments with a diameter of 10 cm.

Three different locations on the lake were cored. In the central part of the lake, a 12 m long core was obtained. It consists of gyttja in the upper part, then alternating gravelly sand and clay. In the northeastern part of the lake the sediments consist of sand, and most of the samples were lost. The best cores were obtained 1 km from the outlet in the southern part of the lake. Here two long parallel cores were collected. Below 2-3 m silty gyttja (Holocene) at the top, are 14 m of laminated clay and silt. At 16.6 m there is a thin organic layer, and at 19.5 m is a 50 cm thick gyttja. Hand picked macro from the upper part of the gyttja has been dated by AMS ^{14}C to 48 ka BP, giving a minimum age. Preliminary pollen analysis indicates either interstadial condition or the end of an interglacial. Below the gyttja are alternating sandy sediments and clay down to 25 m.

Mangerud J, Svendsen JI & Astakhov VI, *Boreas*, **28**, 46-80, (1999).

EVO6 : TUpo21 : PO
Late Pleistocene Land, Sea, Lake and Ice Distribution in the Arkhangelsk Region, Northwest Russia

Michael Houmark-Nielsen
(michaelh@geo.geol.ku.dk)[1], **Igor Demidov**[2],
Svend Funder[3], **Kari Grøsfjeld**[4], **Kurt Henrik Kjær**[3], **Eiliv Larsen**[4], **Nadya Lavrova**[2],
Astrid Lysså[4] & **Jan Kresten Nielsen**[3]
[1] Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350 Kobenhavn K, Denmark
[2] Russian Academy of Sciences, Karelian Research Centre, Institute of Geology, 11 Pushkinskaya Street, Petrozavodsk, 185610, Russia
[3] Geological Museum, University of Copenhagen, Øster Voldgade 5-7, DK-1350, Copenhagen K, Denmark
[4] Geological Survey of Norway, Leiv Eirikssons vei 39, N-7491 Trondheim, Norway

Eight palaeogeographical reconstructions of Late Pleistocene scenarios of the Arkhangelsk region visualise the configuration of land, sea, lakes flood plains and glaciers during selected time slices and are based on a large data set obtained during field campaigns over the last 6 years. Data from river exposures and coastal cliffs forms a lithostratigraphic framework. During the last interglacial rapid rise of relative sea level transformed the North Russian lowland into a shallow shelf sea, extending up to 400 km south of the present coasts. With their characteristic boreal benthic faunas, these deposits are an important stratigraphic marker in the sedimentary record. Weichselian till beds with a specific provenance dependent clast composition and properties reflecting glacier movement are also used as marker horizons. When combined with luminescence and ^{14}C datings, palaeocurrent patterns of fluvial deposits and floral and faunal analyses an event-stratigraphic model can be erected. This model is based on evidence from the rivers Severnaya Dvina-Vaga and Pyoza-Mezen and the Kuloi and Kanin Peninsula coasts. After the Eemian a major drop in eustatic sea level occurred and glaciers were built in the Barents-Kara Sea during the Early Weichselian. The latter ice was responsible for the damming of Lake Komi in the Pechora lowland. Proglacial lake basins developed in the east of the Arkhangelsk region while periglacial rivers were flowing northward and westward. Interstadial and periglacial conditions with forest-steppe tundra vegetation followed. As the glacier in the north vanished ice had build

up on the Timan Ridge and spread north-westward through the Pyoza lowlands reaching the Kanin Peninsula. Open waters in the White Sea allowed drainage in the western part of the region to be directed northward. In the beginning of the Middle Weichselian this drainage pattern was maintained along the Vaga and Severnaya Dvina rivers while glacier growth in the Kara Sea overrode the Kanin Peninsula and reached deeply into the Pyoza lowland. The glacier blocked an outlet towards the west giving rise to the formation of ice dammed lakes on the upper Pyoza river. After an ice free interlude for the rest of the Middle Weichselian the Scandinavian ice sheet grew eastward. It reached its maximum limit in the western part of the Arkhangelsk region around 17 ka BP blocking river outlets towards the north, which resulted in damming of proglacial lakes along the margin. Arial downwasting along the fringes of the ice sheet lead to deposition in local lakes while drainage towards the Barents Sea along the modern river valleys was established and a pioneer vegetation immigrated into the region.

EVO6 : TUpo22 : PO
Volumes and Areas of Early Weichselian Ice Dammed Lakes in Northern Russia

Martin Jakobsson (martin.jakobsson@unh.edu)[1], **Jan Mangerud** (jan.mangerud@geol.uib.no)[2], **Valery Astakov** (valery@nb1466.spb.edu)[3] & **John Inge Svendsen** (john.svendsen@smr.uib.no)[4]
[1] Center for Coastal and Ocean Mapping, University of New Hampshire, Chase Ocean Engineering Lab, 24 Colovos Road, Durham, 03824 New Hampshire, USA
[2] University of Bergen, Department of Geology, Allégt. 41, N-5007 Bergen, Norway
[3] St. Petersburg University, Geological Faculty, Universitetskaya 7/9, St. Petersburg 199034, Russian Federation
[4] University of Bergen, Centre for Studies of the Environment and Resources, Allégt. 41, N-5007 Bergen, Norway

The early Weichselian Ice Sheet on the continental shelves of the Barents and Kara seas advanced onto the Northern Russian mainland and blocked the paths of the north-flowing rivers to the Arctic Ocean. As a consequence huge proglacial lakes were dammed between the ice margin in the north and the continental drainage divides in the south. The lake in the Pechora lowland, named Lake Komi, is the best mapped (Astakhov et al 1999, Boreas, Mangerud et al in press, Global and Planetary Change). The damming of the rivers Yennisei and Ob caused an overflow to the Aral Sea with further drainage to the Caspian and Black seas. Volumes and areas of these Early Weichselian ice dammed lakes were estimated using modern topography, elevations of the former lake surfaces and the geographic position of the damming ice margin. In addition, estimations have been made of the volumes of additional water in the Aral and Caspian Seas respectively; if they were to be filled from today's levels up to their overflow passes. The use of modern topography for the volume and area estimation does not consider sediment deposition or erosion in the lake's basins that took place since the time of the paleo lake's phases considered. The topography was derived from the Global Land One-Kilometer Base Elevation (GLOBE) Digital Elevation Model and the bathymetry from the International Bathymetric Chart of the Oceans (IBCAO) grid model, with a horizontal resolution of 2500 m. The GLOBE and IBCAO grids were projected to Lamberts Equal Area projection, resampled to a grid spacing of 1000 m, and combined using Intergraph's Modular GIS Environment (MGE) software modules were the calculations were performed. The Northern Russian and Western Siberian Early Weichselian ice dammed lakes were comparable in size to the largest stage, Upper Campbell beach level, of the North American ice dammed lake Agassiz that formed 9.9-9.5 ka. The lakes changed the hydrography of much of the continent, the fresh water supply to the Arctic Ocean, and even to the Caspian and Black seas, possibly also the Mediterranean.

EVO6 : TUpo23 : PO
Implications of Rock Surface Exposure Ages for the Latest Glacial Advance on Wrangel Island in the Beringian Region, Russia

Juha A. Karhu (juha.karhu@gsf.fi)[1], **Silvio Tschudi** (tschudi@particle.phys.ethz.ch)[2], **Sergey Vartanyan** (sv@sv1226.spb.edu)[3], **Peter W. Kubik**[4] & **Matti Saarnisto**[1]
[1] Geological Survey of Finland, P.O. BOX 96, FIN-02151 Espoo, Finland
[2] Institute of Geology, University of Bern, c/o Institute of Particle Physics, ETH Hönggerberg, CH-8093 Zurich, Switzerland
[3] Wrangel Island State Reserve, 687870 Ushakovskoye, Magadan Region, Russia
[4] Paul Scherrer Institut, c/o Institute of Particle Physics, ETH Hönggerberg, CH-8093 Zurich, Switzerland

Wrangel Island is an isolated, exposed part of the continental shelf of northeastern Russia, between the East Siberian sea in the west and the Chukchi Sea in the east. Information about the chronology of glaciations on the island is useful for understanding past glacial advances and retreats on the arctic continental shelf in the Beringian region. During an expedition to Wrangel Island in 1997, three samples of quartz veins were collected for surface exposure dating by cosmogenic nuclides. Two of these were bedrock surface samples from different parts of the island, one was from a local boulder. The samples were collected in areas where former coverage by valley glaciers can be excluded. Especially the bedrock surface samples were expected to provide new constraints for the chronology of glaciations on the island and on the arctic continental shelf in the Beringian region. Minimum exposure age estimates for these bedrock samples, calculated on the basis of ^{10}Be concentrations, are 64 600 ±6 400 and 26 400 ±2 100 years. These first, preliminary estimates suggest that no major advances of glacial ice have affected Wrangel Island or the adjacent shelf area after 64 600±6 400 years. Specifically, these dates seem to rule out any major advances during the Last Glacial Maximum. The estimates are compatible with the absence of glacigenic depositional landforms, such as moraines and eskers. Similarly, they are in agreement with radiocarbon dates from mammoth remains that span the Last Glacial Maximum.

EVO6 : TUpo24 : PO
Plants as Climate Indicators- Results of Plant Macrofossil Studies on Late Quaternary Permafrost Sequences of the Laptev Sea Region, Northern Siberia

Frank Kienast (fkienast@awi-potsdam.de), **Christine Siegert**, **Lutz Schirrmeister** & **Hans-Wolfgang Hubberten**
Alfred Wegener Institute, Telegrafenberg A 43, D-14473 Potsdam, Germany

18 well-dated samples from the key section Mamontovy Khayata on the Bykovsky Peninsula near the Lena Delta were paleobotanically investigated. The available age data prove a continuous sediment and ground ice accumulation during a time interval from about 58,000 yrs BP until about 7,800 yrs BP. The species composition, obtained by macrofossil studies, was correlated with different plant communities in the combination the species normally occur. These plant communities indicate local ecological conditions of growth like moisture and temperature similar to modern plant sociological records.

All Late Pleistocene samples of the studied outcrop reflect mosaic-like distributed vegetation complexes of both notedly dry and wet habitats. Most samples even contain species of true water plants from *Potamogetonetalia*. Components of tundra steppe communities, mainly from *Kobresio-Dryadetalia* but also from *Artemisietalia* are particularly representative for the Pleistocene samples. They were accompanied by communities of *Caricetalia nigrae*, *Scheuchzerietalia* and *Calthion*, which indicate moist conditions in the depressions. The proportion of xerophilous plants is highest in the oldest time interval of 58,000 - 40,000 yrs BP and during the global Last Glacial Maximum (LGM about 19,000 yrs BP) and decreases during the interval of 35,000 - 33,000 yrs BP as well as in the Holocene in favour of bog, riperian and submerse plants.

In comparison with the results of macrofossil studies on Cape Sabler, Taymyr Peninsula, there is a higher habitat diversity detectable in the species composition of the Bykovsky Peninsula reaching from water bodies to extremely dry sites during the whole time span. The species spectrum from Cape Sabler reflects more or less uniform site conditions. For instance no moisture-indicating plant species were proved in the sample dated 19,000 yrs BP on Cape Sabler, whereas the coeval Bykovsky sample contains plant remains from species indicating both extremely dry sites and bog, shore as well as submersed habitats. To reconstruct paleotemperatures the comparison of climatic maps with recent areal maps of the determinated species was used on the basis of climagrams after Iversen (1944). This way it is possible to estimate concrete climate values for the life-time of fossil plants, especially for the growing season. First estimations of the mean July temperature on the Bykovsky Peninsula result in 12°C near the surface during the Last Glacial Maximum about 19,000 yrs BP. This value is explainable by an increased annual temperature amplitude due to a more pronounced continentality during this time.

EVO6 : TUpo25 : PO
The Mezen Bay Triple Junction: Interception of Shelf- and Terrestrial-Based Glaciations during the Weichselian in Northern Russia

Kurt Henrik Kjær (kurtk@savik.geomus.ku.dk)[1], **Igor Demidov**[2], **Eiliv Larsen**[3] & **Jan Kresten Nielsen**[1]
[1] Geological Museum, University of Copenhagen, Øster Voldgade 5-7, DK 1350 Copenhagen K, Denmark
[2] Russian Academy of Sciences, Karelian Research Centre, Institute of Geology, 11 Pushkinskaya Street, Petrozavodsk, 185610, Russia
[3] Geological Survey of Norway, N-7491 Trondheim, Norway

The Mezen bay area, situated in the southeastern part of the White Sea, offers the possibility to identify and synchronize regionally significant stadial and interstadial events during the last glacial period in northern Eurasia. Sediments deposited by former glaciers are extremely well exposed and reveals a glaciation history dating back to the Early Weichselian. The area around Mezen bay was invaded by glaciers from a terrestrial-based Scandinavian ice sheet, a marine-based Barents-Kara Sea ice sheet, and from an easterly centered ice cap on the Russian mainland. Following glaciofluvial deposition a glacier invaded the area from the east around 70 Ka BP depositing a till. During the advance the glacier eroded deeply into marine deposits from the last interglacial. As a result, the till contains numerous shell fragments and also whole shells mirroring a complete boreal fauna assemblage. After an ice free period with fluvial deposition an ice lobe from the Barents-Kara Sea deposited a till from northerly directions around 60 Ka BP. The ice retreated quickly and the sea inundated the area and a tidal environment was established, it probably lasted until the main advance from the Barents-Kara ice sheet reached the area. This glacier invaded from the northeast around 50 Ka BP, and deposited a till. Simultaneously, massive muds and silty sand with clasts together with diamict sediment were deposited in a lacustrine basin close to the glacier margin. No evidence on the development during the remaining part of the middle Weichselian is present in the area. Based on lithostratigraphical correlation to sections on the adjacent Severnaja Dvina river, a glacier associated with the Scandinavian ice sheet advanced from west depositing a till around 17 Ka BP in the Mezen area. Deglaciation was dominated by glaciolacustrine deposition in ice-dammed lakes and fluvial deposition under periglacial conditions. By introducing new data from the Mezen bay area a regionally consistent glacial model for the entire Weichselian is presented from the Arkhangelsk region.

EVO6 : TUpo26 : PO
Centennial-Scale Behaviour of the Svalbard/Barents Sea Ice Sheet during Terminations II and I

Jochen Knies (jochen.knies@ngu.no)[1],
Andreas Mackensen (amackensen@awi-bremerhaven.de)[2],
Jens Matthiessen (jmatthiessen@awi-bremerhaven.de)[2] &
Christoph Vogt (cvogt@min.uni-bremen.de)[3]
[1] Geological Survey of Norway, N-7491 Trondheim, Norway
[2] Alfred Wegener Institute, for Polar and Marine Research, D-27568 Bremerhaven, Germany
[3] Faculty of Geosciences, University of Bremen, D-28334 Bremen, Germany

Centennial-scale changes in behaviour of the Svalbard/Barents Sea Ice Sheet (SBIS) were recovered in the European Sector of the eastern Arctic Ocean. Here we present high-resolution oxygen and carbon stable isotope data,ice-rafted debris (IRD) input, mineralogical parameters and variations in the dinoflagellate record from gravity core PS2138 during Terminations II and I (Marine Isotope Stage transitions 6/5 and 2/1).

The oxygen and stable isotope stratigraphy manifested on each centimeter in core PS2138 shows a resolution of ~50 years/sample during Termination I. The MIS 6/5 transition is resoluted in ~150 years/sample. The coarse fractions >63um, >125 um, and >2 mm reflect the disintegration patterns of the SBIS during these peculiar climate transitions. The data show evidences for initial break-up of the ice-sheet before ~134 ka (Termination II) and 16 ^{14}C ka (Termination I). Prior to the final retreat of the SBIS at ~13.4 ^{14}C ka, IRD and mineralogical data indicate, at least, three phases of distinct iceberg discharge from the marine based SBIS that might have influenced the final instability of the Laurentide ice sheet during deposition of Heinrich Event I in the North Atlantic. A similar scenario is observed prior to Termination II. Here, three distinct IRD peaks reflect the step-wise disintegration of the SBIS before a sharp decrease of IRD input towards the last interglacial, the Eemian, occurred. The dinocyst record during Termination II/Eemian slightly differs from those during Termination I/early Holocene. After the final retreat of SBIS to the inner shelf, freshwater dinocysts and high smectite concentrations possibly reflect a huge outflow of melt/freshwater from the Kara and Laptev shelves towards the Nordic seas between 13.6 and 13 ^{14}C ka. In contrast, the transition of glacial reworked input during Termination II to maximum values of warmer, possibly Atlantic-water derived dinoflagellate cysts is relatively sharp.

EVO6 : TUpo27 : PO
Isolation Basin Stratigraphy and Postglacial Sea-Level Change at Zelenoborsk (Head of Kandalaksha Bay, White Sea), Northwest Russia (Preliminary Results)

Vasili Kolka (kolka@geoksc.apatity.ru)[1],
Vladimir Yevzerov (yevzerov@geoksc.apatity.ru)[1],
Jakob Møller, (jakobm@imv.uit.no)[2] &
Geoffrey Corner (geoff.corner@ibg.uit.no)[3]
[1] Geological Institute, Kola, Science Centre, RAS, 184200 Fersman str., 14Apatity, Russia
[2] Department of Geology, Tromsø Museum, University of Tromsø, N-9037 Tromsø, Norway;
[3] Department of Geology, Faculty of Science, University of Tromsø, N-9037 Tromsø, Norway

Previous work (1998-1999) has been carried out at Lesozavod at the head of Kandalaksha Bay, White Sea, to identify and date the marine-lacustrine transition (isolation contact) in sediment cores from ten raised coastal lake basins up to 104 m a.s.l., and construct a relative sea-level curve for the Holocene (Kolka et al., 2000). The present study is a continuation of this work and presents the results of coring in Autumn 2000, in three lake basins situated 117.3 m a.s.l., 133 m a.s.l. and 153 m a.s.l. at nearby Zelenoborsk. The main aim is to solve the question of the elevation of the marine limit in the innermost western part of the Kandalaksha Bay region. Previous investigations in this area (Arnand & Samsonova, 1969) have documented coastal features (terraces and beach ridges) of presumed marine origin up to 150 m a.s.l. The lithological sequence in bottom sediment from lake 117.3 m a.s.l. is similar to the sequence from lake 104 m a.s.l. at Lesozavod and comprises a marine (weakly laminated mud)-transitional (laminated mud and gyttija) -freshwater (gyttija) facies succession (Kolka et al., 2000). The lithological sequences in lakes 133 m and 153 m contain postglacial lake sediments (non-laminated and weakly laminated clay), mixed sediment (laminated silt and sand with organic material) and lacustrine sediment (gyttija). These sequences are similar to those retrieved from lakes situated above the marine limit in the inner part of the Kola Peninsula (Yevzerov et al., 1998). Our preliminary conclusion is that the marine limit in the western region of Kandalakscha Bay is situated between 117.3 and 133 m a.s.l. Final conclusions on the elevation and age of the marine limit will be reached once the results of diatom analysis and radiocarbon dating are available.

KolkaV, Yevzerov, Moller & Corner, *QUEEN Fourth Workshop Abstracts*, 24, (2000).
Arnand & Samsonova, *Problems of georaphy*, 96-112, (1969).
KolkaV, Yevzerov, Moller, Kankainen, Corner & Taldenkova, *QUEEN Fourth Workshop Abstracts*, 25, (2000).
Yevzerov, Khomutova & Moller, *The history of Pleistoctne Lakes of the East European Plain*, 47-54, (1998).

EVO6 : TUpo28 : PO
Fossil Insects as the Indicators of Quaternary Environment of the Laptev Shelf Land

Svetlana Kuzmina (skuz@org.ru)[1] &
Christine Siegert (csiegert@awi-potsdam.de)[2]
[1] Severtsov Institute of Ecology and Evolution, RAS, 33 Leninsky Pr., Moscow 117071, Russia
[2] Alfred Wegener Institute, Telegrafenberg A 43, D-14473 Potsdam, Germany

Insect fossils are quite common in the fine-grained Quaternary sediments along the shores of the Laptev Sea. Thousands of them have been collected by screening the frozen sediments at several sites in this area by the Russian-German expeditions (1998-2000) under the project “Laptev Sea System 2000”. Of special interest is the long succession of the Late Pleistocene and Holocene at Bykovsky Peninsula, east Lena Delta. About 60 fossil insect samples represent the time interval from 48 to 7.5 ka.

Paleoenvironmental interpretation of fossil insect assemblages is based on modern distribution and ecological preferences of species identified. By their taxonomic composition, most Pleistocene insect assemblages are different from the modern tundra fauna of this area. They all contain large, but variable, amount of modern tundra inhabitants, although the relative abundance of species, characterizing dry and wet habitats, varies with time. Besides that, most Pleistocene assemblages include species, currently not known in the area, such as steppe and sedge heath insects, or species, living in the forest zone or related to tree and shrub plants.

The main modern ranges of true steppe insects, such as a weevil *Stephanocleonus eruditus*, are now in southern Siberia, and their northernmost occurrences – on the relic steppe patches in the Yana and Indigirka upstream, where the mean July air temperature is 12-14ºC (i.e., 5-7 degrees higher than in the Lena Delta), and July soil temperature – 22-23ºC. Since these insects cannot develop below this temperature, their presence in fossil assemblages, even in small numbers, suggests highly continental climate with hot and dry summer.

A pill beetle *Morychus viridis* is very common in the Pleistocene insect faunas, quite often dominating fossil assemblages. Now it occupies isolated habitats in north-eastern Siberia with very contrasted conditions – extremely dry and hot in summer and snowless and very cold in winter, with scarce vegetation, mostly xerophilic sedge. The relative abundance of this species is usually in positive correlation with the presence of steppe insects and a high share of xerophiles among tundra species.

An alternative dominant of Pleistocene assemblages is a weevil *Isochnus arcticus* that is now known from arctic tundra on Wrangel Island, Chukotka, and Taimyr. Abundance of this species, concurring with a high share of other tundra insects, indicates colder summer than now. Forest and shrub tundra insects are very rare in the Pleistocene assemblages, but their number and diversity increases in the early Holocene.

The Pleistocene insect assemblages of the Laptev shelf land have no complete modern analogues. They indicate highly continental climate and treeless, grass-dominated, and mostly xeric vegetation, and allow tracing changes in summer temperature. The early Holocene assemblages markedly differ from them, approaching the recent southern tundra and northern taiga.

EVO6 : TUpo29 : PO
Late Quaternary Mammals of the Laptev Shelf Land and their Environment

Tatyana V Kuznetsova (esin@sgm.ru)[1],
Leopold D. Sulerzhitsky[2], **Lutz Schirrmeister** (lschirrmeister@awi-potsdam.de)[3],
Christine Siegert (csiegert@awi-potsdam.de)[3],
Hans-Wolfgang Hubberten (hubbert@awi-potsdam.de)[3] &
Andrei V. Sher (asher@org.ru)[4]
[1] Moscow State University, Faculty of Geology, 119899, Moscow, Russia
[2] Geological Institute, RAS, Moscow, 109017, Russia
[3] Alfred Wegener Institute for Polar and Marine Research, D-14473, Potsdam, Germany
[4] Sevetrsov Institute of Ecology and Evolution, RAS, Moscow, 117071, Russia

More than 2000 fossil mammal bones have been collected in the southeast part of the Laptev Sea coast (Bykovsky Peninsula, Bolshoy Lyakhovsky Island, and the west Lena Delta) by Russian-German expeditions (1998-2000) under the “Laptev Sea System 2000” project. Registration of all identifiable fossils found at the cliffs and on the shore allowed more complete data on the past faunal composition. Extensive program of ^{14}C bone collagen dating (140 dates), together with 210 published dates on mammal bones from the Laptev Sea surroundings, provide a unique evidence to reconstruct the story of mammal populations on the Laptev shelf land.

The taxonomic composition of such bulk collections can be strongly biased by the local geological situation, by taphonomic conditions, and other random factors, so they may give a distorted conception of relative abundance of species in the past. However, repeated statistical estimates allow some generalized inferences to be made. Woolly mammoth bones dominate all our collections from the Laptev Sea coast (25-40%), while horse and bison occupy the next position (15-25% each). That definitely indicates relatively high numbers of these grazers in the past, which were supported by the appropriate pastures and tolerable climate. The presence of saiga antelope at 73ºN (B. Lyakhovsky Island, 47 ka BP) is a reliable indicator of dry and firm soil surface in summer and very thin snow cover in winter.

Certain precautions should be taken when analysing the 14ºC dates on particular species. Only considerable samples from a large territory can be used to estimate the dynamics of abundance of species in the past, but even these data should be used with caution. In our case, only the mammoth date collection (208 ^{14}C dates) is representative for the analysis, while horse and bison collections (55 and 26 dates respectively) are still to be complemented.

The most general inference is that mammoth and horse permanently lived on the Laptev shelf land from the limits of ^{14}C dating to about 12.5 ka (and even later in some places), and bison - most of that time. The distribution of 208 dates on mammoth over the time-scale is more or less uniform, but there is a trend of some reduction of the number of dates during the period of 22-16 ka, including the LGM, with its further increase between 15 and 12 ka (up to 9.5 ka on Taimyr). Still, both mammoth and horse definitely lived on the shelf land during the LGM, which is evidenced by a few fossils from Kotelny and Fadeevsky islands, Lena Delta, Taimyr, and Severnaya Zemlya, dated from 22 to 16 ka. That means that the LGM environment was probably less favourable for these grazers, but not intolerable, and they possibly reduced their numbers.

EVO6 : TUpo30 : PO
Weichselian Ice-Sheet Interactions in the Arkhangelsk Region; Timing and Extent

Eiliv Larsen (eiliv.larsen@ngu.no)[1],
Igor Demidov[2], **Michael Houmark-Nielsen**[3],
Kurt H. Kjær[4] & **Astrid Lysså**[1]
[1] Geological Survey of Norway, Leiv Eirikssons vei 39, N-7491 Trondheim, Norway
[2] Russian Ac. Sciences, Inst. of Geology, 11 Pushkinskaya street, Petrozavodsk, 185610, Russia
[3] Geological inst., Univ. Copenhagen, Øster Voldgade 10, DK 1350 Copenhagen, Denmark
[4] Geological Museum, Univ. Copenhagen, Øster Voldgade 5-7, DK 1350 Copenhagen, Denmark

Until recently, it was common understanding that the Barents-Kara Sea and the Scandinavian ice sheets advanced from different directions to merge in the Arkhangelsk region during the so-called last glacial maximum. This was implicit from the view that both ice sheets reached their maximum position at a time when global ice volumes were the largest. Now it is realized 1) that the Barents-Kara Sea ice sheet reached maximum position(s) in the eastern parts of the Arkhangelsk region in Early-Middle Weichselian time, and had its southern limit north of mainland Russia in the Late Weichselian, and 2) that the Scandinavian ice sheet did not penetrate eastward into the Arkhangelsk region in the Early-Middle Weichselian, but did so during the Late Weichselian when reaching its maximum position.

Considering the area from the Severnaya Dvina drainage basin to the Timan ridge, the following glacial events can be summarised:

- In the Early Weichselian (around 90 ka BP), ice started to grow on the Timan ridge and the Barents-Kara Sea ice sheet advanced from the northwest. The latter did not penetrate into the White Sea region.

- Following upon a deglaciation of the Barents-Kara Sea ice sheet, ice expanded over the Timan ridge. At the maximum position around 70 ka BP, the Timan ridge ice cap penetrated into the Mezen river basin and covered the Kanin peninsula.

- Between some 60 to 50 ka BP, a lobe of the Barents-Kara Sea ice sheet penetrated from the northeast into the lower reaches of the Mezen river, whereas the Timan ice cap had retreated to a more moderate size. Towards the end of this interval, the Barents-Kara Sea ice sheet reached its maximum position depositing end moraines along the Pyoza river. A marine inundation recorded by tidal sediments, was perhaps associated with a glacier retreat before the final advance to the maximum position. To the west, evidence exists for a lobe of the Scandinavian ice sheet, probably from the Kola peninsula, advancing into the western White Sea areas. No indications of the Scandinavian ice sheet occur further south in the western part of the Arkhangelsk region.

- Following upon a long ice-free interval, the Scandinavian ice sheet advanced from the west into the region, and reached its maximum position on the Severnaya Dvina and Mezen drainage basins, and along the western shores of the Kanin peninsula around 17 ka BP. At this time there are no indications of a Barents-Kara Sea ice sheet penetrating into the area. An inference of this ice sheet configuration is that the Scandinavian and the Barents-Kara ice sheets merged somewhat to the north of this part of mainland Russia during the Late Weichselian.

EVO6 : TUpo31 : PO
Late Quaternary Ice Sheets and Stratigraphy on Yugorsky Peninsula, Arctic Russia

Hanna Lokrantz (hanna@gvc.gu.se)[1],
Ólafur Ing-Lfsson (olafur@unis.no)[1] &
Steve L. Forman (slf@uic.edu)[2]
[1] Earth Sciences Centre, Geology, Goteborg University, SE-405 30 Goteborg, Sweden
[23] Dept. of Earth and Environmental Sciences, University of Illinois, Chicago, IL 60607 USA

The magnitude of the Eurasian Late Pleistocene ice sheet, which covered parts of north-eastern European Russia and western Siberia, as well as parts of the adjacent shelf is a matter of intense study and debate. The lack of region-wide stratigraphy in the area has lead to problems with age assignments of Pleistocene stratigraphic units. Apart from extent and timing of glaciations, there are discrepancies regarding source areas of ice and ice-flow directions.

Field research at Cape Shpindler, Yugorsky Peninsula, aimed at deciphering depositional environments, ice sheet dynamics and timing of Late Quaternary glacial and climatic oscillations along the southern Kara Sea. Litho- and chronostratigraphic work together with measurements of glaciotectonic structures was conducted along 4-km-long coastal cliffs in 1998 -99.

The coastal sections were assigned seven stratigraphical units, labelled A-G from bottom to top: Units A, B and C, a clayey diamicton with paired shells, bedded silt and mud/ripple cross-laminated sand, reflect a regressive trend from shallow marine to fluviodeltaic deposition. Their age control consist of four infinite ^{14}C datings from unit C. Unit D, a complex of deformed stratified massive ground ice and a silty clayey diamicton with shell fragments and striated stones, is interpreted as relict glacier ice and till. Associated glaciotectonic structures and lithology of the till of unit D suggest ice movement directions from north to south. Unit E, a cross-stratified sand, indicates a period of fluvial deposition. Wood and a mammoth bone from unit E yield ^{14}C ages > 40 ka and two sediment samples gave IRLS ages of 150-200 ka. Unit F, a clayey silty till lacking shell fragments, represents a second, younger glacial advance. The lithology of unit F and structural measurements of associated glaciotectonically deformed sediments suggest an ice movement from south to north. Unit G, peat and laminated to massive fine sand and silt, caps the coastal cliffs. The environmental setting of unit G is interpreted as shallow lacustrine and peatland, with minor eolian and fluvial deposition. AMS ^{14}C dates from this unit range from 12.8 to 0.8 ka BP.

Two glacial advances are recorded in the Cape Shpindler sections. The oldest advance corresponds to a glacier originating in the Kara Sea and occurred before the Eemian, probably in Saale. A younger glacial advance probably emanated in the highlands to the south of Cape Shpindler. Datings from overlying and underlying deposits bracket this advance between 150-12.8 ka. Our best estimate is that this advance occurred during the late Weichselian.

EVO6 : TUpo32 : PO
ESR/OSL Age of Fauna-Bearing Sub-Till Marine Deposits at 66°24' N and 36°37' E (Varzuga Section, Kola Peninsula)

Anatoly Molodkov (molodkov@gi.ee)[1] &
Vladimir Yevzerov (yevzerov@geoksc.apatity.ru)[2]
[1] Institute of Geology, Tallinn Technical University, 7, Estonia Blvd.,10413 Tallinn, Estonia
[2] Geological Institute of Kola Science Centre, 184200 Apatity, Russia

Up to now, there is no unity of opinions among the researchers concerning the stratigraphical subdivision of Late Pleistocene deposits on the Kola Peninsula. Most researchers agree with the viewpoint that the deposits of the Eemian interglacial sandwiched between the tills of the Saalian and Weichselian glaciations, and the complex of late- and postglacial deposits are distinguished here. Judging from the numerous data, three marine transgressions - Boreal, Strelninian and Byelomorian took place here during the interglacial time. The traces of the first two are distinctly fixed in a number of type sections on the coast of the Kola Peninsula. However, the time, stratigraphic position and correlation of the transgressive deposits remain still problematic, especially for discordantly occurring strata. Among them, there is an up to 6-m-thick upper horizon of fauna-bearing boulder clay revealed in the type section T-13 located on the south coast of the Kola Peninsula at 66°24'N and 36°37'E on the right bank of the Varzuga River. These deposits studied by us are situated above the second (from the bottom) sandy bed immediately under the unit of boulder loamy clay interpreted by most researchers as till of the last glaciation. It has allowed some researchers to attribute them to the deposits of the last Late Pleistocene Byelomorian transgression and to the late glacial basin by others. On the other hand, on the basis of all the geological data available, V. Yevzerov concluded that these sub-till sediments can not represent the sediments of an independent transgression and in contrast to the lower marine bed (lower clay) that occur in situ, higher fauna-bearing sediments are most likely of secondary deposition. It is also corroborated by the fact that no marine bed of the same stratigraphical position has been found in other sections studied. To resolve this issue ESR datings of various bivalve mollusc species taken from the sub-till marine unit of section T-13 (~42 m a.s.l.) and OSL dating of enclosing sediments were carried out at the Institute of Geology, Tallinn Technical University. The discussion of the results and consequences concerning the extent and chronology of the Late Pleistocene transgressions in the western part of the White Sea coast will be reported.

EVO6 : TUpo33 : PO
Climatic Changes in Northern Eurasia over the Last Interglacial (s.l.): Evidence from different Sedimentary Environments

Anatoly Molodkov (molodkov@gi.ee)[1] &
Nataliya Bolikhovskaya
(palaeo@palaeo.geogr.msu.ru)[2]
[1] Institute of Geology, Tallinn Technical University, 7, Estonia Blvd.,10413 Tallinn, Estonia
[2] Department of Geography, Moscow State University, 119899 Moscow, Russia

More than 130 mollusc shell samples taken in Northern Eurasia from deposits of various, mostly marine origin revealed absolute ages within the time span from 145 to 70 ka. The dating frequency curve of the whole collection of shells taken in Northern Eurasia displays peaks and troughs that can be correlated with climatic variations during isotope Stage 5: high frequency intervals (ca. 135, 125-120, 110-105, 95-80 and 70 ka ago) apparently correlate with the climate ameliorations and transgressive phases during which large epicontinental basins occupied vast areas of the Eurasian northern coast. Low frequency intervals (ca. 130, 115, 100 and 75 ka ago) indicate cold events during which the submerged area was substantially reduced. As the collection of samples is quite large the frequency distribution record can be used to define the timing of warm and cold periods over the last interglacial. It is noteworthy that the low frequency intervals revealed coincide surprisingly well with the high-latitude, U-series dated palaeoclimatic proxy data from the last interglacial speleothems in northern Norway (Lauritzen, 1995). Periods of isotopically "cold" signals occurred there at ca. 139, 129, 114 and 100 ka. This data also obviously suggest unstable climate through most of the isotope Stage 5, indicating at the same time the absence of thick ice cover there (i.e. interstadial or glacial conditions) between 150-71 ka (ibid.). It implies that the Scandinavian ice sheet has not most probably reached the coastal lowland in northern Norway during isotope Stage 5.

Reconstructions of landscapes and climate on the basis of detailed palynological investigation of loess-palaeosoil sequences made it possible to establish that during the last interglacial (s.l.) forest was dominant over most of the East European loess province. During the warmest periods, the forests consisted primarily of broad-leaved and coniferous/broad-leaved communities of European and Panholarctic elements. Several smaller climato-stratigraphical units and corresponding climate oscillations (thermoxerotic and thermohygrotic stages, substages, and 'endothermal' coolings) have also been distinguished within the interglacial that imply the complicated character of the interglacial event.

The above data demonstrate that during the "cold" periods of isotope Stage 5 (i) the vegetation cover has kept most likely to be of interglacial character in Northern Eurasia, (ii) coastal areas, which are now dry land, were partly occupied by transgressive basins, (iii) the Scandinavian ice sheet had probably not overrun the continental shelf of NW Fennoscandia.

Lauritzen SE, *Quaternary Research*, **43**, 133-146, (1995).

EVO6 : TUpo34 : PO
3.6 Mio Years of Continuous Lacustrine Sedimentation? Seismic Investigation of Impact Crater Lake El'Gygytgyn (NE Russia)

Frank Niessen (fniessen@awi-bremerhaven.de)[1], **Conrad Kopsch** (ckopsch@awi-potsdam.de)[2], **Bernd Wagner** (bwagner@awi-potsdam.de)[3], **Martin Melles** (melles@rz.uni-leipzig.de)[3], **Matt Nolan** (fnman@uaf.edu)[4] & **Julie Brigham-Grette** (brigham-grette@geo.umass.edu)[5]
[1] Alfred Wegener Institute, P.O.Box 120161, D-27515 Bremerhaven, Germany
[2] Alfred Wegener Institute, Telegrafenberg A43, D-14473 Potsdam, Germany
[3] Institute of Geology and Geophysics, Talstr. 35, D-04103 Leipzig, Germany
[4] Geophysical Institute, University of Alaska, Fairbanks AK 99775, USA
[5] Department of Geoscience, University of Massachusetts, Amherst MA 01003, USA

As part of a multidisciplinary expedition to Lake El'gygytgyn during summer 2000 (THE-IMPACT Project, Terrestrial History of El'gygytgyn - International Multidisciplinary Paleoclimate Project) airgun seismic and 3.5 kHz echosounding investigations were carried out. The aim was to study the geometry and thickness of the sediment fill and to provide a pre-site survey for future drilling proposals. Lake El'gygytgyn, located in central Chukotka, NE Russia, is an impact crater lake with a diameter of 12 km and a water depth of 170 m. A 13.0 m long sediment core retrieved from the deepest part of the lake in 1998 revealed a basal age of approx. 400 ka, and is now the longest lacustrine paleoclimate record in the Arctic. A full-length sediment core would yield a record back 3.6 million years, a million years prior to the first major glaciation of the Northern Hemisphere. Refraction seismics using sonobuoys indicate two layers of unconsolidated muds with velocities of 1580 m/s to a depth of 185 m under lake bottom and 1640 m/s to a depth of 371 m under lake bottom, respectively. The second layer is underlain by a refractor characterized by velocities of 3400 to 3900 m/s and interpreted as bedrock or brecciated bedrock. This implies a total sediment thickness of 371 m in the center of the lake. Single channel reflection profiles exhibit well stratified sediments to a depth of at least 180 m subbottom, locally intercalated with debris flow deposits. The latter are clearly documented in 3.5 kHz profiles and are more common in the western part of the lake and along the slopes. The lower part of the sediment fill appears to be more massive. However, most of the lower sediments including the sediment/bedrock contact are not well documented in field-recorded analog reflection profiles because strata is either masked by multiples or not visible due to limited acoustic penetration. Nonetheless, the top of a cone-shaped sediment drape is identified in the centre of the lake at about 180 m sediment depth. This drape may reflect the presence of a bedrock centre cone typically observed in impact craters. The drape is completely levelled by overlying sediments and not visible in the modern bathymetry of the lake. At both the 1998 and newly proposed drillsites the sediments appear to be well stratified and largely unaffected by debris flows. High resolution reflections are controlled by variation in porosity which reflects glacial-interglacial cycling. The general pattern suggests undisturbed, continuous sedimentation to at least a sediment depth of 180 m. There is no evidence for erosion and/or deposition from grounded ice. This suggests that no glaciation occurred in the area that affected the sedimentary record of Lake El'gygytgyn during the entire Quaternary.

EVO6 : TUpo35 : PO
Weichselian and Holocene Environmental History of Severnaya Zemlya, Northern Central Siberia, as Inferred from Changeable Lake Sediments

Alexandra Raab (araab@awi-potsdam.de)[1], **Martin Melles** (mmelles@rz.uni-leipzig.de)[2] & **Hans-Wolfgang Hubberten** (hubbert@awi-potsdam.de)[1]
[1] Alfred Wegener Institute, Telegrafenberg A 43, 14473 Potsdam, Germany
[2] Institute for Geophysics and Geology, University Leipzig, Talstrasse 35, 04103 Leipzig, Germany

The Severnaya Zemlya Archipelago in northern Central Siberia is a key region for the still controversial discussion of the extensions of Weichselian glaciations in Eurasia. In order to reconstruct the environmental history of the archipelago, two sediment cores (10.4 and 12.7 m lengths) were recovered from Changeable Lake (79°07`N, 95°07`E), October Revolution Island. The 10.6 km2 large and up to 18.5 m deep lake lies in an oblong depression that penetrates below the Vavilov Ice Dome and is believed to be an old karst form. The lake is situated 4 km to the SW of the glacier edge and is fed by glacial melt water. The sediment cores were investigated with a multidisciplinary approach that covered sedimentological, biochemical, mineralogical and paleoecological methods, their chronology is based on AMS ^{14}C ages from different organic fractions (foraminifera, humic acids, pollen grains, insect and plant fragments) and two OSL ages. In this poster we focus on the analytical results form core PG1238. A highly consolidated diamicton at the core base is interpreted as a till derived from the last glaciation of the Changeable Lake basin. The till is overlain by a massive marine sediment rich in benthic foraminifera that was formed during a marine transgression dated by ^{14}C to > 48 ka BP and by OSL to 35±4 and 86±6 ka BP. Thus, the till formation corresponds with an ice advance rather during the Early/Middle Weichselian than during the Late Weichselian, and the transgression consequently with a Middle Weichselian interstadial. After this period, drying up of the basin caused a hiatus in the sediment sequence. Subsequent laminated sediments likely were formend during Late Middle Weichselian time, as indicated by ^{14}C ages between 20 and 30 ka BP of insect and plant fragments. This section is succeeded by black laminated sediments with very low carbon contents. According to radiocarbon ages from horizons below and above, these sediments were formed during the Late Weichselian. Their composition indicate a perennial lake ice cover, but no indications were found the existence of glacier ice in the Changeable Lake basin during that time. The supposed Late Weichselian deposits pass into thick laminated reddish-brown sediments of Holocene age, whose rather uniform composition indicate little environmental changes in the area during the last ca. 10,000 years.

EVO6 : TUpo36 : PO
Late Quaternary Paleoenvironment of the Siberian Arctic- New Data from Permafrost Deposits Around the Laptev Sea

Lutz Schirrmeister (lschirrmeister@awi-potsdam.de)[1], **Christine Siegert** (csiegert@awi-potsdam.de)[1], **Tatyana Kuznetsova** (esin@sgm.ru)[2] & **Andreij Andreev** (aandreev@awi-potsdam.de)[1]
[1] Alfred Wegener Institute, Telegrafenberg A 43, D-14473 Potsdam, Germany
[2] Moscow State University, Faculty of Geology, Vorob´ovy Gory, Moscow 119899, Russia

Syngenetic permafrost deposits present rich archives for paleoenvironmental reconstruction in areas outside huge ice sheets. Permafrost preserves very well organic material like plant and animal remains. Various properties of the deposits reflect the facial conditions of discrete time periods. Features of paleo-precipitations are preserved in ice wedges within the permafrost sequences.

To clarify the environmental conditions in the Eurasian Arctic during the Late Quaternary multidisciplinary studies of permafrost deposits were carried out in the frame of the German-Russian project "System Laptev-Sea 2000". The main results were obtained from two key locations on the Laptev Sea coast - Bol'shoy Lyakhov Island and Bykovsky Peninsula. The investigations included simultaneous studies on sediments, paleosols, ground ice and different fossils (pollen, plant macrofossils, mammoth fauna, insects, ostracods). All studied sequences were dated with overlapping methods (radiocarbon, IR-OSL, ^{230}Th/U).

The permafrost sequence on the Bol'shoy Lyakhovsky Island includes deposits of three Pleistocene cryochrones since Pre-Eemian time, interrupted by deposits formed during thermochrones and Holocene. Available pollen data indicate typical tundra-steppe vegetation with small fluctuations between cryo- and thermochrones for the whole time interval. The Middle Pleistocene is characterized by somewhat moister climate conditions. A climate amelioration about 40-30 ka BP is identified by the highest abundance of mammals and other data. Stable isotope studies indicate clear differences between precipitation accumulated in ice wedges during Pre-Eemian, Middle Weichselian, Late Weichselian and Holocene times. Ice Complex deposits on the "Mamontovy Khayata" site, Bykovsky Peninsula have continuously been accumulated from about 60 ka until 10 ka BP. These deposits were transformed by thermo-erosion and thermokarst during Holocene. Data obtained by paleobotanical and paleontological investigations indicate pronounced continental climate conditions during the investigated Pleistocene times. The associations of plants and beetles reflect dominant "tundra-steppe" biomes in the study area for some time intervals. The presence of algae and ostracods in a great number of sediments indicate moisture conditions in the area of accumulation. The optimal living conditions for big mammals existed during 36 - 26.5 ka BP. This period is also characterized by a relativly intensive soil formation, peat accumulation and abundance of shrubs. Between about 28 ka BP to 15 ka a climate deterioration is evidenced. The environmental conditions during Bölling /Alleröd were again similar to those in the period 40-30 ka BP. Stable isotope ratios in all investigated Pleistocene ice wedges on the Bykovsky Peninsula show relativly small fluctuations. A significant change in the stable isotope values was evidenced only at the beginning of the Holocene

EVO6 : TUpo37 : PO
New ^{26}Al Dates for the Younger Dryas Salpausselkä I Formation in Finland

Silvio Tschudi (tschudi@particle.phys.ethz.ch)[1], **Susan Ivy-Ochs** (ivy@particle.phys.ethz.ch)[1], **Christian Schlüchter** (schluechter@geo.unibe.ch)[2], **Peter W. Kubik** (kubik@particle.phys.ethz.ch)[3] & **Heikki Rainio** (heikki.rainio@gsf.fi)[4]
[1] Institute of Particle Physics, HPK H29, ETH Zurich, CH-8093 Zurich, Switzerland
[2] Institute of Geology, University of Bern, Baltzerstrasse 1, CH-3012 Bern, Switzerland
[3] Paul Scherrer Institut, c/o Institute of Particle Physics, ETH Zurich, CH-8093 Zurich, Switzerland
[4] Geological Survey of Finland, P.O. Box 96, FIN-02151 Espoo, Finland

The Finnish Salpausselkä I (Ss I) end moraine is part of the Younger Dryas margin of the Scandinavian ice-sheet. The dating of this glacial formation is mainly based on varve counting supported by a few radiocarbon dates. Both methods provide indirect dating of the glacial formation Ss I, either by long distance correlation of Baltic Ice Lake sediments to the Swedish varve chronology, or by radiocarbon dating of post Ss I peat bog deposits.

Surface exposure dating with cosmogenic nuclides can provide a direct age estimate for glacial deposits. For this purpose, four boulders of the Younger Dryas Ss I formation west of Lahti, southern Finland, were sampled. The ^{26}Al concentrations determined with accelerator mass spectrometry yield minimum exposure ages of 13560 ±1480, 10690 ±1850, 11780 ±1380 and 11530 ±1380 years using recently published production rates of Kubik et al. (1998) and scaled for latitude and elevation after Lal (1991). The scaling includes a correction to the production rate resulting from post-glacial uplift of the Fennoscandian lithosphere (i.e. changing elevation) during the time of exposure. The presented ^{26}Al data confirm the previously determined ^{10}Be ages of the same rock surfaces (Tschudi et al., 2000). The new data set therefore shows the robustness of surface exposure dating, even if applied on very low elevation sample sites (below 200 m above sea level) with short periods of exposure (less than 15 ka).

The error-weighted mean ^{26}Al exposure age of 11980 ±750 years agrees with the Younger Dryas time bracket, as it is defined by the GRIP and GISP 2 ice cores of Greenland (Johnsen et al., 1992, Alley et al., 1993). Within the uncertainties, the formation of Salpausselkä I agrees also with previous varve dates of Ss I, which range from 11680 to 11430 calendar years BP.

Kubik PW, Ivy-Ochs S, Masarik J, Frank M & Schlüchter C, *Earth and Planetary Science Letters*, **161**, 231-241, (1998).
Lal D, *Earth and Planetary Science Letters*, **104**, 424-439, (1991).
Tschudi S, Ivy-Ochs S, Schlüchter C, Kubik PW & Rainio H, *Boreas*, **29**, 287-293, (2000).
Johnson SJ, Clausen HB, Dansgaard W, Fuhrer K, Gundestrup N, Hammer CU, Iversen P, Jouzel J, Stauffer B & Steffensen JP, *Nature*, **359**, 311-313, (1992).
Alley RB, Meese DA, Shuman CA, Gow AJ, Taylor KC, Grootes PM, White JWC, Ram M, Waddington ED, Mayewski PA & Zielinski GA, *Nature*, **362**, 527-529, (1993).

EVO6 : TUpo38 : PO
The Late-Quaternary Environmental History of the Western Foreland of the Polar Urals Inferred from Lake Sediment Studies

Frank Wischer (fwischer@awi-potsdam.de),
Andreij Andreev (aandreev@awi-potsdam.de),
Wolf-Dieter Hermichen
(whermich@awi-potsdam.de) &
Hans-Wolfgang Hubberten
(hubbert@awi-potsdam.de)
Alfred Wegener Institute, Telegrafenberg A 43, D-14473 Potsdam, Germany

Within the scope of the EU project "Eurasian Ice Sheets", a radar survey and deep sediment coring was conducted on Lake Lyadhej-To in 1999. The lake is situated at the NW rim of the Polar Urals (68°15'N, 65°45'E), at the margin of the Middle Weichselian Barents-Kara-Ice sheet, the so-called Markhida-Line. The lake has an extension of about 4 km2 and has two basins up to 26 m and 21 m deep. The poster focuses on the 11.9 m long core PG 1437, sampled in the deepest basin. The core base is composed of a highly consolidated diamicton, which is interpreted as a till, overlain by stratified to laminated clayey gyttja (6.9 to 1.5 m). The upper 1.5 m consists of stratified silty gyttja. ^{14}C-ages (AMS) of handpicked terrestrial plant remains point to a complete Holocene lacustrine sedimentation which started at least 11 cal ky BP. High contents of authigenic carbonate (up to 60 wt%, 40 samples) in the early-Holocene part of the section with δ^{13}C varying between -5‰ and -10‰ (VPDB) and a high organic carbon content of ca. 5 wt% correlate with an ameriolation of climate as inferred from pollen analyses. Isotope analyses of the bulk organic carbon of 178 samples show an abrupt shift of δ^{13}Corg from -25‰ (VPDB) to -35‰ at the transition from Pleistocene to Holocene, followed by a steady increase to about -27‰ (VPDB) between 9.5 cal ky BP and 4.1 cal ky BP. Several reasons that influence δ^{13}C-values of organic carbon and possible conclusions on paleoclimate are discussed in the poster. δ^{18}O-values of authigenic carbonates rise from -16‰ (VPDB) in early Holocene to -10‰ in middle Holocene, reflecting secular changes of hydrology and climate in the lake's catchment. Pollen analyses result in a formation of five pollen zones, which correspond well with biogeochemical and isotope data of organic carbon. Grain-size analyses and inorganic geochemistry carried out on the whole core reflect also distinct changes in climatic and environmental conditions. The till underlying the lacustrine strata shows a quite similar geochemical signature like till samples from Markhida key sections. Therefore, it seems very likely that the diamicton at the base of the lacustrine sediments is a redeposited till of the mid-Weichselian Barents-Kara-Ice sheet and does not originate from a hypothetical local glaciation of the Ural mountains.

EVO6 : TUpo39 : PO
Last Glaciation Maximum in the NVZ of Iceland, A Limited Extent?

Jean-Christophe Embry
(jl.embry@mail.ac-lille.fr)[1],
Brigitte Van Vliet-Lano'
(brigitte.van-vliet-lanoe@univ-lille1.fr)[1] &
Jean-Luc Schneider
(jlschneider@geocean.u-bordeaux.fr)[2]
[1] FRE 2255, Sédimentologie et Géodynamique, UST Lille, 59655 Villeneuve d'Ascq, FRANCE
[2] Géologie, Univ.Bordeaux 1, av.facultés, 33405 Talence Cedex, France

The morphological and sedimentological analysis of Late Glacial, Last Interglacial and fore last Glacial in the North Volcanic Zone, Iceland, and adjacent area reveal abnormal features. A The morphological and sedimentological analysis of Late Glacial, Last Interglacial and fore last Glacial in the North Volcanic Zone, Iceland, and adjacent area reveal abnormal features. A widespread last interglacial complex, the Sydra Nordmelfjall Formation, is recognised, covering probably O.I.S.5e, 5d and 5c. Subsequently, the region was covered by the Weichselian ice cap. A comparison with the Late Glacial/Holocene deglaciation is provided in the same region. Although considerable glacial erosion had occurred along the North Volcanic Zone before the deposition of the Sydra N. Formation, almost very limited erosion occurred after its deposition, thereby allowing the extraordinary preservation of the sediments, the absence of the Last Interglacial deposits coincides mostly with zones of high geothermal gradients. In Northern Iceland, during OIS 6, glaciation was temperate based but only cold during the Weichselian. Moreover the analysis of deglaciation features at Kaupangur (Eyjafördur), at Hals and Stordarfjall (Ljosavatn), and at Fagranes (Adaldalur) confirm the oldest interpretation of an early deglaciation already within the Late Glacial. From the Stordarfjall stürzström, it is clear that glaciers have early retreated south of the Younger Dryas / Budi moraines before it, probably as early that Middle Pleniglacial or earlier. This fit both with the preservation in altitude of rock glaciers stressed by A.Gudmusson and the recent data provides by Astakov and Mangerud, for the Russian shelf. It is also significant as well for the understanding of the O.I.S.6 deglaciation in Northern Iceland and its relations to volcanism and seismicity.

Wednesday AM Session

EVO6 : WEam01 : F1
A Review of The Consensus View: Limited Glacial Ice Extent across N.E. Russia and Alaska during LGM

Julie Brigham-Grette
(brigham-grette@geo.umass.edu)
Dept Geosciences, University of Mass, Amherst, MA 01003, USA

Radiocarbon and cosmogenic ^{36}Cl ages between 16 and 24 ka on glaciogenic deposits stretching from the northern Koryak Mountains of the western Bering Sea to northern Chukotka confirm that N.E. Russia was occupied by only local valley glacier complexes during the Last Glacial Maximum. This is consistent with years of surficial mapping across northern and western Alaska. Extensive study of the regional geomorphology by aerial photos and satellite synthetic aperture radar confirm the distribution of fresh, well-preserved moraine complexes and valley terrace sequences radiating from mountainous regions. Field-based morphometric, pedogenic, and stratigraphic studies in the Koryak Mts., the Pekulney Mts., the coastal regions of Chukotka Peninsula, and islands in the Bering Strait find no evidence for southward flowing ice sheets from an East Siberian Sea source. Further, isostatically raised marine shorelines predicted by geophysical models of such a ice sheet complex are not found along either the Russian or Alaskan coast. ELA reconstructions across N.E. Russia and NW Alaska of limited LGM valley glacier complexes are consistent with a variety of proxy indicators for regional aridity accompanied by extensive sea ice over the Bering Sea. Our findings are consistent with Russian surficial studies of Wrangel Island on the Chukchi shelf and research along the Kolyma River to the west. Rapid glacierization of the coastal mountains, probably during substage 5d or 5b when the Bering Strait was still flooded, produced valley glacier complexes more extensive than during the LGM in Alaska and Northeast Russia

EVO6 : WEam02 : F1
The Late Quaternary Climatic and Environmental History of the Taymyr Peninsula, Northern Central Siberia

Hans-Wolfgang Hubberten
(hubbert@awi-potsdam.de)[1],
Martin Melles (mmelles@rz.uni-leipzigde)[2] &
Christine Siegert (csiegert@awi-potsdam.de)[1]
[1] Alfred Wegener Institute, Telegrafenberg A 43, D-14473 Potsdam, Germany
[2] Institute for Geophysics and Geology, University leipzig, Talstrasse 35, D - 04103 Leipzig, Germany

In this presentation we summarize the current knowledge about the climatic and environmental history of northern Central Siberia since Early Weichselian time, as revealed by field and laboratory work carried out since 1993 within the scope of the Russian-German research project "Taymyr". Following a larger glaciation in the Early Weichselian, which covered almost the entire Taymyr Peninsula, most of the area remained ice free during Middle and Late Weichselian. The Middle Weichselian interstadial was characterized by a more continental and probably more instable climate than that of the Holocene, with higher summer but lower winter temperatures. The higher continentality could be due to exposed Siberian shelf areas as a consequence of a lower sea level. The landscape evolution during the Middle Weichselian times was dominated by the decay of the ice cover. However, as a result of specific peculiarities of glacier ice thawing in a territory with continuous, low-temperature permafrost, however, dead ice bodies were preserved until the present time. During the Late Weichselian, valley glaciers appeared in the western Putoran Plateau, whilst its foreland, the Taymyr Lowland, low altitudes of the western Byrranga Mountains and parts of the Severnaya Zemlya Archipelago remained unglaciated. A smaller glacier advance from the Kara Sea Ice Sheet only affected the northwestern part of the Taymyr Peninsula. The transition from the Weichselian to the Holocene is characterized by a climatic warming trend during the Bølling, Allerød and Preboreal periods, which is interrupted by cooling during the Middle and Younger Dryas events. In similarity to some intervals in the Middle Weichselian, the Holocene climatic warming resulted in enhanced thermokarst processes, leading to the formation of shallow lakes and ponds and subsequent peat formation. The Holocene climatic optimum occurred in the early

Holocene. During that time, vegetation zones were located 200-400 km to the north of their present position. Since the end of the Subboreal, a more or less continuous climatic deterioration takes place.

EVO6 : WEam03 : F1
Weichselian Glaciations on the Taymyr Peninsula, Siberia

Per Möller (per.moller@geol.lu.se),
Christian Hjort & **Helena Alexanderson**
Dept of Quaternary Geology, Sölvegatan 13, Lund, SE-22362, Sweden

Ice sheets originating on the Kara Sea shelf have inundated the Taymyr Peninsula three times during the Weichselian ice age. The first event, representing the Weichselian glacial maximum in Siberia, took place c. 90 000 years before present (BP). The ice then reached 350 km southwards from the present coast, to well beyond the Byrranga Mountains, and isostatic downpressing led to a marine limit 100 m above the present sea level. During its retreat northwestwards the ice front temporarily halted 100 km inland from the present Kara Sea coast, creating the North Taymyr ice marginal zone (NTZ), an about 750 km long, up to 100 m high and 2 km wide geomorphological feature. The water level in a large (>8000 km^2) frontally dammed glacial lake reached 120-140 m a.s.l.

During a later glacial event, around 60 000 BP, the Kara Sea ice sheet again terminated at the NTZ, now damming a slightly smaller (>3000 km^2) glacial lake, reaching 80 m a.s.l. Finally, during the "Last Glacial Maximum (LGM)" c. 18 000 BP (which, however, in Siberia is the Weichselian minimum glaciation) the Kara Sea ice sheet was much thinner than before and only inundated the lowlands around the lower reaches of the Taymyr River. It did, however, reach some 100 km inland on a more than 150 km broad front. No ice dammed lake has been documented from that time, and the marine limit then was far below the present coastline. But sediments indicating a southward flow of the today northflowing Taymyr River, in combintion with indications of a temporarily higher water level in the Taymyr Lake basin to the south, illustrate the proglacial drainage during this event. The present coastline was deglaciated before 12 000 BP but still today, over large areas, remnant glacier ice from this final glaciation is found under only c. 0.5 m of soil cover.

The glacial history of Taymyr illustrates a general Siberian Weichselian scenario, where the glacial maximum came early, soon after the preceding Eemian interglacial and when the moisture transport system eastwards was still intact, but where the later glacial events showed decreasing amplitude - no doubt due to a continuously lowered moisture influx, caused by the gradual build up of ice in the Scandinavian/Baltic region, closer and closer to the Atlantic primary moisture source.

EVO6 : WEam04 : F1
Late Pleistocene Glaciers Keep Dwindling in West Siberia

Valery Astakhov (valery@nb1466.spb.edu)
Geological Faculty, St.Petersburg University, Universitetskaya 7/9, 199034 St.Petersburg, Russia

The palaeoglaciological reconstruction of a huge Late Weichselian ice sheet in Siberia (Grosswald, 1993) suggested from interpretation of topographic features and selected radiocarbon dates has widely been accepted in geophysical literature (e.g., Peltier, 1994). However, the bulk of geological, palaeonthological and geochronometric information is decidedly against this idea, constraining the latest ice sheet spatially to the Arctic and temporally to a time span beyond 50 radiocarbon kiloyears BP. The long series of `old` radiocarbon dates obtained from sediments covering the uppermost till of glaciated Siberia forbids a substantial Late Weichselian ice on the shores of the Kara Sea (Astakhov, 1998). This has lately been confirmed by several international research projects in the Russian Arctic (Svendsen et al., 1999, Forman et al., 1999).

Data from the ongoing international studies lead to further reduction of Weichselian ice sheets in Siberia. The limit of an Early Weichselian ice sheet along the Arctic Circle suggested by Astakhov (1998) on the base of Arkhipov`s (1998) stratigraphy of the Salehard moraines was ground checked in 2000 during the work on the Russian-Norwegian project PECHORA. The Uralian piedmont south of the hummocky Sopkay moraines at 67°N displays distinct tors and no glacial topography. In the Salehard area the youngest interglacial formation with peat and forest pollen is overlain by a diamicton related to the Late Weichselian by Arkhipov (1998). This diamicton proved to be part of a thick solifluction and colluvial mantle with no glacial disturbances at the base. Therefore, the Salehard moraines are older than the last interglacial This conclusion shifts the Early Weichselian glacial maximum northwards by 100 to 300 km. Numerous finds of fossil glacial ice, which only along the Yenissei reach as far south as the Arctic Circle, are suggested to spatially constrain the Early Weichselian ice limit, because they could hardly survive the warm Eemian transgression.

Only glacial deposits superimposed onto formations with finite radiocarbon dates or devoid of any sedimentary cover may be considered as signatures of the LGM. Such features occur around the Putorana Plateau, along the northernmost edge of the Taimyr Peninsula, and possibly in small alpine valleys of the Urals. Therefore, Late Weichselian glaciation of the Siberian dry land was mostly discontinuous and limited to uplands.

Arkhipov SA, *Quaternary International*, **45/46**, 29-42, (1998).
Astakhov V, *Quaternary International*, **45/46**, 19-29, (1998).
Forman S, Ingolfsson O, Gataullin V, Manley WF & Lokrantz H, *Geology*, **27(9)**, 807-810, (1999).
Grosswald MG, *NATO ASI series*, *Springer*, **112**, 1-20, (1993).
Peltier RW, *Science*, **265**, 195-201, (1994).
Svendsen JI, Astakhov VI, Bolshiyanov DYu, Demidov I, Dowdeswell JA, Gataullin V, Hjort Ch, Hubberten HW, Larsen E, Mangerud J, Melles M, Moeller P, Saarnisto M & Siegert MJ, *Boreas*, **28(1)**, 234-242, (1999).

EVO6 : WEam05 : F1
Late Quaternary Glacial History of Southern Kara Sea Area: Stratigraphical Evidence from Yamal and Yugorski Peninsulas

Olafur Ingolfsson (olafur@unis.no)
UNIS, P.O.Box 156, N-9170 Longyearbyen, Norway

Across the broad expanse of the Eurasian Arctic, Quaternary stratigraphy is still sparsely documented, and controversial reconstructions exist for the configuration and age of former glaciations. Field investigations on Yugorski and Yamal Peninsulas, arctic Russia, have put constraints on glaciations and environmental developments in the southern Kara Sea area through the last interglacial-glacial cycle (Forman et al., 1999, Manley et al., in press). A long, well dated record from western Yamal Peninsula shows that it was subject to a regional glaciation some time before 40 ka BP, but was ice-free during the last glacial maximum in NW Europe. The Late Weichselian record from western Yamal suggests active ice-wedge growth and eolian and fluvial deposition during the period 40-11 ka BP, thus constraining the eastern limit of the Late Weichselian Barents Sea-Kara Sea ice sheet to the shallow Kara Sea proper.

Stratigraphical record from the Yugorski Peninsula indicates that the area was subject to two episodes of glacial overriding during the Weichselian glaciation: during a regional glaciation, the peninsula was overridden by ice advancing southwards from a glaciation centre in the Kara Sea. Lithostratigraphic and structural data suggest that at a later stage a local ice dome expanded from the Pai-Khoi upland and overran the coastal cliffs from south. The ages of the two glacial events recorded at Yugorski Peninsula are poorly constrained, except they occurred later than the last (Eemian) interglacial and prior to 12.5 ka BP.

Forman, S.L., Ingolfsson, O., Gataullin, V., Manley, W.F. & Lokrantz, H., *Geology*, **27**, 807-810, (1999).
Manley, W.F., Lokrantz, H., Gataullin, V., Ingolfsson, O., Forman, S. & Andersson, T., *Global and Planetary Change*, (in press).

EVO6 : WEam08 : F1
The Chronology of the Barents-Kara Ice Sheet Advances and Ice Dammed Lakes in Northern Russia

Jan Mangerud (jan.mangerud@geol.uib.no)[1],
Valery Astakhov (valery@nb1466.spb.edu)[2],
John Inge Svendsen (john.svendsen@smr.uib.no)[3]
& **Henriksen Mona**
(mona. henriksen@geol.uib.no)[1]
[1] Dept. of Geology, Univ., Allégt. 41, N-5007 Bergen, Norway
[2] Geological Faculty, Univ., Universitetskaya 7/9, 199034 St.Petersburg, Russia
[3] Center for Environment, Univ., Høteknologisentret, N-5020 Bergen, Norway

The ice sheet over the Kara- and Barents seas and Northern Russia apparently reacted "opposite" to the ice sheets over Scandinavia and North America during the last ice age, the Weichselian. The Barents-Kara Ice Sheet was small during the Last (global) Glacial Maximum about 20 ka, but large during the earlier Weichselian advances, when the others were small (Astakhov et al., 1999, Mangerud et al., 1999, Svendsen et al., 1999).

During the Late Weichselian (about 18 ka) the ice sheet was centered over the Barents Sea and terminated in the SE part in the sea. Thus it was much smaller in extension than shown by most earlier reconstructions. Mainly aeolian sediments are found in the Pechora lowland from this period.

According to our present hypothesis, there were major advances onto the continent during both the Early and Middle Weichselian. The Middle Weichselian advance is bracketed in age between OSL dates in the range 50-80 ka below the Markhida moraine and non-finite radiocarbon dates above the moraine (Henriksen et al., in press).

The Early Weichselian advance dammed a large lake, named Lake Komi, between the ice sheet and the continental drainage divide (Mangerud et al., in press). The advance is dated to about 90 ka by means of about 20 OSL dates on beach sediments from Lake Komi. At that time the hydrography of much of the continent was changed because the north running rivers were diverted towards south. This also influenced the fresh water supply to the Arctic Ocean and to the North Sea and the Caspian Sea.

Astakhov, V.I, Svendsen, J.I., Matiouchkov, A., Mangerud, J., Maslenikova, O. & Tveranger, J., *Boreas*, **28**, 23-45, (1999).
Henriksen, M., Mangerud, J., Maslenikova, O., Matiouchkov, A. and Tveranger, J., *Global and Planetary Change*, (In press).
Mangerud, J, Svendsen, JI & Astakhov, VI, *Boreas*, **28**, 46-80, (1999).
Mangerud, J, Astakhov, V, Murray, A, and Svendsen, JI, *Global and Planetary Change*, (In press).
Svendsen, JI, Astakhov, V, Bolshiyanov, DYu, Demidov, I, Downswell, JA, Gataullin, V, Hjort, Ch, Hubberten, HW, Larsen, E, Mangerud, J, Melles, M, Møller, P, Saarnisto, M & Siegert, MJ, *Boreas*, **28**, 234-242, (1999).

EVO6 : WEam09 : F1
Palaeogeographical Reconstructions around the Busiest Weichselian Ice-Flow Junction in Northern Russia

Eiliv Larsen (eiliv.larsen@ngu.no)[1],
Igor Demidov[2], **Svend Funder**[3], **Kari Grøsfjeld**[1],
Michael Houmark-Nielsen[4], **Kurt H. Kær**[3],
Nadya Lavrova[2], **Astrid Lyså**[1] & **Jan K. Nielsen**[3]
[1] Geological Survey of Norway, Leiv Eirikssons vei 39, N-7491 Trondheim, Norway
[2] Russian Ac. Sciences, Inst. of Geology, 11 Pushkinskaya street, Petrozavodsk, 185610, Russia
[3] Geological Museum, Univ. Copenhagen, Øster Voldgade 5-7, DK 1350 Copenhagen, Denmark
[4] Geological Institute, Univ. Copenhagen, Øster Voldgade 10, DK 1350 Copenhagen, Denmark

Eight palaeogeographical reconstructions covering time slices from the last interglacial to the last deglaciation in the Arkhangelsk region are presented. Each reconstruction visualises the configuration of land, sea, lakes, flood plains and glaciers. The reconstructions are based on a large stratigraphical and sedimentological data set from river sections along Severnaya Dvina, Vaga, Pyoza and Mezen, and coastal sections along Kuloi and the Kanin Peninsula.

Following a major drop in sea level after the Eemian, glaciers built up on the Timan ridge, the Kola peninsula, and in the Barents-Kara Sea at around 90 ka BP. The latter ice sheet was responsible for the damming of lake Komi in the Pechora lowland. Proglacial lake basins developed in the eastern parts of the Arkhangelsk region while periglacial rivers were flowing northward and westward. This drainage pattern suggests an opening to the Barents Sea, and accordingly, that the lake Komi was restricted to a position east of the Timan ridge. As the marine-based ice-sheet to the north wasted back, ice continued to grow on the Timan ridge, spreading north-westwards into the Pyoza lowlands and reaching the Kanin peninsula. This configuration occurred some 70 ka ago. Open waters in the White Sea allowed drainage in the western part of the region to be directed northward. This drainage pattern was maintained along the Vaga and Severnaya Dvina rivers throughout the Middle Weichselian. In the eastern part of the region, however, renewed growth of the Barents-Kara ice sheet overrode the Kanin peninsula and reached deeply into the Pyoza lowland between ca. 60 and 50 ka BP. The glacier blocked an outlet towards the west giving rise to the formation of ice dammed lakes on the upper Pyoza. Within this interval evidence exists for a deglaciation that opened a seaway between the Kola and Kanin peninsulas with a relative sea level about 15 metres above present. The rest of the Middle Weichselian was characterized by ice-free conditions and a drainage pattern similar to the present. During the Late Weichselian, the Scandinavian ice sheet grew eastwards reaching onto the Kanin peninsula and the Mezen drainage basin. At the same time, the Barents-Kara ice sheet was situated north of the Russian mainland, leading to the formation of proglacial lakes along the Scandinavian ice sheet margin, and a general drainage of these lakes northwards and eastwards south of the Barents-Kara ice sheet margin. During deglaciation areal downwasting along the fringes of the Scandinavian ice sheet led to deposition in local lakes while drainage towards the Barents Sea along the modern river valleys was re-established and a pioneer vegetation immigrated to the region.

EVO6 : WEam10 : F1
The Last Glaciation on the Kola Peninsula, Russia

Juha Pekka Lunkka (juhapekka.lunkka@gsf.fi)[1],
Matti Saarnisto & **Igor Demidov**
(demidov@krc.karelia.ru)[2]
[1] Geological Survey of Finland, Betonimiehenkuja 4, P.O. Box 96 02151 Espoo, Finland
[2] Institute of Geology, Karelian Research Centre, 11 Pushkinskaya, 185610 Petrozavodsk, Russia

Two field expeditions were made in 1999 and 2000 to the interior and southern coastal areas of the Kola Peninsula to shed light on the history of the last glaciation on the Kola Peninsula. Conventional sedimentological techniques were applied in sections investigated in order to reconstruct a lithostratigraphical scheme for the area under investigation. Normal sampling procedures for provenance studies and absolute dating purposes were also carried out from suitable sediments. In addition, on-site geomorphological investigations were used to identify the glacigenic features in the study area.

Results indicate that glaciolacustrine sediments overlie the Eemian marine deposits at many sites along the northern White Sea coast. These glaciolacustrine units are overlain by sand that is covered by one till unit. This till unit is in turn overlain by thick deltaic sands. The OSL (optically stimulated luminescence) results from the sand units above the Eemian deposits yield ages from 84 ka to 55 ka. This indicates that ice-free periods exited in the southern part Kola during the Early and Middle Weichsel.

Investigations on the so-called Keiva moraines (Keiva I and Keiva II) in the southern part of the Kola Peninsula suggest that Keiva I is highly discontinuous and do not represent a prolonged marginal position of an ice-front. Results show that the end-moraines in the Keiva I belt were formed from the south. In contrast, 250 - 300 Keiva II, north of Keiva I, is a complex geomorphological feature, composed of esker-type ridges, deltaic end-moraines and interlobate formations. Keiva II clearly records the interplay between two independent ice masses i.e. the Ponoy Ice Cap to the north and the White Sea Ice Stream. An OSL date from deltaic sediments in Ponoy suggests that the White Sea Ice Stream of the Scandinavian Ice Sheet had already retreated from the easternmost part of the Kola Peninsula ca. 15 ka ago. The OSL ages obtained from the Keiva II end-moraine zone indicate that deposition of Keiva II terminated during the Younger Dryas.

On-site investigations revealed that there are no extensive end-moraine systems in the interior of the Kola Peninsula as suggested by some Russian workers. The superficial, glacigenic deposits in the interior of Kola are sparse, and weathered, barren bedrock dominates the landscape.

EVO6 : WEam11 : F1
Environmental Changes during the Last Interglacial-Glacial Macrocycle in the North-West of the Russian Plain

Andrei Velichko (paleo@online.ru),
Ella Zelikson (paleo@online.ru) &
Olga Borisova (paleo@online.ru)
Institute of Geography, Staromonetny per., 29, Moscow, Russia

Landscape and climatic changes through the last interglacial-glacial macrocycle were reconstructed on the basis of the palynological data and composition of paleofloras. During the Mikulino Interglacial (Eem, oxygen isotope stage 5e) the mean July temperature (t°July) exceeded the present-day level by 1-2°C. Changes of the mean January temperature (t°Jan) were greater than those of t°July exceeding the modern level by 10°C in the optimum phase of the interglacial. Warm-temperate deciduous forest on the East European Plain during the Eemian climatic optimum included some heat-loving species, which grow at present in Western Europe (e.g. Carpinus betulus, Tilia platyphyllos). The first substantial cooling after the Mikulino Interglacial caused a spread of boreal forest (spruce, pine and birch) interspersed with herbaceous communities close to modern meadow steppe. t°Jan was then 8° lower, that of July - 3° lower than the present-day one. Subsequent warming (the Verkhnevolzhsky, or Krutitsky interstadial, stage 5d) is correlated to the Brorup interstadial in Western Europe. According to the palynological data, spruce forest was predominant over the north-western East European Plain. A new cooling following the interstadial is evidenced by spread of steppe and tundra-like communities and open spruce and birch forest in the protected localities. Within a relatively warm time interval from 50K to 23K yrs BP (so-called Middle Valdai megainterstadial, stage 3) the coolings did not reach the magnitude of the Early Valdai cold stages. There are three main warm intervals of the Middle Valdai distinguished on the basis of palynological data: 46-39K yrs BP, 36-33K yrs BP and 30-23K yrs BP. The vegetation during these warm stages was dominated by spruce forest with Siberian trees, such as fir and larch. Vegetation in the final warming of the Middle Valdai (Dunayevo Interstadial, 23-30K yrs BP) was represented by spruce forest with Siberian pine and fir. t°Jan was then 7-9°C lower, that of July - 1°C lower than the present-day one. The frostless period was almost two months shorter than at present, annual precipitation - 50 mm lower. The climate deterioration at the beginning of the Late Valdai glacial epoch (stage 2) resulted in spread of open birch forest and meadow vegetation. During the maximum cooling of the Late Valdai the north-western East European Plain was largely covered by periglacial steppe: a complex vegetation consisting of cold steppe and open boreal forest communities with tundra elements. Paleoclimatic reconstructions show that t°Jan were at least 10-14°C lower, that of July - 2-3°C lower than the present-day one. The frostless period was 1-1.5 months shorter than at present. During the final part of the Late Valdai glacial epoch (in the Lateglacial) the general trend towards warming was complicated by several second-order climate oscillations, the Allerod interstadial (11,8-11K yrs BP) and the Younger Dryas cold stage (11-10,3K yrs BP) being the most prominent of them.

EVO6 : WEam12 : F1
Modelling the Eurasian Ice Sheet Through the Weichselian Glacial Cycle

Martin Siegert (m.j.siegert@bristol.ac.uk) &
Julian Dowdeswell
Bristol Glaciology Centre, School of Geographical Sciences, University of Bristol, BS8 1SS, UK

Recently acquired glacial geological and oceanographic datasets provide information on the Weichselian glaciations of Scandinavia and the Eurasian Arctic. A numerical ice-sheet model, forced by global sea level and solar insolation changes, was run to reconstruct ice sheets compatible with these data. A 'maximum' reconstruction assumes that the modern-type temperature distribution across the Eurasian Arctic is reduced by 10°C at three stages during the Weichselian, which are related to minimum levels of solar insolation. Conversely a 'minimum' model incorporates a reduction in temperature of only 5°C in Early and Middle Weichselian time. The 'maximum' reconstruction employs the relatively larger sea-level fall suggested by the $\delta^{18}O$ deep-sea record, whilst the 'minimum' run uses the more conservative sea-level estimate from New Guinea coral reef terraces. The maximum model predicts three major glacial advances in the Weichselian. These compare well to geological evidence for ice-sheet growth during the Early, Middle and Late Weichselian. Geological evidence for the Late Weichselian ice sheet is compatible with either reconstruction if ice growth across the Taymyr Peninsula is curtailed. The models show that ice-sheet advance caused by the interaction of sea level and solar insolation changes yields a time-dependent ice volume function similar to that established from the geological record. Periods of seasonally open water within the seas bordering the Eurasian Arctic generally occur prior to glaciation, and may provide a source of precipitation for ice-sheet growth. In contrast, periods of ice-rafted debris deposition and depletion in surface-ocean $\delta^{18}O$ in sea-floor sediments compare well with the model's determination of ice-sheet decay and melting.

EVO6 : WEam13 : F1
Reconstruction of the Eurasian Ice Sheets during the Weichselian

John Inge Svendsen (john.svendsen@smr.uib.no)
Centre for Studies of the Environment and Resources, University of Bergen, Bergen, Norway

We here present new results obtained by the European Union project Eurasian Ice Sheets (Contr. No. ENV4-CT97-0563). Based on recent field investigations in northern Russia we have reconstructed the shape of the Eurasian Ice Sheets for three 3 periods during the last glacial cycle: 1) Early Weichselian (isotope stage 5b), Middle Weichselian (isotope stage 4) and Late Weichselian (isotope stage 2). The reconstructed ice limits are based on satellite and aerial photograph interpretation combined with comprehensive geological field investigations, as well as interpretation of seismic- and core data from the adjacent continental shelf. We have compared the empirical data with a model simulation of the repeated growth and decay of the Eurasian ice sheets and have used the glaciological modeling results to reconstruct the ice thickness. The maximum glaciations in the Russian Arctic occurred during the Early Weichselian at around 90,000 years ago, in strong contrast to the ice sheets over Scandinavia and North-America which at that time where much smaller than during the Last Glacial Maximum (LGM) about 20,000 years ago. The Barents-Kara Ice Sheet expanded far onto the Russian continent and blocked the northbound drainage towards the Arctic Ocean. The maximum ice sheet extent is recognized by prominent end moraines that have mapped across wide areas. During the Middle Weichselian about 50-60,000 years ago the Barents and Kara Sea region was apparently affected by another major glaciation of a nearly equal size as the preceding ice sheet. The ice front expanded well onto the continent in the Mezen and Pechora drainage basins, but the West Siberian Lowland seems to have been ice free. The ice sheet also inundated the north-western rim of the Taymyr Peninsula and there is good evidence to suggest that it reached the shelf margins in Kara and Barents Sea. During this period the Scandinavian Ice Sheet grew to a considerable size over the Baltic Seas.

During the Last Glacial Maximum at about 20,000 years ago the Scandinavian Ice Sheet attained its maximum position, also in the Northwestern part of the Russian Plain and the Arkhangelsk region. At this time the Barents-Kara Ice Sheet embraced a much smaller area than shown by most earlier reconstructions which hitherto have been used as a boundary condition for testing and refining General Circulation Models. The southern margin was located on the continental shelf in the SE Barents Sea and in the Kara Sea to the east of Novaya Zemlya. The ice sheet probably reached the NE coast of the Taymyr Peninsula, but apparently the Severnaya Semlya remained ice free.