Editors:
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33rd Annual Arctic Workshop

Abstracts

Polar Environmental Centre, Tromsø, Norway, 3 - 5 April 2003

Norsk Polarinstitutt
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Norsk Polarinstitutt er Norges sentrale statsinstitusjon for kartlegging, miljøovervåking og forvaltningsrettet forskning i Arktis og Antarktis. Instituttet er faglig og strategisk rådgiver i miljøvernsaker i disse områdene og har forvaltningsmyndighet i norsk del av Antarktis.

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Nalân Koç, Norwegian Polar Institute
Tore Vorren, University of Tromsø

Workshop Sponsors

This 33rd Annual Arctic Workshop is sponsored by the Norwegian Polar Institute, the University of Tromsø, the Research Council of Norway and the U.S. National Science Foundation.

PREFACE

The 33rd Annual Arctic Workshop has grown out of a series of informal annual meetings sponsored by INSTAAR and other academic institutions worldwide. Open to everyone interested in the Arctic, these meetings have consisted of a series of talks and poster sessions covering all aspects of high-latitude environments, past and present. Like the previous Arctic Workshops, this workshop also include presentations on Arctic and Antarctic climate, archeology, environmental geochemistry, geomorphology, hydrology, glaciology, soils, ecology, oceanography, and Quaternary history. Thus, the workshop offers an opportunity for stimulating discussions between scientists studying various aspects of high-latitude climates and environments.

The first Arctic Workshop was organized by John Andrews at INSTAAR in 1970 to give graduate students an opportunity to present their ongoing research, obtain some experience in public speaking, and to get feedback from more senior researchers. In keeping with this tradition, the U.S. National Science Foundation and the Research Council of Norway have sponsered the participation of 45 graduate students from all over the world to this meeting. We are extremely pleased to have such a high participation of graduate students - making up nearly half of the workshop participants. We hope to be as much inspired by these young minds as we can inspire them further in their wonderfully exciting quest to understand high-latitude climates and environments.

The conference is being held at the Polar Environmental Centre. The Centre for the Environment and co-operation in the Polar Areas and the Barents region - The Polar Environmental Centre - is Norway's new centre of research, environmental monitoring and advisory services in the Northern Region and the Arctic/Antarctic.

The conveners (Stein Bondevik, Morten Hald, Elisabeth Isaksson, Nalân Koç, Tore Vorren) would like to thank our sponsers: the Norwegian Polar Institute, the University of Tromsø, the Research Council of Norway and the U.S. National Science Foundation. We also offer our sincere thanks to Anne Kibsgaard, who did an excellent job as secretary for this workshop, Ellen Berg, who assisted A. Kibsgaard, and Audun Igesund, who was responsible for the web layout.

We hope the 33rd Annual Arctic Workshop will be a rewarding interdisciplinary meeting for you on a variety of Arctic research themes.

Welcome to Tromsø!

Nalân Koç
(on behalf of the conveners)

33rd Annual Arctic Workshop
Polar Environmental Centre, Tromsø, Norway
3-5 April 2003

PROGRAMME

Thursday, 3rd April

8:00 Registration

8:45 **Nalân Koç** Welcome

<u>*Session:*</u> *Marine records*

9:00 **J.T. Andrews** The last 2000 year: A marine history of the Vestfirdir area of NW Iceland based on results from fjord cores.
9:20 **A.E. Jennings** Holocene climate evolution and variability in the Denmark Strait region from multi-proxy analysis of cores from the SE Greenland and N Iceland shelves.
9:40 **G.B. Kristiansdottir** High latitude Mg/Ca-temperature calibrations for three arctic, benthic foraminifera species: *Melonis barleeanus, Cassidulina neoteretis* and *Islandiella* sp.
10:00 **S. Ólafsdóttir** Late Quaternary marine environments NW off Iceland: Evidence from foraminiferal data and stable oxygen isotope analyses.

10:20 Coffee break

10:50 **G. Dunhill** Snorri Drift – A 200k yr oceanographic and sedimentary record.
11:10 **G. Downing** Absence of Hudson Strait Provenance of ice rafted detritus in Stage 6 from core V28-82.
11:30 **S. Hemming** 40 Ar/39Ar evidence for provenance of ice-rafted hornblende grains from ODP site 984.
11:50 **M. Hald** Late glacial and Holocene paleoceanography of the van Mijenfjord, Spitsbergen.
12:10 **S. Korsun** Glacier proximal foraminifera in a meltwater dominated fjord of Svalbard: year-to-year change.

12:30 LUNCH

13:30 *Poster session*

15:30 Coffee break

15:50 **C. Vogt** Two very detailed clay mineral core records of Marine Isotope Stages 1-6 from the Eurasian Basin, Arctic Ocean.
16:10 **M Vanneste** Arctic gas hydrate provinces along the Western Svalbard Continental Margin.

16:30 **D. Winkelmann** Reconstruction of recent and late Holocene sedimentation processes on the continental shelf west of Spitsbergen.
16:50 **E. Ivanova** The Holocene foraminiferal assemblages of Kara and Barents seas: paleoceanographic implications.
17:10 **J.P.W. Syvitski** Arctic coast erosion: A regional to local perspective.
17:30 **G.I. Ivanov** Migration heavy metals in ore deposite-river-sea system (Novaya Zemlya Archipelago).
17:50 **S. Gerland** The role of sea ice for long-range transport of radioactive pollution-field observations in the Fram Strait and in a Svalbard fjord.

18:10 – 19:30 ICEBREAKER

Friday, 4th April

<u>Session:</u>. *Terrestrial records*

9:00 **M.A. Jensen** Evidence of a high sea level event during the last ice age in the Arkhangelsk area, NW Rusia.
9:20 **L. Anderson** Holocene temperature and moisture reconstructions for the southern Yukon Territory, Canada: oxygen isotope studies of small carbonate lakes.
9:40 **R. Pienitz** Global warming in the Arctic: What about northern Québec and Labrador?
10:00 **J. Théau** Mapping lichen in the caribou summer range of northern Quebec, Canada, using Landsat TM imagery.

10:20 Coffee break

11:10 **D.D. Rousseau** Pollen record of air trajectories in the Arctic.
11:30 **A. Prick** Monitoring weathering processes and rock fall activity in an Arctic environment, longyearbyen, Svalbard.
11:50 **F. Calmels** New knowledge on permafrost provided by medical scanner imaging data in Nunavik, Québec.
12:10 **C.G. Knudsen** Last deglaciation of Jæren, south western Norway – dynamics, chronology and climate variability.

12:30 LUNCH

13:30 *Poster session*

<u>Session:</u>. *Glaciers and Glacial history*

14:30 **J. England** Recent developments on the configuration, surface topography and dynamics of the Late Wisconsinan, Innuitian Ice Sheet.
14:50 **G. Mercier** Glacier fluctuations in the Akshayuk Pass, Auyuittuq National Park (Nunavut – Canada).

15:10 **J. Briner** An extensive northeastern Laurentide Ice Sheet during the Last Glacial Maximum.

15:30 Coffee break

16:00 **P. Lajeunesse** Quaternary glacial geology and relative sea level history of eastern Melville Island, western Canadian Arctic Archipelago
16:20 **I. Lønne** Fridjovbreen on Svalbard – evolution of the two last surge events.
16:50 **S. Åsberg** Satellite remote sensing of glaciers and ice caps in Svalbard, Eurasian High Arctic.

19:30 Workshop dinner

Saturday, 5th April

Session:. Glaciers and Glacial history

9:00 **A. Hormes** Holocene glacier recessions in Lapland and Svalbard inferred from radiocarbon dates of specified organic material.
9:20 **P. Möller** Glacial and environmental history of Severnaya Zemlya, Siberian high arctic, during the last > 130,000 years.
9:40 **I. Murdmaa** Paleoenvironments in the Ruskaya Gavan´ Fjord (NW Novaya Zemlya) during the last millenium: responses to global climate changes.
10:00 **K. Andreassen** Palaeo-ice streams to the southern Barents Sea margin during the Late Cenozoic: evidence from glacial lineations, mega blocks and rafts.
10:20 **S.M. Principato** Using 36-chlorine ages and marine cores to constrain the Late Quaternary history of the Vestfirdir Peninsula, Iceland.

10:50 Coffee break

Session: Ice cores.

11:10 **J. Burkhart** Importance of accumulation timing in preservation of Total Inorganic Nitrate (TIN) at Summit, Greenland: implications for surface snow reconstructions.
11:30 **T. Popp** The anatomy of abrupt climate changes from Greenland ice cores.
11:50 **L. Karlöf** Wavelet methods for analysis of ice core time series.

12:30 End of Workshop

ORAL PRESENTATIONS

The last 2000 year: A marine history of the Vestfirdir area of NW Iceland based on results from fjord cores

J. T. Andrews and J. MacKenzie Richter

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We report the results of decadal to century-scale sampling of marine sediments from two fjords in Vestfirdir, NW Iceland. The cores were retrieved on cruise B997 with the *Bjarni Saemundsson* . B997-328 is from Reykjarfjördur, on the outer north coast of the peninsula whereas B99-341 was retrieved from Jokulfirdir, a branch of the main Ísafjardardjúp system, which received drainage from Dragnajokull, a local ice cap. The two cores have modest ^{14}C AMS control based mainly on *in situ* molluscs averaging one date per 500 yr for the last 2-3 cal ka. The rates of sediment accumulation at both sites show little variability and average around 100 cm/ky. As common data at both sites we have total carbonate content, mass magnetic susceptibility, grain-size, and $\partial^{18}O$ of benthic foraminifera. At B997-328 we also posses the foraminiferal assemblage data. At nearby sites we have a variety of sediment magnetic properties measured at 1 cm intervals. Our goal is to see how far we can extract paleoclimatic data from these sites to both compare with and extend some of the historical information related to the Settlement and human history of Iceland. Both sites have comparable records of carbonate content, marked by high values at the beginning of the period and with a sharp decline at the start of the last millennium. The $\partial^{18}O$ in the benthic foraminifera track the changes in carbonate and show a sharp increase in $\partial^{18}O$ during the interval broadly defined at the Little Ice Age (LIA). The $\partial^{18}O$ record also matches rather closely the reconstructed "sea-ice index" for Iceland. The association between lower carbonate and heavier $\partial^{18}O$ values indicates that the LIA in Vestfirdir is cold rather than wet and/or "fresh". However, the broad LIA interval coincides in B997-328 with a major peak in the percentages of the Arctic foraminifera *Elphidum excavatum* form *clavata* which often implies a freshening in the water column. Perhaps surprisingly, plots of the mean grain-size from laser-sizer measurements suggest comparable changes in the energy levels of transport between the two sites with a decrease in mean size over the last 500-600 yr.

Holocene Climate Evolution and Variability in the Denmark Strait Region from Multi-Proxy Analysis of Cores from the SE Greenland and N Iceland Shelves

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Holocene oceanographic and environmental changes are compared on the East Greenland shelf and N. Iceland shelf, using IRD, total carbonate and foraminiferal records from four, high-resolution sediment cores. The goal of the study is to characterize Holocene climate evolution and the patterns and potential cyclicity of natural climatic variability. The four cores are well positioned to capture the ocean/atmosphere/ice dynamics in this region of contact between the Arctic and Atlantic realms. Core MD99-2317 has a *c*. 13 m Holocene section. It was raised from an E Greenland shelf basin on the north side of the Denmark Strait. This site is influenced mainly by Polar Water of the East Greenland Current. Two cores are from the Kangerlussuaq Trough, on the East Greenland shelf on the south side of the Denmark Strait. Core JM96-1216/2-GC is a 2.5 m core from the outer shelf and core MD99-2322 is a 26 m Holocene core from the deepest part of the trough on the middle shelf. These sites underlie the East Greenland Current, but are also influenced by modified Atlantic Water at intermediate depths, that enters the trough via a westward turning branch of the Irminger Current. The fourth core is MD99-2269, a 25 m-long Holocene core raised from Hunafloadjup on the northern Iceland shelf. This core site lies close to the boundary between the Atlantic Water carried northward in the Irminger Current and the southern limit of Arctic/Polar water in the East Iceland Current. The cores are well dated and correlated with both AMS ^{14}C dates and by Icelandic tephra marker horizons: Vedde Ash and Saksunarvatn tephra. The comparisons of carbonate, IRD, and foraminiferal records among these cores shed light on environmental contrasts north and south of the Denmark Strait, and the competing influences of freshwater forcing, summer solar insolation, and the history of Atlantic Water in the Irminger Current.

High latitude Mg/Ca–temperature calibrations for three arctic, benthic foraminifera species: *Melonis barleeanus, Cassidulina neoteretis* and *Islandiella sp.*

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Since the mid 1990s foraminifera Mg/Ca studies have been growing evermore important in paleoreconstructions. Development of the technique has been driven by the need for quantitative paleotemperature reconstruction. A distinct advantage of the Mg/Ca method is the opportunity to reconstruct temperature and salinity of seawater by paired measurements of Mg/Ca and $\delta^{18}O$. The basis for Mg/Ca paleothermometry is the temperature dependent incorporation of Mg into calcite. Empirical studies and thermodynamic calculations of inorganic calcite show an exponential relationship between Mg incorporation and temperature. An exponential relationship is similarly observed for both benthic and planktonic foraminifera.

Calibrations of Mg/Ca ratio against temperature are reasonably well-constrained for temperatures >10°C but are poorly developed for cooler temperatures, thus limiting the methods applicability to high-latitude studies. We have developed preliminary calibrations for three common, arctic, benthic foraminifera by using modern samples from the Iceland and Greenland margins. These two margins are ideally suited to conduct cool water calibrations for Mg/Ca studies because they offer a spatial bottom-temperature gradient of 0 to 9°C.

We use a set of surface grab samples collected from the Iceland margin during cruise B997 along with Greenland margin surface samples from cruise BS1191 (grab samples) and HU93030 (boxcores). All samples were stained with Rose Bengal upon collection. Both stained and unstained individuals were use for this study due to a limited number of stained individuals in the samples. Three infaunal, benthic species: *Melonis barleeanus, Cassidulina neoteretis*, and *Islandiella norcrossi/helenae* were analyzed. Before analysis each sample went through a rigorous cleaning procedure established by Boyle and Keigwin (1985/1986) as modified by Boyle and Rosenthal (1996). This cleaning procedure requires a sample size of at least 0.175 mg. Arctic foraminifera are, in general, smaller than their tropical counterparts and therefore a larger number of individuals (60-100) is needed to obtain the required weight. One advantage of the larger number of individuals needed for each measurement is that we obtain a more consistent value for the Mg/Ca ratio of the sample.

All three species show Mg/Ca ratios comparable to other published values for benthic foraminifera (Lear et al., 2002). *M. barleeanus* shows the greatest temperature sensitivity, while both *C. neoteretis* and *I. nor/hel* show a slightly lower (but quite clear) sensitivity. Minor elements (Mg, Sr, Na) and trace-elements (Cd, Ba, La, Ce, Nd, Eu, Lu, U) were measured on an ICP-MS at the Univ. of California, Santa Barbara. Isotope analysis was done at the Leibniz Laboratory at Kiel Univ. Hydrographic data were collected during the respective cruises and supplemental data are archived at the Icelandic Marine Research Institute.

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Lear, C. H., Rosenthal, Y., and Slowey, N., 2002: Benthic foraminiferal Mg/Ca-paleothermometry: A revised core-top calibration. *Geochimica et Cosmochimica Acta*, 66: 3375-3387.

Late Quaternary marine environments NW off Iceland: Evidence from foraminiferal data and stable oxygen isotope analyses.

Sædís Ólafsdóttir[1], Áslaug Geirsdóttir[1], Anne E. Jennings[2], John T. Andrews[2], Gudrún Helgadottir[3].

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[3]Marine Research Institute

Core MD99-2264 was collected in 1999 during the IMAGES cruise on the Marion Dufresne from the Djúpáll trough, NW Iceland shelf. Presently, the Northwest shelf of Iceland is a boundary region for the oceanographic Polar Front, where surface water masses from the warm and saline Irminger Current (>4°C; S>35) passes the cold East Greenland Current (<0°C;S<34). Past changes of the Polar Front are registered in our records.
The core is 38 m long and extends back to 33,000 ^{14}C BP. We use grain size, IRD (>2 mm clasts), lithofacies, benthic foraminiferal assemblages and stable isotope measurements in order to reconstruct paleocurrents, sea-ice cover and climatic variations. The study focuses on the deglaciation period around 15,000 to 10,000 cal. years BP. The chronology is based on 12 AMS ^{14}C datings and two tephra markers (Jóhannsdóttir et al, this volume). Sedimentation rate during this time period varies from 12 mm/year (warmer periods) to 3 mm/year (cooler periods). The foraminiferal assemblages record has therefore an extremely high resolution, sampled every 20 years throughout the period.
Our research questions are directed towards 1) determining the income and strength of the Atlantic Irminger Current from LGM towards modern conditions. 2) determining the proximity of the local glacier to the study site, and 3) to compare our records to results from other study sites in the Nordic Seas.
Preliminary results suggest the income of the Atlantic water mass during the Bølling interval with the presence of the Atlantic species *Cassidulina laevigata*, *Stainforthia fusiformis* and *Trifarina angulosa* around 14,100 cal yr BP. At that time IRD was low and totally absent around 14,500 – 14,300 cal yr BP. Other key species suggest marked environmental change after 13,800 cal. yr. BP. This section contains glacimarine sediments with a dominating Arctic fauna of *Cassidulina reniforme* and *Elphidium excavata* f. *clavata*. The species *Cibicides lobatulus* and *Astrononion gallowayi* also increase considerably indicating stronger bottom current conditions. The appearance of IRD and the cold Arctic fauna suggest readvance of the NW Ice Cap well out into Isafjardardjup during the Younger Dryas chron. Around 10,800 cal. yr BP a gradual change in faunal composition and rise in diversity is recorded. The IRD diminishes and disappears along with increase of Atlantic indicators suggesting that the Irminger Current was traversing the NW shelf at that time.
Stable isotopes measurements on the benthic foraminifera species *C. reniforme* is in progress and will add valuable information to the interpretation.

Snorri Drift - A 200k yr oceanographic and sedimentary record

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Preliminary investigations of an 18 meter core collected from the Iceland slope south of Denmark Strait reveal a coherent record reaching back to oxygen isotope stage 7. The core provides a rare opportunity to study the environmental and oceanographic conditions just south of Denmark Strait over the last 200k years. Oxygen isotope data, sedimentological analyses, and grain counts provide the data to interpret climatic shifts as well as changes in the strength and direction of the bottom currents.
Core MD99-2323 was collected in 1062 meters water depth from Snorri Drift, which is one of the northern North Atlantic drifts. The chronology of the core is based on radiocarbon dates, tephrachronology and an oxygen isotope curve derived from the planktic foram, Neogloboquadrina pachyderma sinistral. The 18 core shows a widely varying lithology with the interglacial intervals consisting of mostly muddy sand with few clasts and some laminations. Within the interstadials are abrupt coolings, which are marked by darker gray, clast rich units. Sediment from stages 1, 3 and 5 have distinct lithologic and mineral characteristics. Stage 3 and 5 being much more variable than stage 1. Interstadial sediment of stage 1 contain muddy sand with some clasts and laminations. Grain counts reveal that sediments from stage 1 have a distinctly Icelandic origin. Although no basalt is present, the sediment contains abundant amounts of basaltic and rhyolitic ash grains. There are minor amounts of quartz and forams. Sediments from stage 3, on the other hand, contain units of finer, laminated, muddy sand with few clasts (similar to stage 1 sediments), which alternate with darker pebble and clast rich units, which represent the abrupt coolings. Grain counts reveal minor amounts of basalt and rose quartz, fewer forams, and significantly less tephra, except in the primary ash zone II deposit. The darker, coarser units are characterized by increased amounts of quartz and basalt. The sediments of stage 5 are quite distinct from the more recent interstadials. The lithology is a weakly laminated foram rich, well sorted muddy sand. In general there are no clasts and the interval is finer than in the rest if the core. The grain are dominated by planktic forams with less than 3% basalt, variable amounts of quartz. In general, there is no obvious Icelandic contribution to this interval.
The stadials are characterized by pebble and clast rich, dark grey, stiff layers. Many of these intervals are punctuated by lighter, softer, finer sandier units which represent warmings within the stadials. The grain counts from stage 2 sediments show an increase in basalt, grey lithic fragments, and rose quartz relative to the surrounding interstadiials, as well as an increase in quartz. There are fewer planktic forams and an equal amount of basaltic glass grains. The lithology and grain counts of stage 4 are quite similar to those of stage 2, except, there is a lesser amount of basaltic glass grains and an increase in plantik forams.
As the climate shifts from interglaicals to glacial stages there are accompanying changes in lithology, sediment source and grain sizes as recorded at this drift site. As the climate cools the sediment carried to this site shows increasing quantities of quartz, grey lithic fragments, and basalt and decreasing abundances of planktic forams indicating a change to a more distal source (not Icelandic). This change in sediment provenance suggests a shift in the bottom current's direction.

Absence of Hudson Strait Provenance of Ice Rafted Detritus in Stage 6 from core V28-82

Greg Downing, Sidney Hemming, & Dennis Kent

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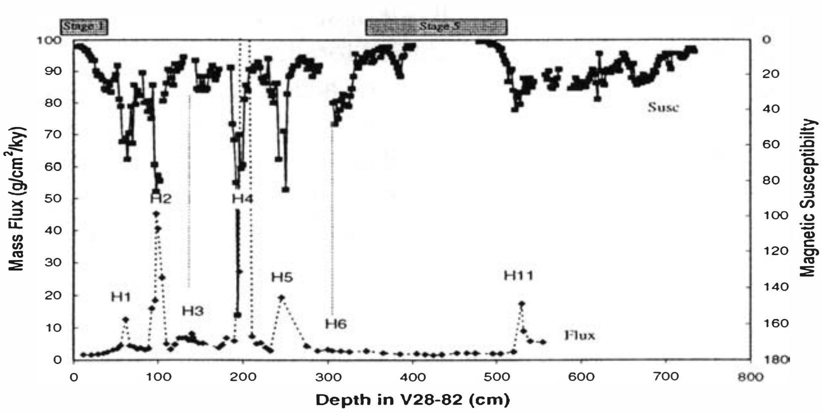
Core V28-82 in the eastern North Atlantic (49° 27' N, 22° 16' W) is located in the heart of Ruddiman's IRD belt (Ruddiman, 1977, GSAB, v. 88, p.1813-27) and has prominent Heinrich layers. Magnetic susceptibility measurements taken on V28-82 show that the background susceptibility of the last glacial interval is uniformly higher than that of the stage 5 interglacial (see the Fig.). In addition, distinct peaks for H1, H2, H4, and H5 are present, consistent with published data from other cores in the IRD belt (Grousset et al., 1993, Paleoceanography, v. 8, p. 175-92), and most likely represent a Hudson Strait source. Stage 6 also has similarly high background susceptibility compared to the last glacial interval. However, no distinct peaks exist, including at H11 (Termination II). Flux measurements (McManus et al. 1998, EPSL, v. 155, p. 29-43) show that there is, however, an IRD flux peak at H11 (see the Fig.). The susceptibility measurements indicate that this IRD must have a different provenance from H1, H2, H4, and H5. Pb isotope measurements reported by Gwiazda et al. (1996. Paleoceanography, v. 11, p. 371-78) suggest H11 is similar to H3, in that the compositions of Pb in feldspar are like those of the background glacial sediment. Ar ages from hornblende grains show a structure similar to H1, with Paleozoic and Mesoproterozoic grains being dominant leading up to the flux peak, and Paleoproterozoic grains being dominant in the heart of and following the peak. Additional counting and isotopic measurements are currently being taken across H11 and should aid in the comparison with the Heinrich layers of the last glacial interval. The lack of a strong Hudson Strait signal in H11 suggests that either a Hudson Strait ice stream was not operating during Stage 6, or that one was operating but was not as effective in diluting the sediment provenance in the eastern IRD belt. Measurements from the western part of the IRD belt appear to indicate the absence of a Hudson Strait ice stream in Stage 6.



^{40}Ar/^{39}Ar evidence for provenance of ice-rafted hornblende grains from ODP site 984

Sidney Hemming[1], Greg Downing[1], & Jerry McManus[2]

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Core ODP-984 in the North Atlantic (61°26'N, 24°05'W) is located outside of the ice rafted detritus (IRD) belt, and on the Bjorn drift deposit southeast of Iceland. The average sedimentation rate is 11.5 cm/ky (Channell et al., 2002, JGR 107(B6) #2114). We have measured the ^{40}Ar/^{39}Ar ages of multiple individual hornblende grains from the >150 μm fraction from several of the more prominent IRD intervals from Marine Isotope Stages 2, 6, 8, and 10. Most of the samples have a large ca. 1 Ga population of ages, consistent with derivation from the Grenville province. The youngest sample analyzed is from approximately Termination I (~H1). H1 in the IRD belt has no evidence of a substantial Grenville population, and thus it is unlikely that the Grenville province of North America (e.g., Gulf of St. Lawrence) is the source of these hornblendes. Analyses from hornblendes sampled from cores east of Greenland (and north of the Denmark Strait) and from the Bear Island trough mouth fan and mid-Norwegian margin (Hemming et al., 2002, QI, 95-96, p. 75-85) has revealed no Grenville-age grains. The southern part of Norway has a large Grenville province, and is the northern side of the passage leading to the North Sea trough mouth fan. We consider it likely that the Grenville grains were derived from this province via ice streams feeding the North Sea trough mouth fan. In addition to the ca. 1 Ga population, there are Paleozoic (~400-600 Ma), Paleoproterozoic (~1.6-1.8 Ga), and some very young (<50 Ma: Iceland hotspot) grains. Analyses of hornblendes from samples of the North Sea trough mouth fan would help to constrain the sources of hornblendes in ODP 984.

Late glacial and Holocene paleoceanography of the van Mijenfjord, Spitsbergen

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An 18 meter long sediment core, MD99-2305, retrieved by the IMAGES cruise in 1999, , has been investigated for paleoceanographic proxies. Van Mijenfjord is 50 km long and 10 km wide with three tide water glaciers and a sill in the outer part. The fjord is normally covered by sea-ice 8-9 months per year. The core is located in the outer part of the fjord, about 10 km in fjord from Akseløya at 115 meter water depth. The uppermost 16 m of the core contains a Holocene mud, and the lowermost 2 m consist of glaciomarine muds and diamictons, the latter interpreted to be a basal till. A total of 10 radiocarbon dates have been obtained and an age model in calendar years BP have been produced. The boundary between till and glaciomarine sediments is dated to c. 11 000 cal. years BP, (corresponding to 9800 ^{14}C years BP). The glaciomarine sediments and Holocene mud represent the last 11 000 cal. years BP. A proxy record of this part of the stratigraphy, including benthic foraminifera, IRD counts from X-radiographs and stable oxygen and carbon isotopes, has been established. The Younger Dryas/Preboreal transition is characterized by a marked depletion in both $\delta^{18}O$ and $\delta^{13}C$ (measured on the benthic foraminiferal species *Cassidulina reniforme*). The structure of the $\delta^{18}O$ is similar to that of the IRD curve. Relatively low $\delta^{18}O$ corresponds to a minimum in IRD and a reduction in the ice proximal species *C. reniforme* and *Elphidium excavatum*. During this period there is a high flux of foraminifera and high content of bivalve mollusks. A broad maximum in both $\delta^{18}O$ and IRD is found between 7000 and 5000 cal years BP. During this period there is a rise in the ice proximal foraminifera. The last 4000 cal years BP is characterized by low IRD (except from one surge-event at 1300 AD), a depletion in $\delta^{18}O$, decline in bivalve mollusks and foraminiferal flux.

A preliminary interpretation suggest that early Holocene was a relatively warm, high-productive phase with reduced glacial activity. Mid Holocene (7000-5000 cal years BP) appears to have experienced increased glaciation and increased flux of $\delta^{18}O$, either due to increased oceanic flux or due to cooling. Upper Holocene probably reflects a more local fjord signal due to a progressing isolation resulting from the postglacial isostatic rebound of the fjord sill. The low IRD content the last 4000 cal. years BP may represent conditions similar to that of the modern fjord. The depletion in oxygen isotopes the last 4000 years BP may be due to increased sea ice formation bringing light isotopic water to the fjord bottom by brine formation.

Glacier proximal foraminifera in a meltwater dominated fjord of Svalbard: year-to-year change

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Subpolar glaciers reaching sea level produce turbid meltwater, which, being a powerful ecological-stress agent, structures foraminiferal assemblages into an off-glacier sequence along the gradient of mineral fallout. Such a sequence imprinted in the fossil record portrays a transition from glacier-proximal via glacier-distal to normal marine settings. The increasing attention to ultra-high resolution climatic archives has encouraged us to address the following question: How recurrent is the off-glacier sequence of foraminiferal assemblages on a year to decade timescale?

The study area, Tempelfjorden (tributary to Isfjorden, western Svalbard), 110 m water depth, has two coalescing large outlet glaciers calving into the fjordhead. The meltwater plume, measured in July 2002, had a typical structure. The highest concentrations of suspended matter (25 to 45 mg/l, consisting entirely of mineral particles) were observed in the surface layer within 200 m from the glacier front. The concentration decreased with water depth and away from the source. In the distal part of the plume (10 km from the source), surface concentrations were 5 to 20 mg/l. Beyond the plume (>15 km), concentrations reached typical offshore values of ca. 1 mg/l above the pycnocline and 0.1 mg/l below it, while the suspension largely consisted of organic particles.

A 25-km-long transect of 8 stations, first sampled in August 1995, revealed that the area affected by the turbid outflow was inhabited by a typical sequence of characteristic foraminiferal taxa. *Elphidium excavatum* and *Quinqueloculina stalkeri* were most proximal. Further away from the glacier, *Cassidulina reniforme* became dominant. The glacier-distal peaks were of *Nonionellina labradorica* and *Islandiella norcrossi*.

The second sampling along the same transect in August 2001, showed that all populations had retained their relative positions in the sequence, but absolute positions along the fjord had consistently changed. Four of the five species had moved ca. 2 km toward the fjordhead, following the receding glacier (except for *I. norcrossi*, which population had remained in the same place). Thus, (1) the sequence of foraminiferal populations, inhabiting meltwater dominated environments, is consistent over years, whereas (2) absolute distances are sensitive to fluctuations in glacial impact, which essentially is meltwater production.

Two very detailed clay mineral core records of Marine Isotope Stages 1-6 from the Eurasian Basin, Arctic Ocean

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The impact of sea-ice cover on the sedimentation of the Arctic Ocean is of particular interest as its large extent compared to its small thickness results in an extreme sensitivity to climatic change. Predominantly fine grained material is entrained in the shallow shelf regions (< 30 m water depth) and in particular in the polynyas where most sea-ice is formed. Newly produced sea-ice transports smectite-rich sediments from the Laptev and Kara Seas through the Southern Eurasian Basin of the Arctic Ocean. Northwest of Svalbard relatively warm Atlantic Water of the northward flowing Westspitsbergen Current (WSC) submerge at the Polar Front beneath the cold sea-ice covered Polar Water. The position of the Polar Front and the sea-ice edge depends on the strength of the WSC and the outflow of the Polar Water which is closely related to the freshwater input to the Arctic Ocean. Fine grained sediments, just released from melting sea-ice may be deposited on the sea-floor very close to the actual position of the marginal ice zone (MIZ) due biologically accelerated sedimentation. As sea-ice contains high amounts of smectite, bottom sediments derived from sea-ice should contain increased smectite contents.

In this presentation we will compare a sediment core close to the MIZ and the last glacial maximum Barents Sea Ice Sheet (PS2138, 6.31 m core length) with a sediment core from the western Gakkel Ridge (PS2206, 1.57 m). We sampled and analysed the grain size distribution and the clay fraction mineral content with the highest possible sample resolution (every cm). In both cores the age model is based on a rather complete stable isotope record and several AMS ^{14}C ages. Both cores reach the Marine Isotope Stage 6 to 5 transition, the Termination II. The very different core length already point to the very different sedimentation and sediment accumulation rates of the cores close to the MIZ and the LGM ice sheet (PS2138) and below the nearly permanent sea-ice cover in the central Eurasian Basin (PS2206). Nevertheless, very similar developments in the clay mineral records of both cores are observed pointing to a common transport mechanism of this tiny material for the whole Eurasian Basin. Changes of the clay mineral content related to the global interglacial to glacial changes as well as local influences will be illustrated in this presentation. Regarding clay mineralogy, the clay mineral group smectite is one of the best tracer in the Arctic Ocean, pointing to the large flood basalt region of the Putorana Plateau which is drained by the tributaries of the Khathanga (into the western Laptev Sea) and the Yenisey rivers (into the Kara Sea).

Arctic Gas Hydrate Provinces along the Western Svalbard Continental Margin

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In 2001, we devoted a high-resolution seismic survey within the framework of the HYDRATECH and INGGAS projects to the detailed study of the spatial distribution of gas hydrate and free gas accumulations West of Svalbard.

The seismic data from the first study area clearly illustrate the widespread occurrence of gas hydrates and free gas accumulations north of the Knipovich Ridge. A nearly-continuous polarity-reversed BSR is present on down-slope seismic profiles and can be traced across the NW-Svalbard slope from ~800 m to ~2300 m of water depths. In the absence of a distinct and/or continuous BSR, it is the sudden change in reflection amplitude and frequency content that marks the base of the hydrate zone that coincides here with the top of the free gas zone. Velocity analyses and modelling reveal high P-wave velocities above the BSR attributed to a gradually increase of partial hydrate saturation (6-10% of pore volume) and a sharp drop of acoustic velocity across the BSR due to free gas accumulation. The sub-bottom depth of the BSR closely matches the calculated stability limit for methane hydrates. The deep-water methane hydrate zone lies in an area characterised by mid-ocean ridge escarpments related to the northwards propagation of the Knipovich Ridge in its early stage. Tectonic activity related to incipient rifting and faulting may eventually result in changes in heat and fluid flow regime, gas composition and origin, and therefore control the hydrate and free gas accumulation and distribution on the continental slope off NW-Svalbard.

Data from the second study area located ~40 km east of the Knipovich Ridge off SW-Svalbard margin in water depths of ~2250 m are characterised by mud diapirism. The mud domes seem to rise from a seismically chaotic zone, buried under a 200 to 400 ms thick sediment drape. The mud diapirism is most pronounced in the southern part of this study area. Several bright spots developed on top of the domes within specific stratigraphic layers. These enhanced reflections are interpreted as the result of sediment mobilisation and subsequent changes in fluid flow patterns, leading to stratigraphically-controlled gas trapping within the local highs. We observe short reflections (~1 km long) with reversed polarity, obliquely crossing the stratigraphy. These reflections show all characteristics typical of a gas hydrate-free gas BSR and lie close to the theoretical methane hydrate limit. Therefore, they might indicate the local formation and accumulation of gas hydrates above gas-bearing sediments. The origin and the extent of diapirism is unclear, but lies most probably in a combination of overpressured gas, continuous loading of clay-rich sediments, and neotectonic activity of the Knipovich Ridge.

Reconstruction of recent and late Holocene sedimentation processes on the continental shelf west off Spitzbergen

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48 marine surface sediment samples from west off Spitzbergen and the Barents Sea have been analysed for TOC, $CaCO_3$, N_{tot}, N_{org}, N_{bnd}, $\partial^{13}C_{org}$, $\partial^{15}N_{tot}$, $\partial^{15}N_{org}$, and parameters from Rock-Eval-pyrolysis as well as for clay mineral assemblages (XRD) with focus on organic carbon origin and distribution to yield an up to date picture of recent sedimentation pattern. ROV-pictures have been used to support interpretation of the results. Three short cores of Storfjorden (dated by ^{14}C and ^{210}Pb) were analysed similarly to reveal environmental changes during the last ~150 years.
Coarse grained surface sediments from outer shelf areas are considered to represent erosional surfaces formed by contour currents. Thus nearby palaeo IRD-signals do not necessarily reflect recent ice rafting rather than out-washing of soft Holocene sediments since the onset of the contour current most probable during neoglaciation ~2,6 Ky BP (Andruleit et al., 1996). Low carbonate contents in fjord environments and their submarine extensions to the shelf break are interpreted as a result of dissolution presumably due to brine formation in these environments. Erosional channels in the soft substrates as seen by ROV pictures are probably caused by dense brines flushing the shelf (e.g. Quadfasel et al., 1988) and may be related to extraordinary high sedimentation rates recorded by Honjo et al. (1988).
Organic matter from surface sediments exhibits highest TOC/N_{org} ratios and lowest $\partial^{13}C_{org}$ values at inner fjords while strong gradients exist towards more open marine conditions. Decreasing maturity of organic matter (Rock-Eval pyrolysis) from land to sea support these results. Based on a $\partial^{13}C_{org}$ binary mixing model, organic matter of the inner fjords is dominated by the terrigenous portion while more open marine sites display minor or even no terrestrial contribution. Spots dominated by marine productivity have been found at the outer Isfjorden, west off Prins Karls Forland as well as off the Kongsfjorden/ Krossfjorden area and may reflect local upwelling in concert with geologic hinterland conditions at this locations (Svendsen et al., 2002).
Accumulation rates of marine organic carbon as well as reconstructed primary productivities decreased since the early 1960ies. Negative correlation of the Isfjord temperature record with reconstructed productivities of core 1244 could be explained by a reduced annual duration of the marginal ice zone in the area.

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The Holocene foraminiferal assemblages of Kara and Barents seas: paleoceanographic implications

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Spatial and temporal variations in the Holocene benthic foraminiferal assemblages were studied in six sediment cores from Kara and Barents seas. Three cores were retrieved by R/v's "Polarstern" and "Boris Petrov" from eastern part of the Kara Sea (Core PS-2718-6, Vilkitsky Strait, w.d. 153 m, Core BP01-62/4 and Core BP00-07/5, Siberian shelf, northward of the Yenisei estuary, w.d. 120 and 43 m respectively). Three cores were obtained by R/V "Akademik Sergey Vavilov" at similar water depths from northern (Core ASV 880, Franz Victoria Trough, 388 m) and central (Core ASV 858 and ASV 1200, Central Basin, 312 m and 308 m) parts of the Barents Sea. AMS-14C dates obtained within the framework of Russian-French and Russian-German projects provide the calendar scales for all six cores (Levitan et al., 2000; Duplessy et al., 2001; Ivanova et al., 2002; Simstich et al., in preparation). Common arctic species *Cassidulina reniformis* and *Elphidium excavatum* forma *clavata* strongly dominate throughout the Holocene record in 5 of 6 cores, except for the shallowest Core BP00-07/5. The latter record demonstrates the highest species diversity resulting from the vicinity of marine to river waters mixing zone. In the Kara Sea, two northern cores show the similar Early Holocene trend of increasing percentage of rather stenohaline calcareous species (*C. reniforme, Nonion labradoricum*, *Islandiella* spp.) preferring normal marine salinity whereas in the southern Core BP00-07/5 a group of species (*E. asklundi/incertum, Haynesina orbiculare, E. groenlandicum* and *E. bartletti*) thrieving the lower salinity predominates over the "marine" calcareous species from 7 to 1.6 cal. ka BP.."Marine species" becomes more common later on. This pattern points to the Atlantic water penetration in the Eastern Kara Sea in the Early Holocene, likely from ~11 to 7 cal. ka BP.. About 7 cal. ka BP. the mixing zone moved northward which allows to suppose an increase in river discharge. However, mixing zone did not reach 76°N as follows from the strong dominance of "marine species" during the Holocene in the northern Core BP01-62/4. Suggested Atlantic water input from the north in the Early Holocene is consistent with our oxygen isotope and benthic foraminiferal data on Core ASV 880 from Franz Victoria Trough (Duplessy et al., 2001) as well as with published data on Saint Anna Trough (Hald et al., 1999), and Laptev Sea (Boucsein et al., 2000). The Holocene optimum, 7.8-6.9 cal. ka BP., established in Franz Victoria Trough (Duplessy et al., 2001) is characterized by the assemblages with enhanced value of *Islandiella* spp. as a respond to sea-ice margin retreat to the north at least during summers and/or longer ice-free season. However, foraminiferal assemblages in three studied cores from the North-Eastern Barents Sea don't demonstrate higher values of so-called "Atlantic species" (like *Cassidulina teretis*), or planktic foraminifera. In the Late Holocene, an increased percentage of opportunistic *E.clavatum* points to more stressed bottom environments.

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Arctic Coast Erosion: A Regional to Local Perspective

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High-latitude coasts are susceptible to increases in global temperatures, through extending the periods of ice thaw and reduction in summer sea-ice extent, thereby creating greater wave exposure. One consequence is increased coastal erosion (Solomon et al., 1994). Reduction in the ice season, combined with a shrinking and thinning of the Arctic sea-ice cover (Rothrock et al., 1999; Serreze et al., 2000), is contributing to Alaskan and Siberian coastline retreat at rates of meters per year (Are, 1999). Paradoxically, sediment transport by ice is likely to increase along with more frequent and stronger storms (Proshutinsky et al. 1999; Stierle and Eicken, 2002). The increase in coastal erosion will be offset locally, around the mouths of Arctic Rivers that are expected to deliver ever more sediment with warming of the hinterland (Syvitski, 2002). Along with these structural impacts, sea level rise continues, with the largest contribution (80%) to Arctic Ocean sea level rise (≈5mm/yr) coming from melt of ice fields.

Arctic coastal communities depend on access to the sea and to sea ice, but are vulnerable to flooding and erosion. To examine the combined impact of climate change at the local scale, a variety of approaches are used to assess the history and risk of erosion and flooding along the Chukchi Sea coast near Barrow, Alaska (www.colorado.edu/Research/HARC). The study utilizes field measurements, digital imagery, GIS, and numerical modeling to quantify past processes and rates, as well as possible future scenarios of variable conditions and changing environment. Shoreline and nearshore bluff erosion rates are observed to be spatially variable, averaging 21m per 50yr, and 26m per 50yr, respectively. These erosion rates are about 50% smaller than rates calculated for ice-rich, peaty shorelines, east of Barrow (Brown et al., 2002). Several mitigation strategies for slowing shore currents and associated sediment transport were investigated using the Delft3D hydrodynamic modeling system. Simulations suggest that a well-placed groin, or a sunken barge, could reduce flow velocities by >10%. Scenario modeling continues in an effort to predict the coastal impact from a series of 100-yr ocean storms.

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Migration heavy metals in ore deposite-rever-sea system (Novaya Zemlya Archipelago).

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Annually the great amount of suspended and dissolved material (including toxic elements and heavy metals) enters Barents and Kara seas. The Novaya Zemlya Archipelago (NZ) is among the most important source provinces of West Arctic shelf (WAS). Among the largest is Pavlovskoye (Bezymyannoe) lead-zinc deposit (POF), involving several deposits and ore occurrences of Pb, Zn and Cu (Kalenich, Kryukov, Semenov, 1998). Seasonal and climate changes provoke erosion of ore bodies thus much increasing amounts of heavy metals supplied to the environment of the Novaya Zemlya Shelf. The studies carried out within the littoral zone by MAGE, PMGRE and VNIIOkeangeologia in 1991-2002 revealed high and abnormal concentrations of toxic elements in water, suspended matter and bottom sediments. In this connection, detailed geochemical works have been initiated in order to assess the impact by a natural exogenic source. The main ore bodies are located on the left shore of the Bezymyannaya River. They are crossed by permanent deeply incised tributaries (creeks: Vetvisty, Rzhavy, Pryamoy). Seasonal streams and swamped stagnant-water sites are also present within the area.

Studies carried out by PMGRE in 1994-2001 in the shelf area adjacent to the deposit have formed the base for assessment in-flow of toxic elements deep in offshore NZ. The main ore bodies are located in the left coast of Bezymyannaya river, forming the source exposures in its border in the southern part. They are crossed by permanent deeply incised tributaries (streams Diabasovy, Vetvisty, Rzhavy). Moreover, there are seasonal currents and swamped sections of standing water over the area. The Bezymyannaya River, its tributaries and lagoon separated from the inlet by a sand bar and the Bezymyannaya Inlet have been investigated. The POF area (Rzhavy Creek) was studied in detail. HM (Pb, Zn, Cu, Cd) in water column were analyzed by inversion voltmeter-ammeter method (IVA-1M device).

The Bezymyannaya Inlet is supplied with 29, 8,7, 1,9 and about 0,1 tons of Zn, Pb, Cu and Cd, respectively per annum suggesting the profound importance of the Barents Sea ecosystem in the geochemical respect. We can state that the volume of HM supplied from the natural source is incommensurable with that disposed into the marine environment from industrial technogenic sources. The POF is a powerful source of HM supplied to the Bezymyannaya River ecosystem. It provides a hydrogeochemical background two orders exceeding maximum permissible concentrations (MPC) in streams draining the deposit and four times exceeding MPC in the undercurrent of the Bezymyannaya River. Moreover, within some stagnant-water sites, metalliferous solutions with huge concentrations generate above ore bodies. High concentrations of Cu and Cd are typical of sub- and superpermafrost waters in this region. No abrupt spasmodic change in concentrations of toxic elements has been recorded at the river-sea barrier. The frontier of this barrier zone is most likely located west of the Lebed' Island.

The role of sea ice for long-range transport of radioactive pollution – field observations in the Fram Strait and in a Svalbard fjord

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The isotope caesium-137 (^{137}Cs) in the Arctic environment originates from long range transport from various sources such as the fallout from nuclear test explosions during the 1950s and 60s and the Chernobyl accident, and discharges from nuclear reprocessing plants and other nuclear installations. Levels are typically very low in the environment far away from sources, and therefore large sample volumes are required for doing analyses. Accordingly, little data exist on sea ice, due to difficult and time-consuming sampling procedures. A small number of measurements of the levels of the gamma radiation emitting ^{137}Cs radionuclide in multi-year sea ice from the Fram Strait at about 79 °N and seasonal fast ice in Kongsfjorden (Svalbard) was performed in order to improve the understanding of the role of sea ice in long-range transport of radioactive pollutants, and to understand how varying sea ice properties could affect this transport. For the Svalbard location, a closer relation between fast ice and fjord water can be expected, since the ice is not drifting. The samples from the Fram Strait were taken from multi-year ice, and back-trajectory calculations with the help of remote sensing and buoy data show potential source areas in the area of the Laptev Sea, especially from its western part. For low-level samples as investigated here, the gamma measurement method (gamma spectroscopy), requires approximately 200 litres of water per sample, i.e. the corresponding amount of sea ice. Ice was obtained by coring with a mechanical drill, and water was sampled by pumps or by means of a bucket. Samples were prefiltered and pumped through a sorbent filter system. The filters were ashed and measured on a high-purity Germanium detector for gamma radiation. The results from Kongsfjorden showed relatively low ^{137}Cs levels both in sea water and in melted sea ice. More interesting, the ratio between the two levels was agreeing well with the ratio of bulk salinities in both media. This would confirm that the ^{137}Cs radionuclides stay with the brine during ice formation and are not otherwise incorporated in the ice's matrix. Gamma measurements from multi-year ice in the Fram Strait were then used to calculate sea water levels for ^{137}Cs during ice formation. Tests with measurements of technetium-99 (^{99}Tc), another radionuclide, and measurements of sediments from the sea ice surface and the sea floor will be presented along with the ^{137}Cs results.

Evidence of a high sea level event during the last ice age in the Arkhangelsk area, NW Russia

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Raised marine deposits are found below till at several localities along the Barents- and White Sea coast, NW Russia. Stratigraphically these deposits are placed above Eemian marine deposits, indicating a separate, later transgression in the area. The Arkhangelsk area experienced a complex glaciation history during the last ice age (the Weichselian), where first a terrestrially based ice sheet from the east, later the marine based ice sheet from the Barents – Kara Sea and finally the Scandinavian ice sheet reached the area. The marine unit is placed stratigraphically between two advances of the Barents – Kara Sea ice sheet. The deposits are dated by means of OSL, and several dates from all localities give consistent ages around 60 ka BP, suggesting a Middle Weichselian age for the transgression. Weichselian marine deposits are rarely reported from northern Russia and the deposits from the Arkhangelsk area are the first stratigraphically well-constrained evidence of a Weichselian marine transgression in NW Russia.

The marine unit comprises facies from four depositional environments: offshore mud, estuary mouth, estuary flank and inner estuarine tidal deposits. Most localities are dominated by tidal deposits including extremely well-preserved tidal rhythmites. At one locality a continuous succession from distal marine to proximal brackish deposits is preserved. The marine mud contains a sparse *Yoldiella intermedia* fauna, indicative of cold, but not glaciomarine conditions. The tidal deposits contain a low diverse *Macoma calcarea* fauna composed of shells brought in from nearby habitats, indicating arctic conditions, somewhat colder than the present but not high arctic.

The well-preserved tidal rhythmites comprise alternating spring and neap tidal deposits. These provide a high-resolution tool for estimates of sedimentation rate. A very high sedimentation rate of up to 60 cm/ month is suggested from a 10 m thick aggradational succession. This indicates deposition during rapidly rising sea level. Marine mud and forced regressive estuary mouth deposits below aggrading tidal deposits suggest a complex transgressive – regressive – transgressive sea level history.

The isostatic component of sea level change provides additional constraints on the glaciation history of the area. Assuming a tidal range similar to the present, the relative sea level during deposition was at least 25 m above present. At 60 ka BP eustatic sea level was approximately 90 m below present. The occurrence of marine deposits from this time 25 m above sea level indicates substantial isostatic subsidence, and the demise of a significant ice sheet before this time.

Holocene temperature and moisture reconstructions for the southern Yukon Territory, Canada: oxygen isotope studies of small carbonate lakes

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Oxygen isotope and lake-level data from the sediment cores of three geographically proximal lakes are used to reconstruct changes in regional Holocene climate. The combined results are an unprecedented separation of the effects of temperature and moisture on the $\partial^{18}O$ signal through time that provide new opportunities for evaluating environmental response. Each of the three lakes is a depressed kettle basin. They are situated in late Quaternary carbonaceous till and outwash deposits of the southern Yukon in the semi-arid rain-shadow of the St. Elias Mountains. The proximity of the lakes to the St. Elias Range allows insight into the record of late Holocene glacial history in addition to regional paleoecological change. The three lakes are representative examples of hydrologically closed, intermediate and open lake-systems. Sedimentation rates for all three sites are relatively high. The 0.5 to 2.0-cm sampling interval for $\partial^{18}O$ analyses are equivalent to a time resolution of 10 to 20 years. Chronologies are constrained by ^{210}Pb dating, the White River volcanic ash, and radiocarbon ages of terrestrial macrofossils.

Jellybean Lake (60.351 °N, 134.805 °W) is hydrologically open, with modern lake-water $\partial^{18}O$ values similar to regional rivers, spring-waters and precipitation (-21‰). We propose that Jellybean Lake sediment-core $\partial^{18}O$ values reflect input waters that are controlled by changes in ambient temperature and/or moisture source regions. Sediment-core $\partial^{18}O$ values range from –18.5‰ to –21‰. Marcella Lake (60.074 °N, 133.898 °W) is hydrologically closed, so that most, if not all of the outflow is via evaporation. Modern Lake water $\partial^{18}O$ in Marcella is –8‰ and sediment-core $\partial^{18}O$ values range from –7.5 to –13‰. Changes in Marcella (closed) sediment-core $\partial^{18}O$ values are controlled by changes in relative humidity, which governs evaporation rates, and changes of the input water $\partial^{18}O$ (precipitation). We correct Marcella (closed) data with Jellybean (open) data to calculate isotopic enrichment in Marcella due solely to changes in relative humidity. In addition to the Marcella $\partial^{18}O$ data, sedimentological analyses of sediment cores from shallow to deep water-depths indicate that the lake-level has fluctuated >4 m between the early and middle Holocene, providing stratigraphic evidence that the lake is highly sensitive to changes in moisture. A synthesis of the results provides a glimpse of complex climate change and a basis for evaluating environmental response.

Global warming in the Arctic: What about northern Québec and Labrador?

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The predicted amplification of the effects of global warming at high latitudes makes it important to understand the potential response of the circumpolar region and its abundant freshwater ecosystems to global climate change. To explore the potential responses of northern lakes to climate change and to place instrumental temperature records into a longer-term perspective, we studied the fossil diatom, chironomid, pollen and macrofossil records preserved in the sediments of 15 lakes distributed throughout northern Québec and Labrador. Diatom stratigraphic sequences and diatom-inferred patterns of limnological change since basin formation following the retreat of ice sheets and post-glacial marine waters revealed Holocene lake trajectories that are closely associated with successional shifts in lake catchment vegetation and soils. The main trends observed in all reconstructed lake histories are: (1) a progressive loss of alkalinity over time; (2) abrupt increases in dissolved organic matter (DOC) and water colour that coincide with the arrival of conifer trees; and (3) subsequent shifts that are closely correlated with the export of organic matter to recipient lakes. In terms of paleoclimate, our chironomid-based reconstructions of surface water temperatures together with the diatom records provide evidence for relatively stable climatic conditions or slight cooling over recent decades and centuries in eastern subarctic Canada, up until the present-day. This climatic scenario is in sharp contrast with records of climate warming as inferred from other paleolimnological studies conducted in northwestern Canada and Alaska, yet it is consistent with decadal observational data that reveal pronounced climatic cooling over the western subpolar North Atlantic and adjoining land areas of eastern Canada.

Mapping lichen in the caribou summer range of northern Quebec, Canada, using Landsat TM imagery

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The George River caribou herd increased from about 5,000 in the 1950s to about 700,000 heads in the 1990s. This has led to an over-utilization of the summer habitat, resulting in a strong degradation of the vegetation cover. This degradation has had a direct impact on health problems observed in the caribou population over the last few years and has also likely contributed to the recent decline of the George River herd which has been observed in a recent survey (440,000 heads in 2000-2001). Lichen habitats are a good indicator of caribou herd activity because of their sensitivity to overgrazing and overtrampling, their widespread distribution over northern territories, and their influence on herd nutrition. The study area is located in the northeast Quebec-Labrador peninsula (Canada). It covers a very large territory which is not easily accessible (Fig. 1). As a result, field studies over the whole territory are limited and aerial surveys cannot be conducted frequently. Satellite remote sensing offers the synoptic view and temporal resolution necessary for mapping and monitoring caribou habitats.

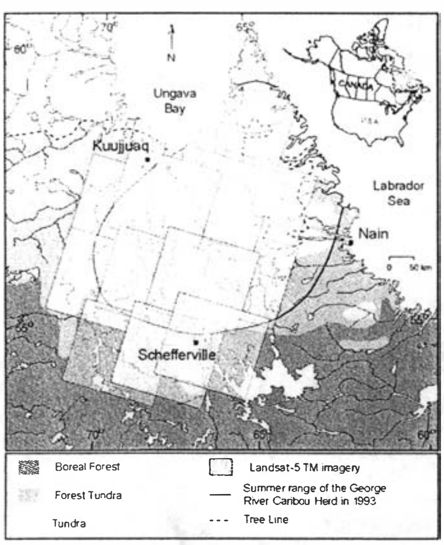

Figure 1. Study area

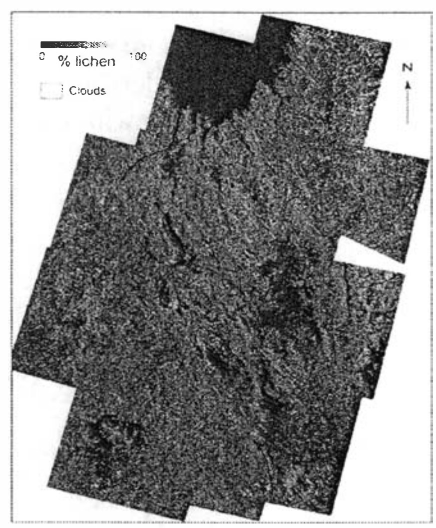

Figure 2. Lichen map

In this paper, we present a new approach for the detection and mapping of lichen in a heterogeneous habitat of northern Quebec. The method is based on spectral mixture analysis (SMA). SMA is based on the concept that each pixel contains different surface elements which contribute to the pixel value detected by the remote sensing instrument. SMA quantifies the contribution of each of these elements to the pixel value and retrieves proportions inside each pixel. When applied over the entire study area, consisting of a mosaic of thirteen Landsat TM images (Fig. 1), a map is produced showing the lichen fraction for each pixel (Fig. 2). These results provide additional and more detailed information than the more traditional image classification methods. This new approach presents a good potential for monitoring lichen covers over large areas and for change detection studies.

Pollen record of air trajectories in the Arctic

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Tracing modern atmosphere dynamics is important to constrain models used for past climate reconstruction. The main types of tracers of arctic air masses are chemical and show different patterns. Dust in the ice at the summit of the Greenland ice cap has been shown, through isotope analyses, to have originated from Chinese deserts, mostly the Takla Makan and Gobi. Conversely, the chemical composition of the aerosols reaching the summit of the ice cap associated with backward air masses trajectories points to source areas in North America, Europe and Asia. A total of four pollen traps have been displayed on both coasts of Greenland during the last two years in order to assess long distance transport in the Arctic domain and to identify potential vegetation source areas (EPILOBE Project) associated with air mass pathways.

° Another pollen trap was installed on the sea ice during the ice-sea drift expedition from North Pole of French explorer Dr. Jean-Louis Etienne. Until now the use of pollen as an air mass tracer had not yet been investigated. Here we show that first evidence pollen represents a biological alternative to understand both present and past air mass dynamics in the Arctic and its associated relationship with biosphere changes. Examples are taken from the Greenland Southern-West coast and from North Pole.

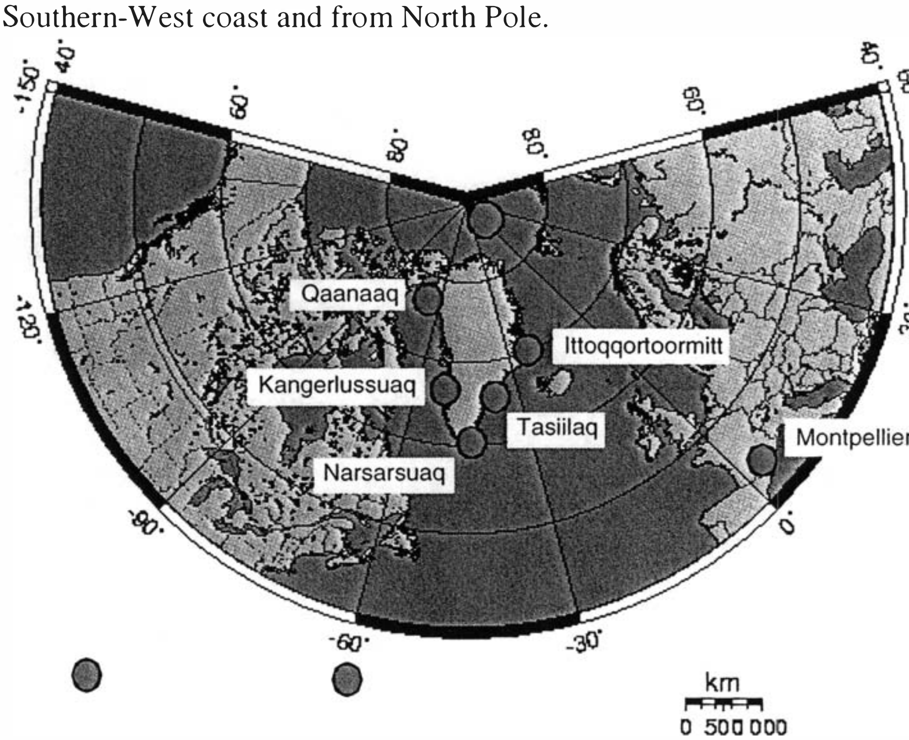

Fig. 1
Location of the pollen traps on the Epilobe network and during the "Banquise 2002 expedition"

Monitoring Weathering Processes and Rock Fall Activity in an Arctic Environment, Longyearbyen, Svalbard

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A rockwall constituted of sandstone and shale has been monitored on an all year-around basis since the Summer 2001 in order to better understand the relationship between rock temperature, rock moisture content, weathering evolution and rock fall occurrence in a high latitude environment (Longyearbyen, 78° 13' N).
The rockwall temperature is monitored at depths of 40 cm, 10 cm, 1 cm and at the rock surface. The rockwall is experiencing numerous and sometimes considerable temperature fluctuations, even during the polar winter. Nevertheless, rock surface temperature crosses the zero degree threshold only in the fall and in the spring; it gets very close to zero degree several times during the polar winter, due to milder weather conditions. The amplitude of temperature variations decreases from the surface downwards due to thermal flow dampening. At 40 cm deep, the rock freezes once in the fall and remains frozen.
Rock moisture content is monitored by daily weighing exposed rock tablets; it undergoes large and quick variations linked to weather conditions during the fall and spring. The winter is characterized by a progressive drying of the rock, linked to sublimation. Rocks rarely reach high saturation values, and when it is the case, this happens in the fall and in the spring. Therefore, conditions favourable to cryogenic weathering (i.e. freezing of the rock when its moisture content is high) are met only rarely. But when these conditions are met, frost action can be very aggressive, because of the high rock moisture content, the quick cooling or the extended duration of freezing periods.
A regular evaluation of rock weathering (before cracking, weight loss or any other visible change) is assessed for rock specimens exposed to the natural environment using as a criteria the variations of their dynamic Young's modulus. These measurements are aimed at evaluating how long an exposure to the Svalbard environment has to be for the weathering process to be initiated and how fast this decay will progress. The aggressivity of the environment on the weathering point of view is proven by the decrease in Young's modulus of 4 out of 5 porous limestone tablets after the first five months of exposure (Sept. 2001- January 2002) at the study site. A similar exposure did not cause any decrease in the Young's modulus of 5 samples of the local sandstone. Frost action does not act through the porous media of this poorly porous sandstone, but by wedging of its wide opened and well-developed crack system. Cryogenic weathering is thought to act on this rockwall by wedging.
Rock fall activity is evaluated using sediment traps and checking the decay evolution of painted squares on the rockwall. Five sediment traps are set at the base of the rockwall and collect the falling rock debris. These traps are 1.25 to 3.50 meters long and collected debris coming from rockwall portion estimated to be between 31 and 88 m^2 in surface. They are emptied about 4 times a week and the collected debris are sieved at 2 mm, dried and weight. Rock fall occurrence shows a very irregular distribution, with maximums in autumn and spring. The largest rock fall events happened on days when cryogenic weathering conditions were met. These measurements allow the assessment of rockwall retreat rates.

Climate change impact on hydrological processes in the sub-arctic Tana Basin in Northern Fennoscandia

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Hydrology plays an important role in arctic and sub-arctic ecosystems. The length of the growing season for example, depends on the moment of snow cover depletion in spring. In summer, the amount of water that is available to plants is partly controlled by evaporation. Being dependent on temperature as well as precipitation, hydrological processes such as snowmelt and evapotranspiration may be highly sensitive to changes in climate, such as those predicted for the coming century due to the enhanced greenhouse effect. In this study, the impact of climate change on hydrological processes was analysed in detail for the sub-arctic Tana River Basin, in northernmost Finland and Norway. For this purpose, a conceptual water balance model (Dankers, 2002), that uses physically-based descriptions of snowmelt and evaporation, was coupled to a regional climate model (RCM). Unlike most other hydrological models, the current model simulates the spatial patterns in snow coverage and evaporation, in addition to river discharge. This model was used to calculate the A2 scenario of the IPCCSpecial Report on Emission Scenarios (SRES) (Nakicenovic & Swart, 2000). All model experiments that were performed, indicate a significant shortening of the snow season of 30 to 70 days (figure 1). Due to the much shorter snow season, the significance of sublimation in the annual water balance decreases, the growing season is extended, and the amount of radiation that is received during the snow-free season increases by about 16%. In summer, evapotranspiration is significantly higher, and the annual river discharge increases by almost 40%. Changes like these are believed to be highly relevant to the entire sub-arctic ecosystem, and may even provide a feedback to the global climate system.

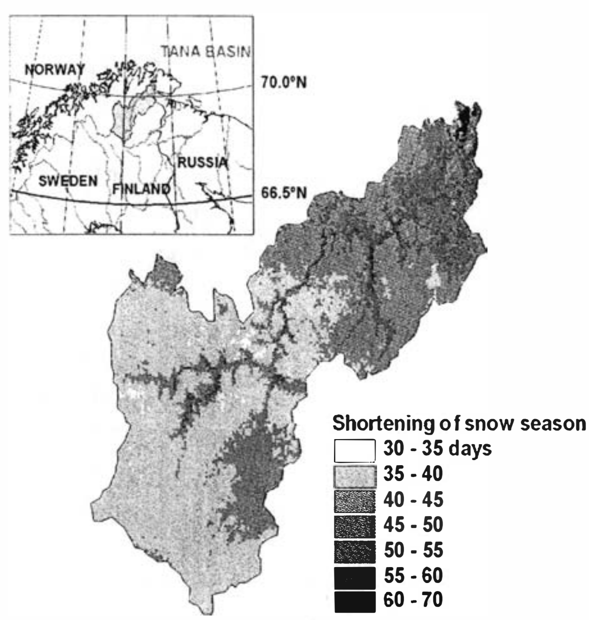

Figure 1 Shortening of the snow season in the Tana Basin under the SRES scenario A2

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New Knowledge on Permafrost Provided by Medical Scanner Imaging Data in Nunavik, Québec.

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In geocryological studies, report on permafrost structure is usually limited to the description of cores or sections supported by photographs. Other information such as grain-size, water content (volumetric or gravimetric), mechanical properties and chemical parameters require that the cores be destructed. Manipulating the core excessively for these purposes is likely to lead to contaminations. This causes a problem when the core's integrity must be preserved for subsequent gases or water content determination and analyses (e.g. isotope studies). As a result, in most cases, ice gaz and soil volumetric contents are only estimates.

In the context of a multidisciplinary research on a palsa in the discontinuous permafrost zone, an innovative and non destructive method was applied to image cores and to plan subsampling sections for water and gas extraction.

Imaging was done with the help of a scanner by X-ray tomography. Imaging ice lenses, soil layers, faults, sedimentary structures and gas bubbles permits to interpret ice lensing and soil cryo-structure issued from permafrost aggradation and segregation ice formation. Two kinds of image were produced : two-dimensional section images which allow to measure ice, gases and soil volumetric contents (figure 1), and three-dimensional reconstructions of cores.

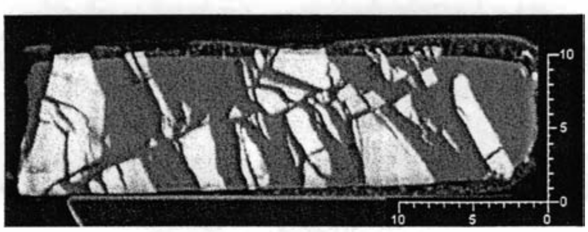

Figure 1 : 2-D Scan

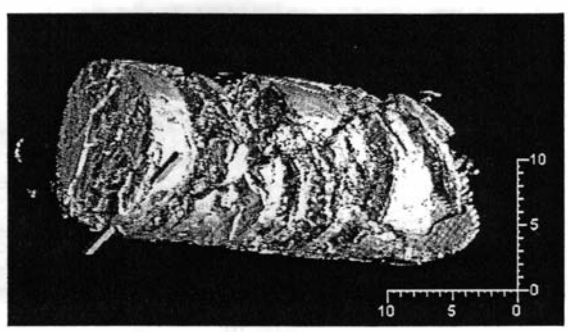

Figure 2 : 3-D Scan

An image analysis software will be applied to make quantitative measurements of gaz inclusions and ice contents while the structure of ice lenses, ice veins, faults, and sedimentary facies will be interpreted in terms of known theories of frost heave and water migration in frozen ground. A virtual record of the whole cryostratigraphic sequence will remain available after destructive sub-sampling will have been done.

Last deglaciation of Jæren, south western Norway – dynamics, chronology and climate variability

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At Jæren, south western Norway, a thick sequence of Quaternary sediments from the Weichselian and older glaciations are preserved. Based on observation of N – S oriented drumlins, striations and fabric measurements it has been suggested that Jæren on multiple occasions through the Pleistocene was inundated by an ice stream following the Norwegian Channel around southern Norway to the shelf edge (Sejrup et al. 1998). During the last glaciation, the lowland of Jæren acted as a confluence area for relatively slow flowing terrestrial ice from the inland and the Norwegian Channel Ice Stream (NCIS), with flow towards SW and N respectively. Radiocarbon dates from the Norwegian Channel suggests that the NCIS disintegrated rapidly at c. 15 ^{14}C ka BP. Even if not conclusive, dates from terrestrial basins suggest that parts of Jæren were deglaciated at c. 14 ^{14}C ka BP, and the Younger Dryas margin are mapped 50 km inland of the coast in this region (Andersen et al., 1987; Paus, 1989). Morphological and sedimentological studies at Jæren have revealed evidences of an extensive readvance during the last deglaciation. In the Bryne area shallow marine sand, most likely deposited during early deglaciation, has been deformed and overlain by till. Further south, in the Storamos area, a readvance are implied by a lobate pattern of marginal moraine ridges surrounding an area dominated by drumlinoid ridges. Small lakes are concentrated inside the area affected by the readvancing glacier, resulting in a fresh glacial impression. Both readvances are found in the continuation of valleys towards east. Ridges transverse to the last ice flow direction, interpreted as Rogenmoraine, and ring shaped ridges, interpreted as puljumoraine, are found in the immediate vicinity of areas affected by the readvance. The preservation of these landforms indicates that parts of the glacier were stagnant during the same phase.
Several frontal deposits are mapped between Jæren and the Younger Dryas marginal deposits (Andersen et al., 1987). The fragmented nature of these deposits, and lack of chronological control, makes it hard to correlate them, and further correlate to climatic changes during the Late Weichselian. To contribute to this issue, new cores from three coastal basins, placed in a hummocky bedrock landscape south of Jæren, were taken during 2002. Dating and sedimentological description of these cores are in progress, with the main aim to get a better chronology of the deglaciation. Further investigations of the cores will contribute to our understanding of the last deglaciation at Jæren and to the understanding of late glacial climate oscillations in south western Norway.

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Recent developments on the configuration, surface topography and dynamics of the Late Wisconsinan, Innuitian Ice Sheet.

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It is now recognized that the Innuitian Ice Sheet (IIS) consisted of alpine and lowland sectors (Dyke et al 2002). The alpine sector was comprised of radially-outflowing ice from highland divides close to those of the contemporary icefields on Axel Heiberg and Ellesmere islands. This ice coalesced and filled the intervening basin of Eureka and Nansen sounds that constituted the axis of maximum former ice thickness in the alpine sector, the removal of which has been long-attributed to the corresponding axis of maximum postglacial emergence (Blake 1970). Along the length of Nares Strait, the alpine sector of the IIS coalesced with the Greenland Ice Sheet, allowing the Ellesmere Island ice divides to thicken and migrate westward. An increasing number of AMS ^{14}C dates on erratic shells in till indicate ice buildup from margins close to modern positions as late as 19 ka BP. Recent field work (1997-2000) across S. Ellesmere Island to western Axel Heiberg islands has focussed on this buildup and ice divide migration. This includes the mapping of a prominent granite dispersal train that forms a 600 km arc extending from SE Ellesmere Island across the archipelago to the polar continental shelf. Northwest of Norwegian Bay, this granite dispersal train is predominantly confined to Massey Sound, however; along its western margin, it trims the north side of Amund Ringnes Island, where striae parallel the sound. The northern margin of the dispersal train is confined to the channel along the entire length of S and W Axel Heiberg Island where vigorous outflow from local IIS divides held the Ellesmere Island ice offshore, displacing it northwestward, where the granite dispersal train next appears on S. Meighen Island. Approximately 300 new ^{14}C dates on deglacial and postglacial shorelines are now available across S. Ellesmere Island and most of Axel Heiberg Island showing IIS still seaward of most coastlines at 9 ka BP.

The lowland sector of the IIS occupied the central part of the Canadian Arctic Archipelago, joined to the alpine sector via a saddle over Norwegian Bay. Geological mapping of striae and dispersal trains in the lowland sector show divergent outflow from a divide oriented east-west across what are now mostly marine channels. The western limit of the lowland divide remains undetermined but growing evidence suggests its replacement by island-based ice caps on Melville, Prince Patrick and Ellef Ringnes islands, flanking the polar continental shelf. Rapid breakup of marine-based ice throughout the lowland sector progressed from west to east, largely after 10 ka BP, leaving the island-based ice to retreat radially inland.

The expanding ^{14}C database on deglacial and postglacial shorelines is helping to refine the location of former ice divides (areas of greater unloading) and the configuration of ice retreat. Although postglacial emergence is ongoing throughout most of the alpine sector of the former IIS, widespread and ongoing submergence dominates the western part of the lowland sector. The onset of submergence began in the westernmost islands possibly as early as the mid Holocene and has recently progressed to the E. coast of Melville Island. This eastward migration of submergence (following earlier emergence) is assumed to record the migration of a crustal forebulge now crossing this region of formerly thinner, marine-based ice. Ongoing fieldwork is designed to complete a pan-archipelago synthesis of the IIS and its resulting sea level adjustments.

Glacier Fluctuations in the Akshayuk Pass, Auyuittuq National Park (Nunavut – Canada)

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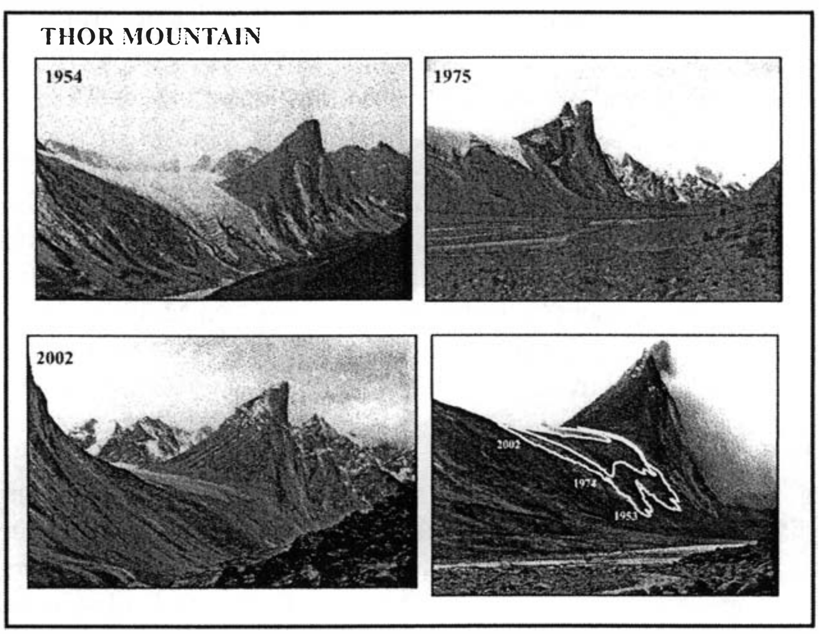
Akshayuk Pass, located in Auyuittuq National Park on Baffin Island, is a deep valley where numerous glaciers of all sizes are present. Glacier fluctuation analyses in this valley have been based on lichenometric studies (Dyke, 1990; Locke et al., 1979). The objective of this presentation is to show results obtained during the summer of 2002, in particular the same sites studied by Thompson (1954), Davis (1985) and Graham (1997). According to the first analysis results, it is possible to ascertain that glaciers have retreated rapidly over the past 50 years, for example, Fork glacier (**Figure 1**) and Turnweather glacier. Size-frequency distributions, Schmidt hammer R-values and lichen percentage cover statistical analyses, based on the availability of control points, permit the establishment of relative and absolute ages. A monitoring program of glacier snout retreat in the Park was also undertaken. Data was collected via field observations and measurements, as well as remote sensing techniques.

Figure 1



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An extensive northeastern Laurentide Ice Sheet during the Last Glacial Maximum

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The current last glacial maximum (LGM) reconstruction in the eastern Canadian Arctic depicts the Laurentide Ice Sheet (LIS) terminating at the mouths of fiords and sounds, with the adjacent inter-fiord plateaus ice-free. However, >100 cosmogenic exposure ages that directly date LIS deposits in the Clyde Region, northeastern Baffin Island, indicate that the LIS terminated far beyond fiord mouths during the LGM. Furthermore, summits up to 450 m directly adjacent to Baffin Bay are covered with weathered blockfields that contain scattered LGM and deglacial erratics, indicating that cold-based, non-erosive ice covered even the outermost summits. In the most distal sector of the Clyde Foreland, where cold-based ice hardly modified the landscape, erratics yield a multi-modal exposure age distribution suggesting numerous advances and retreats across the foreland from ~60 ka to the last deglaciation ~13 ka. At numerous locations, unconsolidated sediments at the surface of the foreland are beyond the range of radiocarbon dating, indicating that scattered erratics and melt-water channels, but not basal till, are the dominant LGM features on the foreland. Finally, the raised, >50 ka Aston Delta, a cornerstone in the "small ice" model of LGM ice extent that lasted for three decades, was overridden by cold-based ice during the LGM, as were scattered high peaks that punctuate the Aston Lowlands.

These new cosmogenic exposure age data depict an extensive LIS in the Clyde Region during the LGM, and contrary to earlier interpretations, support generally synchronous northern and southern LIS margins during the LGM. Beyond fiord mouths, ice occupied over-deepened continental-shelf troughs, probably terminating at the shelf break. The ice sheet margin along inter-fiord regions is less clear, but was probably beyond the modern coastline as well. Strong gradients in basal thermal regimes suggest spatially variable patterns in glacier thickness, velocity, and erosion, an overall behavior that points to an ice-stream-dominated ice sheet margin.

Quaternary glacial geology and relative sea level history of eastern Melville Island, western Canadian Arctic Archipelago

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Melville Island occupies a strategic geological position because it lies at the junction of the former terminus of the Laurentide Ice Sheet to the south, the Innuitian Ice Sheet to the northeast, and local island-based ice caps. Results of our study clarify the interactions between the former ice sheets and document their influence on subsequent glacio-isostatic relative sea level adjustments. Radiocarbon dating on fossil shells indicate that deglaciation of the island occurred between 10.5 and 9.6 ka BP. On northeast Melville Island, evidence of a northeast-southwest ice flow of unknown age and origin is recorded by flutings with granite erratics. On the southern part of the island, an ice-shelf associated with the Laurentide Ice Sheet grounded on Dundas Peninsula and deposited several till sheets (Hodgson, 1994; Hodgson et al., 1983; Hodgson and Vincent, 1984). An older till sheet enclosing granite erratics occurs some 25 km inland from the east coast of the island and records the passage of an ice margin of unknown age associated with undetermined and higher (~80-150 m asl) relative sea levels. In the study area, late Wisconsinan marine limit varies between 35 and 90 m above sea level. Postglacial isobases traced on the elevation of shorelines that emerged at the same time (~10.5-10.3 ka BP) indicate strong glacio-isostatic influence from the northeast, i.e. Innuitian dominated. After more than 10 300 years of glacio-isostatically induced land emergence, sedimentary and geomorphic evidence indicate that the coastline of eastern Melville Island is now undergoing transgression. Recently activated coastal processes include inland beach migration over the vegetation mat, drowning of gullies, rising of the water table, formation of lagoons, barrier reefs and islands, and shoreline erosion. This rapid recent sea level rise is attributed to the eastward migration of the crustal forebulge which bordered former ice margins. Results imply that the zero isobase, the threshold between submergence and emergence, is located east of where it is located in previous models.

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Fridtjovbreen on Svalbard - evolution of the two last surge events

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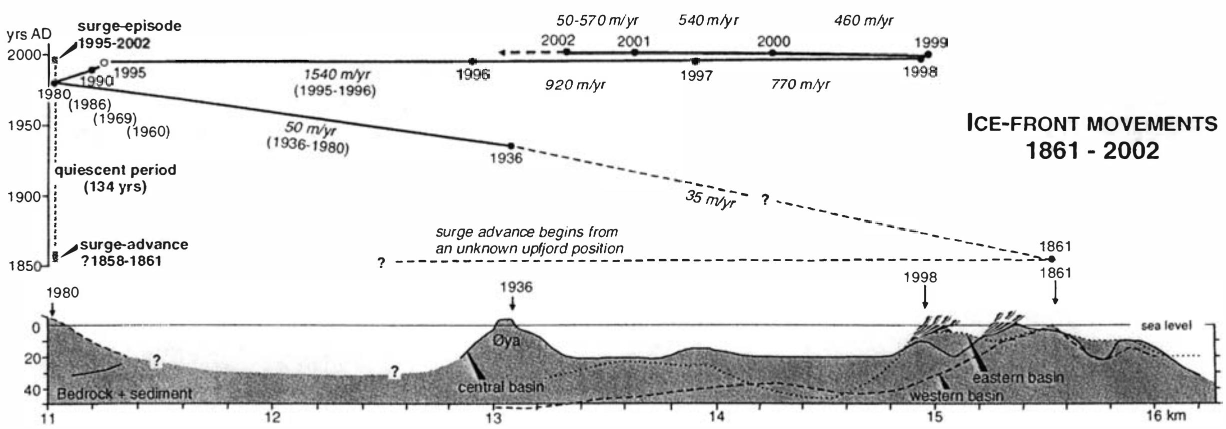
Fridtjovbreen is a 48.7 km^2, polythermal surge-type glacier on Nordenskiöldland, western Spitsbergen, terminating in the fjord. Historical data suggest that the glacier surged in the late 1850's, and reached its maximum position in 1861. This event was followed by 119 years of ice-front retreat, with an average rate of 37.8 m/yr, until its minimum documented extent was reached in 1980. The ice-front, partly terrestrial at this time, remained more or less unchanged in 15 years, mainly controlled by the geometry of the ablation area.

From 1995 to 1998, the ice-front advanced 4000 m in 33 months and filled 5 km^2 of the inner, 0-50 m deep fjord basin as well as a small terrestrial area. The average advance rate reached 154 m/month during the first ten months. The ice-front has subsequently retreated 1800 m, on average 600 m/year, mainly by calving, and probably reached the end of its 7-year-long active phase in August 2002.

The ongoing surge has taken place during the warmest interval of the last century, whereas the former surge was during the Little Ice Age maximum, the coldest part of the Holocene. The evolution of the two surge-episodes and the intervening quiescent phase has been reconstructed from aerial photographs, bottom profiling data (3.5 kHz), ground-penetrating radar and field observations. During the last advance, the ablation area increased by 5.0 km^2 and covered a 15.1-km^2 large area compared to 21.0 km^2 in 1861. Ice-cored moraines, formed during the 134-year-long quiescent phase, cover 4.9 km^2.

Although the ice-front advance phase terminated in 1998 (see figure below), the ice-flux remained high until 2002. Processes observed during the last part of this 7-year-long active phase, include internal deformation of the glacier ice in the frontal area, entrainment of marine sediments by subglacial thrusting, and formation of proglacial push-moraines along the terrestrial margin as well as below sea level.

Conclusion: The active surge-phase for calving glaciers may be divided into an ice-front advance interval and an ice-front retreat interval. The beginning of ice-front retreat does not necessarily mark the termination of the surge.



Fluctuations of the Fridtjovbreen ice-front in Fridtjovhamna, west coast of Spitsbergen, 1861-2002.

Satellite remote sensing of glaciers and ice caps in Svalbard, Eurasian High Arctic

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Recent compilations of climate-related observations show that important changes are now underway in the High Arctic, probably as a response to anthropogenic greenhouse gas emissions over the last ~250 years. These changes include warming of the troposphere, reductions in sea ice cover, decreases in snow cover area, and warming of tundra permafrost. Glaciers and ice caps are probably also changing. However, the number and length of systematic mass balance observations is relatively small. My PhD research is a study of glacier and ice cap variations over a relatively long period (the last ~80 years) on a large scale (the High Arctic archipelago of Svalbard) based on satellite imagery and archival maps. Measurements of glacier variations and mass balance have been conducted continuously on Svalbard since 1966, but most investigations are restricted to small glaciers in northwestern Svalbard. The behavior and current status of most large glaciers and ice caps is largely unknown.

In this project high resolution, modern satellite imagery is used to map current glacier and ice cap extents. These maps are being compared with archival information to assess rates and styles of change. The primary type of modern imagery is from the Advanced Spaceborne Thermal Emission and Reflection radiometer (ASTER) instrument carried onboard Terra. The satellite was launched on December 18, 1999 and image collection commenced on February 24, 2000. The ASTER instrument collects 60 km × 60 km scenes using three subsystems: visible and near infrared images (VNIR) in three bands have a nominal 15 m ground resolution; six bands of short-wave infrared images (SWIR) have ground resolution of 30 m; and, thermal infrared images (TIR) are acquired at 90 m resolution across a further five bands. The fine spatial resolution (15 m) and good radiometric range (14 bands) make ASTER imagery well suited for a number of glaciological applications, including measuring flow speeds (using feature tracking of crevasses), discriminating glacier boundaries, mapping snowline positions, and monitoring meltwater discharge into surrounding coastal waters.

Satellite imagery provides climate-related information about ice masses in Svalbard. The position of a late summer snowline indicates the spatial distribution of net accumulation on a glacier. As the mass balance of a glacier becomes increasingly negative, the snowline will retreat to higher elevations. A time series of observations of snowline positions can yield important information about the short term mass balance of an ice mass and its variability.

Svalbard contains approximately 1,200 ice masses, many of which are of surge-type. To ensure that we are studying climate-related changes, we have selected benchmark glaciers in characteristic regions of the archipelago. Details of the selection process will be described.
As an example, we shall describe results of a study of Storøyajøkulen, a simple, self contained ice cap occupying an island in northeastern Svalbard. Storøyajøkulen had in 1977 an area of 29.10 km^2 calculated from vertical aerial photographs. A comparison with ASTER imagery reveals that the ice cap has undergone a reduction in glacier area with a couple of square kilometers between 1977 and 2001.

Holocene glacier recessions in Lapland and Svalbard inferred from radiocarbon dates of specified organic material

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Palaeoclimate reconstructions based on accurate geochronology are needed to assess former variations of climate parameters. Mountain glacier mass balance changes are sensitive indicators of changes in temperature and precipitation. Bulk samples of terrestrial organic material are widely used to build chronologies for former glacial advances and retreats. The problems associated with contamination by the infiltration of younger humic acids, penetration of roots, bioturbation and redeposition of palaeosols are well known. The aim of this study is to improve the age data that has established the Holocene glacier variations in Svalbard and northern Lapland. AMS-dates of specified and extracted organic material like insects, spores, seeds, plant macrofossils and humic acids have been collected and analyzed for comparison with existing bulk ages.

In Lapland, organic material in the Kaskasevagge valley in front of Nipalsglaciären (67°58'N; 18°33'E) was sampled from two frontal moraines located at 1160 and 1165 m asl. Two palaeosols, which are buried 15-50 cm in the till sediments of the two different moraines have been dated. The first soil has two date clusters: beetles and *Cenococcum geophilum* spores are dated with 1060-790 cal yr BP, whereas woody plant tissues and the SOL (soluble fraction, mainly humic acids) have an age of 2310-1730 cal yr BP. There is a lack for material of about 1000 years. This soil has previously been dated in a former study to 2750-2100 cal yr BP (Denton and Karlén, 1973). The second soil has three clusters: 4840-4410, 6290-5460 cal yr BP (both *Cenococcum geophilum* and SOL) and 7740-7610 cal yr BP (*Cenococcum geophilum).* Former dates on humic acid point to 6180-5790 cal yr BP (Karlén, 1973). Some more sub samples are actually processed.

In Svalbard, fieldwork will commence in 2003. We are looking systematically for organic material that has been disgorged from beneath glaciers and within ice caves formed by subglacial melt water streams. In spring 2001 Ole Humlum (UNIS) found organic mosses within Longyearbreen glacier, providing an opportunity for an improved chronology of Holocene glacier recessions. Test samples are in progress and will be presented at the workshop. A key task is to compare ages from within glaciers with glacial variations, reconstructed by investigations of proglacial lakes on Svalbard (Svendsen and Mangerud, 1997). We will discuss the comparability and discrepancies of different organic materials within different records used for Holocene climate variations in Scandinavia.

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Glacial and environmental history of Severnaya Zemlya, Siberian high arctic, during the last >130,000 years

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With a position on the north-eastern flank of any Kara Sea-based ice sheet, stratigraphic data from the Severnaya Zemlya islands (ZS) is crucial for any ice-sheet reconstruction. The area was, however, excluded during QUEEN field investigations. In order to resolve this, a new field research programme has been launched, with its first field season on SZ in 2002 at two key locations on October Revolution Island.

Our main effort was put into the stratigraphy along the Ozernaya River. Here we mapped three marine sequences, divided by glacial tills. The lowermost sequence is shallow-marine stratified sand (*M-1*) with *in situ* mollusc shells. It is tectonized by a glacier which advanced southwards from inland SZ towards the Kara Sea, depositing the lowermost till (*T-1*). Clayey-to-sandy marine sediments (*M-2*) in turn overlie this till, containing numerous *in situ* fossil mollusc shells, as well as driftwood and whalebones. Clast fabrics from the above-lying till (*T-2*) and glaciotectonics in the underlying *M-2* show that also this glacier advance was southwards into the Kara Sea. The uppermost marine unit (*M- 3*) is a sandy sublittoral deposit and beach gravels. The beach gravels, in turn, are covered by a thin, cryoturbated diamicton, probably of a glacial origin (*T-3*).

The data indicate three Late Quaternary major glaciations on October Revolution Island, where local ice caps grew and expanded and probably coalesced with ice from Taymyr and Novaya Zemlya to form a Kara Sea Ice Sheet. The significant isostatic depression, causing subsequent deposition of marine sediments and formation of raised beaches at altitudes up to 100-130 m a.s.l. suggest that the glaciation was regional, not only expansion of local glaciers, and that SZ was an ice-sheet nucleation area. The age of the glaciation events is still uncertain: Our best candidate for Eemian deposits is marine unit 2, with its rich fossil record. If that will be substantiated by our pending age determinations, the stratigraphy records a pre-Eemian marine event (*M-1*), followed by a major Saalian (>130 ka) glaciation (*T-1*). There follows an Eemian interglacial marine event (*M-2*), which is in turn followed by a major glaciation (*T-2*). Later, following an ice retreat, marine unit 3 and subsequently the capping glacial drift sheet were deposited.

Paleoenvironments in the Russkaya Gavan' Fjord (NW Novaya Zemlya) during the Last Millenium: Responses to Global Climate Changes

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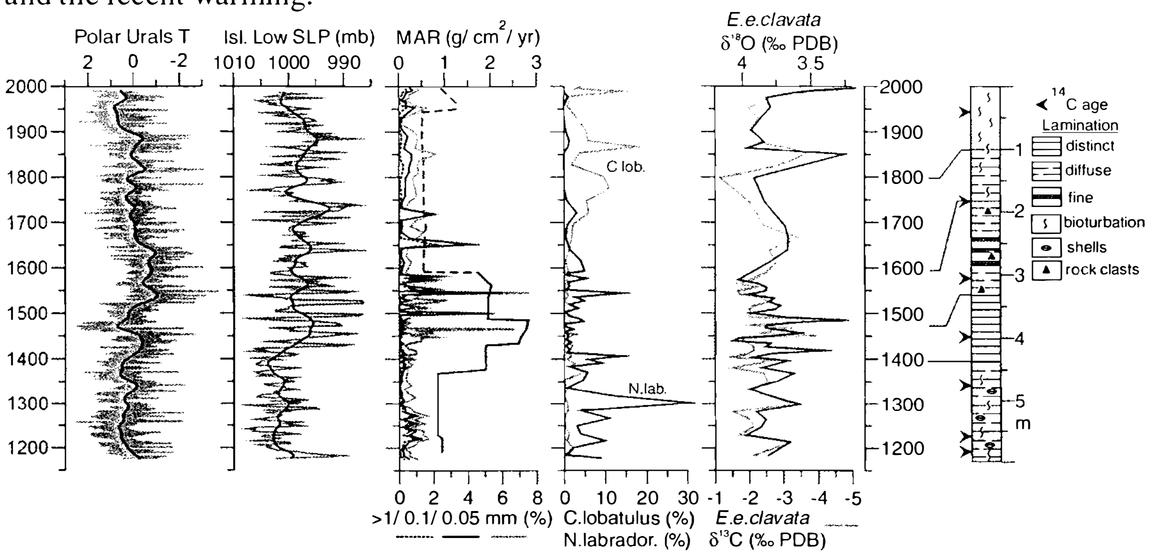
The 6-m long sediment core ASV-987 collected from the deep part of the glaciated Russkaya Gavan' Fjord in 1997 (r/v Akademik Sergei Vavilov) was investigated for lithology, grain size, coarse debris, organic carbon, foraminifera, macrobenthic remains, and stable isotopes in foraminiferal tests. Age control was provided by seven AMS ^{14}C ages. The recovered sedimentary section spans approximately 800 years, from ca. 1170 AD. The proxy records reveal variations in sedimentation processes, bioproductivity, glacier front position, sea-ice conditions, and hydrographic regime in the fjord. These characteristics are interpreted in terms of regional and global climatic changes in the last millennium. We distinguish four stages in the environmental evolution of Russkaya Gavan', which presumably responded to major climatic events: the Medieval Warm Period, the Little Ice Age (early and late phases), and the recent warming.



Lithology and time series of major characteristics of ASV-987 correlated with tree-ring based summer temperature anomaly from Polar Urals (Briffa et al., 1995) and with reconstructed Islandic Low intensity (Meeker& Mayewski, 2002). ASV-987 characteristics shown are: Mass Accumulation Rates (MAR, calculated using interpolated ages< density, and water contents), coarse grain-size fractions, percentage of selected foraminiferal species, and stable isotopes. Age interval for the Early LIA unit is highlighted.

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Palaeo-ice streams to the southern Barents Sea margin during the Late Cenozoic: evidence from glacial lineations, mega blocks and rafts.

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The study area is located at the south-western end of the Bjørnøyrenna glacial trough at the SW Barents Sea continental margin. Industry 3-D seismic data show the existence of mega-scale glacial lineations on seven seismic reflectors that can be correlated regionally over the western Barents Sea, documenting that grounded glaciers reached the shelf edge in this area at least seven times.

This study is based on ~2000 km^2 of industry 3-D seismic data, which is designed to image deeper targets. The vertical resolution is not very good compared to high-resolution 2-D seismic data that is commonly used to study the upper glacigenic sediments. The horizontal resolution is, however very good due to high spatial sample rate, and the data provide detailed images of interpreted horizons and horizontal attribute maps. A data-cube where frequencies lower that 40 Hz had been removed by post-stack filtering was used to study special features.

The mega scale streamlined lineations, 0.8-25 km long, around 100 to 200 m wide and with a relief of about 3 m, are taken as indication of fast-flowing ice-streams. Their orientations indicate that the study area has been influenced both by westwards moving ice streams occupying the Bjørnøyrenna and north-westwards moving ice streams from the Scandinavia mainland. The seismic units within the study area are dominated by a chaotic seismic facies on vertical seismic profiles. We focus here on mapping high-amplitude segments within these units, using the RMS (root-mean-square) amplitude volume attribute. The high-amplitude segments represent mega blocks and rafts, which in several units are aligned in 1-2 km wide and over 50 km long chains. The sediment chains have the same orientation as flow lines of palaeo-ice streams, determined from the mega scale glacial lineations on seismic horizons. This indicates that the sediment blocks were transported and deposited by ice that drained out Bjørnøyrenna to the shelf edge. Individual mega blocks, which may have an areal extent of over 2.2 km^2, were probably transported by freezing onto the bottom of overriding ice. At a later stage, basal melting would have allowed separation of sediment blocks from the ice. Lineations on the attribute maps indicate that that many mega blocks have been partly or completely disrupted, sheared and pulled apart from each other. Disrupted parts of sediment blocks fit together like parts of a jig saw puzzle.

Preliminary mapping indicates that mega blocks and rafts occur in most units of the glacigenic section within the study area, aligned in sediment chains or scattered throughout the area. This indicates that the process of glaciotectonic erosion, transportation and deposition by ice streams may account for high sediment fluxes to the shelf edge and the Bjørnøya Trough Mouth Fan during the Late Cenozoic.

Using 36-chlorine ages and marine cores to constrain the Late Quaternary History of the Vestfirdir Peninsula, Iceland

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During the Last Glacial Maximum (LGM), ice extended offshore around Iceland, and ice margins are commonly interpreted from marine cores and seismic studies. However, the precise interpretation of the timing of re-advance and retreat is complicated by the uncertainties associated with interpretation of diamictons and ambiguities in radiocarbon dating. It is also difficult to determine the chronology of terrestrial glacial history in this region due to a lack of dateable organic material and radiocarbon dates are limited.

The purpose of this study is to determine the late glacial and deglacial history of the eastern limb of the Vestfirdir Peninsula (VP), Iceland using new ^{36}Cl exposure ages of boulders and bedrock surfaces. These ages are constrained by correlation with fjord and shelf sediment cores. One of the primary uncertainties of cosmogenic dating in Iceland is defining a production rate. The production rate of Swanson and Caffee (2001) provides more reasonable ages corresponding to the marine records than using the production rate of Phillips and Plummer (1996). Using Swanson and Caffee's production rate, bedrock surfaces range in age from 24.4ka±3.2ka to 11.8ka±2.4ka. Boulders from the crests of end moraines in the valley of Laugaland correspond to a mean age of 15.85±1ka (n=4) and the outermost moraine in Kaldalon has an average age of 11.5± 0.9ka (n=3). Age calculations of boulders on each moraine show that there is good precision within the moraine, which suggests a systematic offset in the ^{36}Cl ages. An additional correction for the Iceland low is also probably necessary (Stone, 2000).

^{36}Cl ages from the upland bedrock surface of Armuli suggest that ice was at least 376m asl thick in Isafjardardjup until approximately 22ka. The morphology of the landscape (cirques, horns, and arêtes), the preservation of block fields on uplands, and the lack of glacial sediment suggest that thin, cold based ice or ice free areas were present on the parts of the upland plateau on the VP during the LGM. Submarine ridges at the mouth of Isafjardardjup and within the fjords suggest a stepwise retreat of the ice-cap from the northwest. It is more difficult to constrain ice retreat from the northeast direction, i.e. the Hunafloaall trough system, as a systematic set of submarine ridges have not been identified. It is likely that ice from the mainland ice cap and the VP converged before reaching the Hunafloaall trough system. Ice probably retreated from this trough via calving in the direction of decreasing water depth.

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Importance of accumulation timing in preservation of Total Inorganic Nitrate (TIN) at Summit, Greenland: implications for surface snow reconstructions.

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Concentrations of chemical species preserved in the ice core record can provide a proxy record of paleoatmospheric concentrations and oxidation capacity. Through transfer function modeling these proxy records may be used to validate climate change models, atmospheric photochemical models, and separate anthropogenic climate forcing from natural variability. Understanding the nonlinear relationship between concentrations in the atmosphere, snow, firn and ice is critical if the ice core proxy record is to be useful for validating atmospheric photochemical models or further developing the records into indices for climate dynamics.

This study investigates the preservation of total inorganic nitrate (TIN) in firn as a function of accumulation. TIN is the preserved combination of aerosol NO_3^- plus gaseous HNO_3 and is considered the sink of total reactive nitrogen, NO_y. NO_3^- measured in ice cores has been considered a proxy for TIN in the atmosphere. Toward understanding the transfer function model for NO_3^-, snow pits were excavated during the spring of 1998 following a winterover measurement period at Summit, Greenland. Firn profiles of NO_3^- from 10 snow pits collected demonstrate the importance of accumulation timing on the preservation of NO_3^-. Using a time series of NO_3^- surface snow concentration and accumulation collected during the 1997-1998 winterover the firn profiles are re-created and compared with sampled measurements. Results indicate that prior to the summer season, accumulation timing is an important parameter in the preservation of the species. NO_3^- concentrations in the snow pits have a maximum of 12 μM and a mean of 2.6 (SD: 0.05) μM. Concentrations in the surface snow ranged from 1 to 19 μM with a mean of 2.7 (SD: 0.3) μM. The spatial variability of preserved NO_3^- as it is related to accumulation is also demonstrated. Additional physically-based transfer function modeling is being conducted to further understand post-depositional processes. The results from this study suggest that the strongest control on the preservation of nitrate at Summit, Greenland is accumulation. However, there is evidence that other post-depositional processes such as grain metamorphism also play an important role.

Developing a proxy of paleoatmospheric concentrations begins with deriving the surface snow concentrations based on the ice core record. Once the surface snow concentrations are established, the atmosphere-to-firn dynamics may be modeled in reverse, as they are understood. The results from this investigation demonstrate that surface snow concentrations can satisfactorily be estimated from snow pits accounting for accumulation variability alone.

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The Anatomy of Abrupt Climate Changes from Greenland Ice Cores

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Detailed sampling from Greenland ice cores has a great potential for revealing clues to the anatomy of an abrupt climate change. Stable isotopes measurements of ice have been made with nearly annual resolution across the end of the Younger Dryas in the new NorthGRIP ice core. Detailed sampling reveals a multiple event structure for the Younger Dryas termination. The atmospheric warming of the ice sheet occurs in three phases, beginning with warming of roughly half of the total over about 10 years, stable period of about 30 years, and a resumption of rapid warming for another 10 years. The pace of warming in each step is about 0.5 to 1 degree C per year. The detailed isotope records of NorthGRIP and GISP2 are remarkably coherent and both share a similar structure to lower resolution isotope records available from GRIP and DYE3. The similarity at this fine detail lends support to the hypothesis that the isotope shifts are recording climate fluctuations over a large region, rather than noise, and that year-by-year climate changes can be reconstructed for these very large abrupt climate changes.

All four cores show a large and extremely rapid drop (1 to 5 years) in deuterium excess, an indicator of sea surface conditions at the moisture source, and it is this event that is used to synchronize the four cores. The deuterium excess drop correlates well with abrupt changes in chemistry and dust records, but precedes a change in accumulation rate by about 15 years. It is thought that these climate events are tied to the re-establishment of the North Atlantic deep water formation and the polar front retreat, followed by the re-establishment and strengthening of the Iceland Low pressure system drawing storms into Greenland.

The sequence of events at the end of the Younger Dryas is then compared to similar measurements made at the start of the Younger Dryas and across the Bolling warming. We begin to assess if all of these abrupt changes have the same mechanisms, or if they have different fingerprints and thus perhaps driven by markedly different processes.

Wavelet methods for analysis of ice core time series.

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We have used wavelet methods to analyse data sets from ice cores in an attempt to answer climatological questions such as how representative time series from ice cores are. Wavelet methods have become a mature method in analysing geophysical time series e.g. [*Percival and Mofjeld,* 1997] [*Kumar and Foufoula-Georgiou,* 1997] and recently in glaciological applications [*Winebrenner et al.,* 2001]. The key idea is that noise created by the environment acts on different scales for different time series and by using wavelet analysis we are able to decompose the data series into components that correspond to changes of data averages on varying scales [*Percival and Walden,* 2000]. By doing this we can investigate at what time scales we have common changes in our time series. The analysis quantifies not only the data variance on various scales but also the locations in the original series at which changes on these scales occur. Wavelet methods as opposed to classical spectral analysis handle non-stationary time series well. We applied these techniques on time series obtained from firn cores collected during the Norwegian Antarctic Research Expedition (NARE) in 2000/01 [*Karlöf et al.,* Submitted]. The analysis reveals different characteristics of variance contribution depending on the type of signal analysed. This has implications for the planning of what species that should be analysed from an ice core.

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The Ancient Inuit: Political Consequences of an Archaeological Interpretation

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When Europeans penetrated Arctic North America, they found the land occupied by a people remarkably different from any that they had ever known. The existence of such a people appealed to the romantic tradition of nineteenth century exploration literature, and European explorers and travel writers accentuated the simplicity, the isolation, and the alien quality of Inuit life. Early theories on Inuit history pictured them as a surviving remnant of Ice Age cultures, or as Amerindians whose unique way of life had evolved as the result of an ancient and isolated adaptation to arctic regions. This perception underlies much anthropological writing related to the unique attributes of the Inuit and of traditional Inuit culture, and the view has attained wide public dissemination through popular accounts and the promotions of the Inuit art industry.

Archaeological evidence indicates that the Inuit of Arctic Canada and Greenland derive from an ancestral culture which developed in the Bering Sea-North Pacific region, and that they reached their current homelands through an apparently rapid expansion which occurred during the past millennium. This interpretation of Inuit history has not deeply impacted the public view of ancient and isolated adaptation; it has merely transposed the site of that adaptation to Alaska, and interpreted the eastward expansion and the subsequent development of Eastern Inuit culture in terms of processes of adaptation to changing environmental conditions. A reassessment of evidence related to the timing of these events, combined with a growing appreciation of the extent of European presence in the eastern Arctic during the past millennium, suggests that historical rather than environmental factors were central to these major developments in Inuit culture.

Ancestral Inuit culture appears to derive from the Bering Strait, in a segment of Alaskan Eskimo society which for the past 2000 years controlled the iron trade from Asia to America. Recent revisions to the dating of the eastward expansion of Thule culture Inuit to Canada and Greenland indicate that it occurred during the 12th or 13th centuries AD, and was probably instigated by the development of metal sources—the Cape York meteorites and Norse farmers/traders—in the Eastern Arctic. The subsequent development of Inuit culture was closely tied to economic relations with the growing European presence in Greenland and Arctic Canada. This interpretation forces a revision of our concept of traditional Inuit culture as the product of long-standing isolation and adaptation to the unique environment of the Eastern Arctic.

It is argued that political and social decisions relating to the Inuit—including the resettlement of communities and the devolution of political decision-making—have been adversely influenced by this false concept. The image that the world holds of a people, and indeed a people's self-image, is closely tied to the understanding of their history. The image of the Inuit as a simple, unspoiled, unthinking society of noble and capable hunters is intimately related to the view of Inuit history as an ancient and isolated adaptation to a harsh environment. It is now clear that the Inuit way of life that was described by nineteenth century explorers had developed during the preceding few centuries in response to rapidly changing economic circumstance. The ancestors of the Inuit were not the most isolated nation on earth, but were in fact an entrepreneurial North Pacific people who were attracted to the Eastern Arctic during the 13th century in order to trade with Europeans, and whose way of life had developed in contact with the evolving global culture and economy ever since.

POSTER PRESENTATIONS

Antiphase SST relation between the North-Iceland Shelf and the Vøring Plateau through the last Eight Centuries

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The main objective of this study is to document patterns and frequencies of natural climate variability on decadal time scales during the last millennium in the Nordic Seas. Sea surface temperatures (SSTs) are reconstructed from high sedimentation rate sites on the North-Iceland Shelf (66°37.53 N, 20°51.16 W) and the Vøring Plateau (66°58.18 N, 07°38.36 E) by using diatom based transfer functions. The North-Iceland Shelf is at present under the influence of the Irminger Current and the East Icelandic Current. Recorded changes in SSTs and diatom species assemblages are interpreted to represent the proportional relationship between these two currents. The Norwegian Atlantic Current (NwAC) characterize modern surface conditions over the Vøring Plateau and its past variability is reflected in the reconstructed SSTs. Chronologies of the cores are based on AMS radiocarbon datings and ^{210}Pb measurements.

The results show high climate variability and contrasting SSTs between the North-Iceland Shelf and the Vøring Plateau for the last eight centuries. Between 1250 and 1400 AD, i.e. at the end of the Medieval Warm Period (MWP), the Vøring Plateau experienced warm SSTs preceding an abrupt temperature cooling of 1.5°C within a decade that lead to the Little Ice Age. At the same time, North-Iceland Shelf was warmer than present during the Medieval Warm Period, but was followed by an even warmer period between 1400 and 1650 AD. Surface conditions improved over the Vøring Plateau after 1600 AD, while SSTs cooled on the North-Iceland Shelf. These results thereby indicate that during a strengthening of the NwAC, the East Icelandic Current is also strengthened and/or the Irminger Current became weaker. This climatic antiphase relation documented between these two areas suggests an atmospheric circulation pattern similar to the recent North Atlantic Oscillation, however with centuries duration.

Mega blocks and rafts in buried till units at the Barents Sea Margin: evidence for large-scale glaciotectonic erosion, transportation and deposition.

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Mega blocks and sediment rafts are mapped in buried till units of Late Cenozoic sediments using industry 3-D seismic data from the south-western margin of the Bjørnøyrenna glacial trough in the SW Barents Sea.

The 3-D survey, covering an area of ~2000 km^2, was primarily designed to image deeper targets, and the vertical resolution is low compared to high-resolution 2-D seismic data that is commonly used to study the upper glacigenic sediments. The horizontal resolution is, however very good due to high spatial sample rate, and the data provide detailed images of interpreted horizons and horizontal attribute maps. A data-cube where frequencies lower than 40 Hz had been removed by post-stack filtering was used to study special features.

The 3-D seismic data show the existence of mega-scale glacial lineations on at least seven seismic reflectors that can be correlated regionally over the western Barents Sea, documenting that grounded glaciers reached the shelf edge in this area at least seven times. The seismic units of this sequence are all in vertical profiles characterized by chaotic seismic facies. We focus here on mapping high-amplitude segments within these units, using the RMS (root-mean-square) amplitude volume attribute. The high-amplitude segments represent mega blocks and rafts, which in several units are aligned in 1-2 km wide and over 50 km long chains. The sediment chains have the same orientation as flow lines of palaeo-ice streams, determined from mega scale glacial lineations on seismic horizons. This indicates that the sediment blocks were transported and deposited by ice that drained out Bjørnøyrenna to the shelf edge. Individual mega blocks, which may have an areal extent of over 2.2 km^2, were probably transported by freezing onto the bottom of overriding ice. At a later stage, basal melting would have allowed separation of sediment blocks from the ice. Lineations on attribute maps indicate that many mega blocks have been partly or completely disrupted, sheared and pulled apart from each other. Disrupted parts of sediment blocks fit together like parts of a jig saw puzzle.

Preliminary mapping indicates that mega blocks and rafts occur in most units of the glacigenic section within the study area, aligned in sediment chains or scattered throughout the area. This indicates that the process of glaciotectonic erosion, transportation and deposition by ice streams may account for high sediment fluxes from the Barents Sea and Scandinavian mainland to the shelf edge and the Bjørnøya Trough Mouth Fan during the Late Cenozoic.

Environmental changes on the Laptev Sea region during the Late Quaternary reflected in Bol'shoy Lyakhovsky Island pollen records

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Pollen records completed by ^{14}C, IRSL, and U/Th dates from Bol'shoy Lyakhovsky Island (73°20'N, 141°30'E) document the environmental history in the region during the last 200 ka. Rich grass-sedge tundra occupied the area about 200 U/Th ka ago. Absence of typical cryoxerophitic taxa, high pollen concentration, and low amounts of redeposited pollen indicates relatively warm and wet climate. This interval may correspond with an interstadial during the Tazovskiy (Saalian) stadial.

Poaceae-*Artemisia* steppe-like vegetation with some shrubs (*Alnus fruticosa*, *Salix*, *Betula nana* dominated vegetation shortly before Kazantsevo (Eemian) Interglacial (ca 125 ka ago). Climate was rather warm and wet during this interval, corresponded to some Pre-Kazantsevo (Pre-Eemian) warming similar to Allerød.

Alnus fruticosa, Betula, and Cyperaceae pollen are characteristic for the Eemian deposits survived only within the buried ice wedge casts. The high concentration of pollen and content of the spectra reflect warm and relatively wet climate during that time, resulting thermokarst processes. *Betula nana* pollen is dominant in the late Eemian spectra that may indicate a climate deterioration.Low pollen concentration, large amounts of redeposited palynomorphs and presence of cryoxerophitic taxa characterise pollen records dated >55-50 ^{14}C ka BP and from 119±22 to >79 IRSL ka. Dry grass and sedge communities with few other herbs occupied the area during this time, corresponding to the Zyryan (Early Weichselian) stadial. Dominance of redeposited pollen reflects scarce vegetation cover and/or low pollen productivity.

Higher pollen concentration, fewer redeposited palynomorphs, and increase of Cyperaceae pollen content are characteristic for records dated ca 47-37 ka by ^{14}C and IRSL. Sedge and grass tundra-like vegetation with some other herbs (mostly Caryophyllaceae) dominated vegetation. Presence of some warm pollen indicator (*Salix*, *Betula nana*, Ericales) reflects relatively warm and wet climate during this interval, corresponded to the Karginski (Middle Weichselian) interstadial. Similar paleoenvironmen for this interval are also recorded on the Bykovsky Pns. (Andreev et al., 2002).

In the pollen spectra dated ca. 31-28 ^{14}C ka BP pollen concentration decreased. Grass-sedge communities with some Caryophyllaceae, Asteraceae, Brassicaceae, and *Valeriana* dominated vegetation during this interval. Large amounts of redeposited pollen reflect scarce vegetation cover and/or low pollen productivity in that time. Climate was much dryer and colder than during the previous interval. There are no records from Sartan (Late Weichselian) stadial. This may indicate extremely unfavorable environment during that interval.

Middle Weichselian environments on western Yamal Peninsula, Kara Sea

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Two sections from coastal cliff near the Marresale Polar Station on western Yamal Peninsula were recently investigated for pollen. A detailed description of the sections and their lithostratigraphy was published by Forman et al. (2002). Our study focuses on the environmental changes reflected in the pollen records, completed by ^{14}C and IRSL dates. They document the environmental history in the area during the late Karginski (Middle Weichselian) interstadial.

Low pollen concentration, large amounts of redeposited pollen, and relatively large presence of *Artemisia* pollen characterise bottom sediments from the 4.1 km section (Forman et al. 2002), dated from 33,4±5 to 32,7±6 ^{14}C ka BP and 45,1±4 to 41,3±4 IRSL ka, respectively. The narrow age interval defined by the ^{14}C ages possibly indicate that some of the dated plant macrofossils were reworked or they may indicate high accumulation rate during the time of deposition. Grass-sedge plant associations with few other herbs occupied the area during this time, corresponding to the late Karginski interstadial. *Artemisia* pollen may indicate rather xerophitic vegetation, and/or disturbed soils in the area. Dominance of redeposited pollen reflects scarce (disturbed) vegetation cover or/and low pollen productivity. The climate was relatively cold and dry.

The upper part of the section contains less redeposited pollen, and consequently the concentration of non-redeposited pollen is significantly higher. Pollen contents indicate the dominance of tundra-like grass-sedge vegetation. The upper part of the section is ^{14}C dated to ca. 33,4 ka, whereas an IRSL age determination gives 35,7±3 ka. The pollen composition suggests more humid conditions during the later part of the late Karginski interstadial.

Pollen records from the 4.7 km section (Forman et al. 2002) reflect environmental condition in the area between 30,1±3 and 25,1±6 ^{14}C ka BP. Large amounts of redeposited Pinaceae pollen characterise the deposits. Pollen spectra reflect scarce tundra-like vegetation cover during this interval. Presence of *Betula nana* and *Salix* pollen may reflect some presence of shrub communities in the area. This suggests that the climate was somewhat warmer than during the interval, recorded in the 4.1 km section.

Generally, rather warm environments prevailed during the Middle Weichselian time in many Siberian regions (e.g. Andreev, 2002b), but severe environments haves also been reconstructed based on pollen records from coastal areas of the East-Siberian Sea (Andreev et al., 2001), Laptev Sea (Andreev et al., 2002a), and northern Taymyr (Andreev, et al., 2003). Hence, the harsh environmental conditions prevailed in a broad region of the high Eurasian North, in areas proximal to the Arctic Ocean, during the Karginsky interstadial.

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Postglacial emergence of Amund and Ellef Ringnes islands, Arctic Canada: implications for the northwest sector of the Innuitian Ice Sheet

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During the late Wisconsinan glacial maximum, Amund and Ellef Ringnes islands were covered by the northwest sector of the Innuitian Ice Sheet. Ice-flow indicators and granite erratics distributed along eastern Amund Ringnes Island indicate regional ice from the south and east converged in Norwegian Bay, supplying an ice stream that flowed northwest through Massey Sound. In contrast, ice-flow features and deglacial landforms demonstrate Ellef Ringnes Island supported a local ice cap, but it remains unclear whether this was a full-glacial ice cap or a late-glacial remnant of Innuitian ice. Collectively, these data provide a *minimum* estimate for the extent and thickness of the northwest Innuitian Ice Sheet.

The oldest deglacial dates occur on east-central Ellef Ringnes and northern Amund Ringnes islands, where ice had evacuated surrounding marine channels by 10 ka BP. Three new relative sea level curves are presented for the Ringnes Islands. These are well described by a simple exponential function, and record continuous, ongoing emergence of Amund Ringnes Island and eastern Ellef Ringnes Island. However, late Holocene submergence characterizes western Ellef Ringnes Island, likely recording the passage of the crustal forebulge. Isobases drawn on postglacial shorelines rise southeastwards, across the Ringnes Islands, recording greater uplift towards Norwegian Bay, which is consistent with the source of the Massey Sound Ice Stream. The fact there is no deflection of the isobases from the Ringnes Island across Massey Sound and Peary Channel suggests a relatively uniform ice load across the area. However, northeast of the Ringnes Islands, the isobases deflect northwards, recording the greater influence of the former Axel Heiberg ice load (see England, Atkinson and Dyke, this volume). Collectively, these data will contribute to improved geophysical modelling of the former Innuitian Ice Sheet and adjacent independent ice masses to the west, fringing the polar continental shelf.

Plant cover and microtopography controls on nitrogen dynamics in hummock tundra ecosystems

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One of the most widely distributed forms of surface structures in circumpolar arctic regions are earth hummocks (MacKay 1980). They consist of mineral soil and appear regularly, fragmenting the landscape into areas occupied by hummocks and areas of intermediary depressions. We investigated N pools and N turnover rates of hummocks and inter-hummock areas at a Typical Tundra site and a Southern Tundra site in arctic Russia (Taimyr Peninsula). The aim of the present study was to investigate the relationship between landscape characteristics and nutrient cycling in arctic ecosystems.

Results and Conclusion

On regional scales, N dynamics were positively related to latitude (temperature). However, on local scales, the wetter and thus cooler inter-hummock areas (Chapin et al. 1979) showed higher N pools and N transformation rates (Fig. 1) than the relatively warmer hummocks. Thus, effects of temperature were overridden by

- effects of plant cover: inter-hummock areas are dominated by mosses, which indirectly promote microbial activity, since they are poor competitors for soil nutrients. Furthermore, these plants efficiently absorb nutrients from precipitation and surface water and are, thus, responsible for high amounts of nutrients in the particular microhabitat (Bates 2000). In contrast, in hummocks resource limitation most likely occurs due to depletion of nutrients through graminoids, which are the main vegetation component of this surface type.
- effects of microtopography: due to lower levels in the relief litter is accumulated in the inter-hummock areas providing external substrate input to these soils. Additionally, subsurface run-off of water is channeled in inter-hummock depressions leading to nutrient accumulation in these microhabitats.

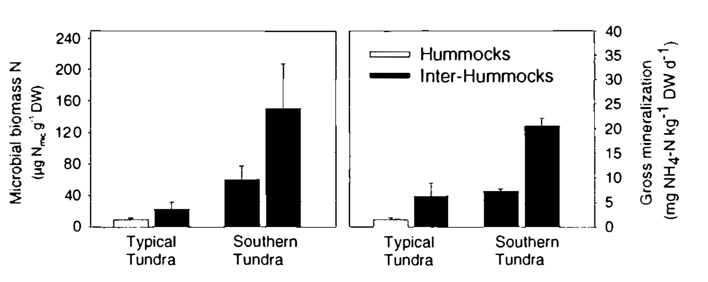

Figure 1: Microbial N (left) and gross N mineralization rates (right) in soils of hummocks and inter-hummock areas of a Southern Tundra and

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Investigating the Holocene Thermal Maximum in Iceland

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Iceland is situated at the boundary between cold, polar air masses and relatively warm air masses of tropical origin. Iceland is also at the boundary between the cold, relatively fresh East Greenland Current and the warm, salty North Atlantic Drift. Subtle shifts in either atmospheric or oceanic circulation are expected to produce strong changes in the terrestrial environment of Iceland. As a consequence, the impact of North Atlantic Holocene circulation variability is likely to be stronger on Iceland than most other North Atlantic landmasses. Despite the large amplitude of climate change expected for Iceland during the Holocene, and numerous large ice caps that would respond to these changes, there are no complete records of terrestrial environmental change for the Holocene of Iceland, and the status of Icelandic glaciers in the early Holocene remains debated. It is not known whether Iceland's large ice caps disappeared in the early Holocene, and if they did, when they re-grew.

To address these questions, continuous cores from a deep, high-sedimentation-rate lake basin will be taken to provide high-resolution, quantitative evidence of environmental change over the past 10 ka. To determine the best position of the continuous sediment cores, an initial seismic survey of sediment fill in Hvítárvatn (a glacial dominated lake located at 420 m elevation on the eastern margin of Langjökull Ice Cap in central-western Iceland) was completed. Analysis of the seismic data reveals over 30 m of finely stratified postglacial sediment in the north basin, and shifting locations of primary sediment sources during the Holocene. The approximate sediment volumes for each of these periods have been determined. The shifting sediment sources are indications of possible environmental changes in Hvítárvatn basin and shifts in Langjökull Ice Cap.

The uppermost sediments in Hvítárvatn exhibit all the characteristics of clastic varves. Once the continuous cores are recovered, there is significant potential to use the varves to help address the question regarding the status of Icelandic glaciers during the Holocene. As each clastic varve couplet represents one year of sediment accumulation, a chronology can be constructed for Hvítárvatn for approximately the last 1500 years. Tephra marker beds will be identified in the cores to correlate with the varve chronology. In addition, for glacially dominated lakes, varve thickness is generally regulated by the intensity of summer melt. Initial study of the varved lake sediments confirms their nature and potential for more extensive work to be conducted.

Glacier front retreat in Van Keulenfjorden, Svalbard, during the last 100 years.

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Two large fronts of tidewater glaciers (Nathorst-, Liestøl- and Doktor glacier) are today terminating in Van Keulenfjorden, southern part of Spitsbergen. 100 years ago, these tidewater glaciers ended almost 15 km further out in the fjord (Hamberg, 1905). The climate on Svalbard has, since the first meteorological measurements started in 1912, become warmer, especially in the beginning of the last century, up to the 1930ies (Førland et.al., 1997), but this climatic change is probably not big enough to cause such a dramatic glacial retreat. Echo sounding measurements, aerial photos and old maps have provided information about the retreat history and fjord floor topography in Van Keulenfjorden, during the last century. The echo profile (fig. 1) starts just outside the large Nathorst end-moraine, marking the maximum glacial extent in historical time. It follows an approximate straight line, nearly reaching the 2002 glacier front in south east.

Retreat rates during the given periods are calculated from old glacier front positions (Liestøl, 1976). Between 1898 and 2002, the fronts retreated 14 km (≈135 m/yr), with rates varying from 77 to 250 m/yr. The fastest retreats appeared in periods when the glacier front terminated in relatively deep water. This relationship between retreat rate and water depth at the glacier front is clear. It suggests that water depth is an important controlling factor, and that a tidewater glacier retreat is not necessarily a climatic signal.

The preliminary results in this study indicate that water depth control the retreat rate of the glaciers in this arctic marine system, Van Keulenfjorden, Svalbard. Also, fjord geometry, surge events and sediment distribution are considered to be important, and will be studied further.

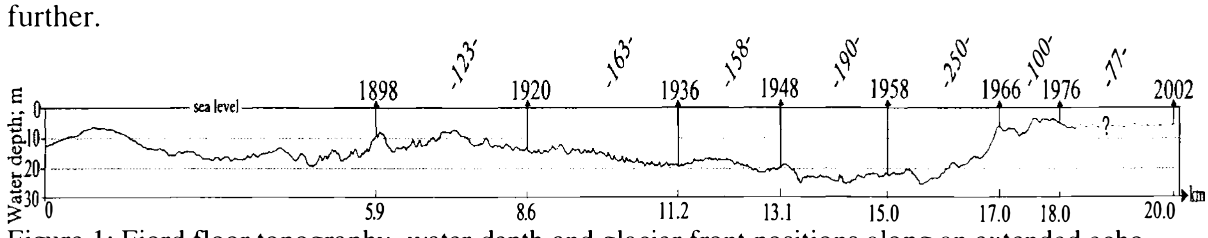

Figure 1: Fjord floor topography, water depth and glacier front positions along an extended echo profile in Van Keulenfjorden, Svalbard. Retreat rates during the given time periods (on top, in *italic*) are given in m/year. Front positions based on data from Liestøl, 1976.

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Deglaciation of the Aston Lowlands, Baffin Island, Eastern Canadian Arctic: the marine limit enigma

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The Aston Lowlands (AL) are the largest coastal foreland on eastern Baffin Island, located between Clyde Inlet and McBeth Fiord, both of which may have contained large ice streams during the last glacial maximum (LGM). Due to its relative isolation from the ice-stream-dominated fjords, the central AL is a key area for understanding the earliest stage of the last deglaciation of the Eastern Canadian Arctic (ECA). Previous workers traced delicate lateral meltwater channels on the central AL to a prominent shoreline at ~80m aht, the same elevation as the huge, raised Aston delta, from which *in situ* molluscs were dated >54,000 ^{14}C yrs BP. This led to the supposition that ice had not crossed the AL since the formation of the Aston delta (Løken, 1966), which became a cornerstone of the "small ice" model for the ECA.
New cosmogenic exposure (CE) ages of glacial erratics atop the Aston delta and adjacent summits indicate these sites were glaciated during the LGM. This suggests that the meltwater channels that end at the 80m shoreline may have been carved during the last deglaciation. However, aerial photograph and field observations suggest the late-glacial or Holocene marine limit to be ~30m aht, in accordance with the highest radiocarbon-dated raised marine features on the Clyde Foreland to the north, and Henry Kater Peninsula to the south. Raised marine features between 30m and the 80m marine limit are also present on the AL, but no distinct shorelines are preserved. Two shallow lakes above 30m on the AL contain simple deglacial sequences of till overlain by gytja, with no evidence of a marine incursion or non-marine pre-Holocene sedimentation. Radiocarbon ages are pending on shells collected between modern sea level and 80m and on basal organic macrofossils from a lake core at 75m.
CE ages and lake core stratigraphy support LGM ice cover on the AL. However, landforms presumed to relate to this glaciation are associated with the 80m marine limit that is demonstrably >54,000 ^{14}C years old. Three possibilities are suggested. 1. The 80m marine limit was reoccupied during the last deglaciation, but fossiliferous sediments were not deposited or not preserved, or have not yet been found despite detailed investigations. 2. Despite abundant and consistent CE ages, the central part of the AL was not glaciated during the LGM. The 30m shoreline, defining the deglacial or Holocene marine limit, was built by meltwater flowing in modern streams over an unglaciated landscape to the sea, while deglaciation proceeded farther west. 3. Meltwater channels draining to the 80m marine limit are relict features from a previous glaciation whose decay built the prominent shoreline. The channels and shoreline were preserved under minimally erosive cold-based ice. The Holocene marine limit is at least 30m aht, and meltwater descended to it along large channels now occupied by underfit modern streams rather than the channels that descend to 80m. We favour the last option.

Large scale development of the late Pliocene to Pleistocene glacigenic prograding wedge off Mid-Norway

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The post-Oligocene sedimentary succession offshore mid and northern Norway 65°-70°N is the focus of an ongoing collaboration project between the University of Tromsø and Statoil. The overall aim of the project is to achieve a better understanding of the sedimentary patterns and processes along the margin, and how these relate to vertical movements of the shelf as well as the bordering land areas. In this presentation we will focus on the late Pliocene to Pleistocene margin development. During this period a glacigenic prograding wedge (the Naust Formation) was deposited offshore mid-Norway. In places the wedge reaches a thickness in excess of 1.5 km, and during its deposition the shelf break migrated up to 200 km seaward.

Interpretation of an extensive seismic database comprising a dense grid of 2D- as well as 3D-seismics is well underway, and a detailed seismo-stratigraphic framework has been established. We have subdivided the entire late Plio- to Pleistocene prograding wedge of the Naust Formation offshore Nordland, and are thus able to reconstruct the out-building of the continental margin and make inferences about the sedimentary processes and paleo-environment.

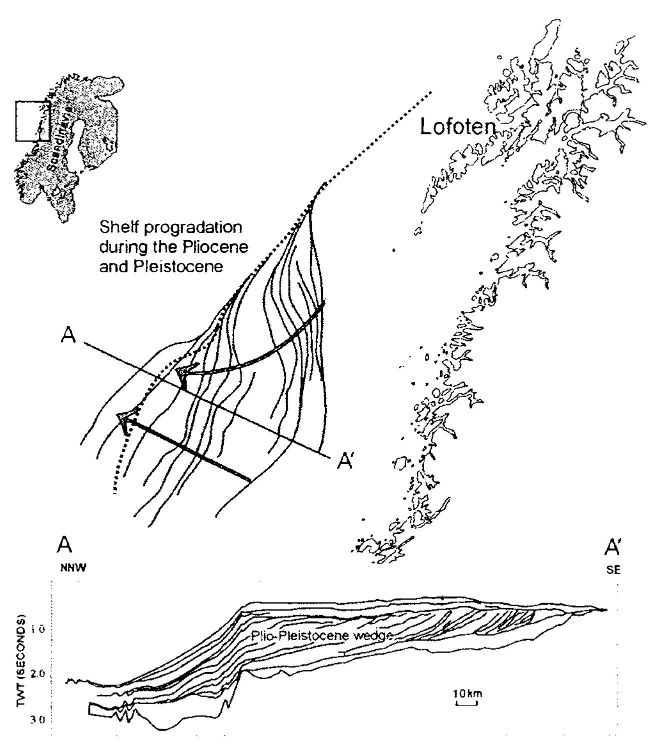

Figure illustrating the Pliocene to Pleistocene migration of the shelf break off mid-Norway. Also shown is an interpreted seismic profile running across the shelf. The present day shelf break is marked by the broken line.

Inter-species, radiocarbon age comparisons on subfossil molluscs from Arctic Canada: the *Portlandia arctica* problem.

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Ninety ^{14}C dates have been obtained on multiple species of marine molluscs collected from either the same enclosing sediments (direct comparisons, > 20 sites) or from sediments closely related to the same deglacial sea level (associations, ~10 sites). These sites range across the eastern Queen Elizabeth Islands (>100, 000 km^2), including one site on NW Greenland. All but one site occurs outside the limit of widespread carbonate terrain, predominantly of Paleozoic age. The study was prompted by the growing recognition that there was a noticeable discordance between ^{14}C dates obtained on the infaunal bivalve *Portlandia arctica* and its epifaunal counterparts, predominantly *Hiatella arctica* and *Mya truncata*. Most samples have been corrected for natural and sputtering isotope fractionation to a base of. 13C = -25 0/00, from which a marine resevoir correction of -410 years was then applied. These ages are essentially equivalent to the minority of samples calculated to a base of. ^{13}C = 0 0/00 (with no marine resevoir correction applied). We note that although the marine resevoir correction may vary in space and time, this variability would not account for age differences determined on species *within the same sample*.

Our 'direct comparisons' show that on the outer Hazen Plateau, NE Ellesmere Island, and at the entrance to Nares Strait, *P. arctica* is commonly. 1000 ^{14}C yrs older than *H. arctica* and *M. truncata*. Similar differences were found > 400 km to the west, on NW Axel Heiberg Island. Within the 'associations', *P. arctica* also displays consistently older ages, occasionally < 500 ^{14}C yrs older but in some cases up to 1500 - 2200 ^{14}C yrs older. Though some unknown amount of these reported differences may be the product of inter-laboratory factors, several of our 'direct comparisons' are the product of successive analyses in the same laboratory run.

We conclude that the older dates on *P. arctica* reported here are due to an exaggerated resevoir-age effect related to the uptake of 'old' carbon derived from adjacent carbonate terrain that characterizes most of the Queen Elizabeth Islands. It is noteworthy that the only direct comaprison that shows concordant inter-species ^{14}C dates (including *P. arctica*) comes from deglacial sediments within the Precambrian Shield. The so-called *Portlandia*-effect presented here has important implications for the Canadian High Arctic. Here, *P. arctica* has often been the shell-of-choice for field workers trying to establish the date of deglaciation because it is often the solitary pioneer species that prevails under the high sedimentation rates that characterized this environment. Excessive ages on *P. arctica* have also contributed to unusual postglacial emergence curves from this region. Whether the inter-species differences are site specific or vary systematically across this region is presently unknown. However, the persistence of this problem in samples as young as 3.5 ^{14}C ka BP indicates that this problem is not confined to deglacial environments.

Former ice shelves of the NW Laurentide Ice Sheet, Melville Island, NWT.

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The Viscount Melville Sound Ice Shelf, emanating from the M'Clintock Ice Divide of the NW Laurentide Ice Sheet, overrode the coast of SW Melville Island towards the end of the Late Wisconsinan. The ice shelf deposited Winter Harbour Till that extends 5-10 km inland and to ~100 m asl (Hodgson et al. 1984). Distal to the Winter Harbour Till, Bolduc Till extends ~10 km farther inland where it terminates against the oldest, recognized ice margin marked by Dundas Till. Degraded kames at the limit of Dundas Till form the drainage divide (~200 m asl) on central Dundas Peninsula. All three till sheet margins are convolute and remain broadly parallel for tens of kilometers suggesting that they all may be products of successive ice shelves.

Prior to our fieldwork (2002), two alternative interpretations were published concerning the age of Winter Harbour Till: Hodgson et al (1984) proposed that the till was bracketed by ^{14}C dates on marine shells spanning 10.3 to 9.6 ka BP, whereas Dyke (1987) proposed that the till was bracketed by older dates spanning 11.3 to 11.0 ka BP. The 11 ka BP date was required by deglacial shells collected by Dyke hundreds of km up-ice on Prince of Wales Island. The age of the Bolduc Till was unknown (possibly Late Wisconsinan, and equivalent to Liddon Till along M'Clure Strait to the south) whereas the Dundas Till was regarded to be pre-Late Wisconsinan.

We revisited several key stratigraphic sites on and adjacent to Winter Harbour Till. We determined that a large area of glaciomarine rhythmites (previously dated to 10.3 ka BP, Hodgson et al. 1984) prograded from the Winter Harbour Till into which outwash deposited shorelines at marine limit (72 m asl). Furthermore, this same marine limit overlies Bolduc Till, requiring them to be coeval. Hence, the Winter Harbour Till is simply a stillstand or readvance following deposition of Bolduc Till by the Viscount Melville Sound Ice Shelf. Retreat of Winter Harbour ice occurred when relative sea level had dropped to 35 m asl, marine limit on its proximal side (9.6 ka BP). This interpretation is consistent with Hodgson et al's (1984) original chronology, but incorporates Buldoc Till as well. Therefore, Buldoc Till cannot be coeval with Liddon Till (11.7 ka BP). Furthermore, if the original GSC dates bracketing Winter Harbour Till are confirmed by those currently submitted, then the 11 ka BP dates from Prince of Wales Island warrant further testing.

Hodgson (1993) reports that the advance responsible for the Viscount Melville Sound Ice Shelf first overrode shells on Victoria Island sometime after 10.4 ka BP (their ^{14}C age). Our observations indicate that this same ice had reached the inland limit of Bolduc Till and had retreated back to the limit of Winter Harbour Till by 10.3 ka BP. If this date is verified, then the 400 km advance of the Viscount Melville Ice Shelf (60, 000 km^2) occurred in less than 100 years during the Younger Dryas Geochron. Such a catastrophic evacuation of ice would have significantly lowered the marine-based M'Clintock Ice Divide, increasing its susceptibility to calving as eustatic sea level rose. Our current observations suggest that the Dundas Till may also be of Late Wisconsinan age, possibly the northern extension of Liddon Till. This will be tested by fieldwork in 2003.

Abrupt climatic variations during Younger Dryas and Early Preboreal in the northern Norwegian Sea continental margin

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New, detailed stratigraphical analyses, from sediment core JM99-1200, based on the planktic foraminiferal fauna, oxygen isotopic measurements (benthic and planktic), the content of ice rafted debris have been carried out. The aim is to reconstruct abrupt climatic change and variability during the Younger Dryas (YD) and during the Allerød (AL)/YD and YD/Preboreal– transitions to discuss the causes of the abrupt climatic changes.

The core is located in Andfjorden on the continental shelf off northern Norway at 476m water depth. This is an open marine location, which can provide us with a high resolution of climate records. The core site is influenced by two water masses. The relatively warm Atlantic Water from the North Atlantic Current and the less saline coastal water from the Norwegian Coastal Current. The chronology of the core is based on ten AMS ^{14}C datings performed on macrofossils. The AMS datings have been calibrated to calendar years by using INTCAL 98 (Stuiver et al., 1998). Sea surface temperatures (SST) were calculated by using the SIMMAX transfer function. The method is developed by Pflaumann et al., (1996) based on the modern analogue technique. Sea surface salinity were calculated by using the method of Duplessy et al., (1991).

Allerød has low temperatures in this area, but the Atlantic Water was probably present because of the high production signal in the amount of planktonic foraminifera/g. -The production decreases towards the transition between AL and YD. This is also supported by an abrupt and large decrease in the $\delta^{13}C$. In the beginning of YD there is an extreme low production signal and low temperatures. Late YD shows the lowest temperatures, which correlates very well to other high resolution records, in particular the GRIP ice core (Johnsen et al., 1997). The gradual decrease in oxygen isotopes during YD indicates an accumulation of fresh surface water in the area. The transition from YD to Preboreal is characterized by extreme temperature instability between cold (2°C) and warm (10°C) from 11300-11500 calendar yr. BP in the sea surface temperatures. These fluctuations are also observed in extreme variations in the planktic fauna composition, by a shift in dominance between the polar and sup polar species and planktic foraminifera/g. Areas close to the large ice sheets glaciers appear to be very sensitive to climatic variations at the transition between cold and warm climatic modes. A possible explanation for the instability seen in this record may be the interaction between meltwater from the waning Fennoscandian Ice Sheet and high influx of Atlantic Water.

Deglaciation of Vestfjorden, North Norway

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The deglaciation of the Trænadjupet – Vestfjorden – Ofotfjorden area, one of the major drainage routes of the north-western part of the Fennoscandian Ice Sheet, is being studied as part of the Norwegian Research Council funded project SPONCOM (2002 – 2006) at the University of Tromsø. Here we focus on some preliminary results from the Vestfjorden area, an area which so far has received little attention from researchers.

Two distinct submarine ridges have been identified on seismic profiles. The outer ridge, situated across the fjord from Røst to Bodø, is 20 km across and up to 80 m high. The inner ridge lies parallel to the outer ridge, about 25 km further north-east, near Værøy. It is 20 km wide and up to 50 m high. Both ridges have an acoustically transparent seismic signature.

A 4.36 m long gravity core was retrieved from a small basin immediately outside the outer (Røst) moraine. Preliminary examination of the core reveals three main units: the lowermost unit consists of 1.6 m of dark grey diamicton, interpreted as a basal till. The middle unit consists of 2.35 m of bioturbated, massive silty clay. Sporadic clasts interpreted as IRD, and a cold-water fossil fauna suggest a glaciomarine origin for the silt. The upper unit consists of a 30 cm thick, bioturbated clast-rich silt, fining upwards into 10 cm of silty clay with occasional clasts and 5 cm of clayey silt. A relatively warm-water fossil fauna suggests a non-glacial origin for the upper unit.

The timing of events are not yet precisely known. Previous workers have indicated that the ice front retreated from the shelf edge south of Lofoten somewhere between 19 and 16 ^{14}C ka BP (Olsen et al., 2001; Dahlgren & Vorren, 2003), and north of Lofoten by 14.6 ^{14}C ka BP (Vorren & Plassen, 2002). The ice front was positioned at the coast during the Older Dryas chronozone (12.2 ka BP; Olsen, 2002). Thus, the locality was deglaciated between 12.2 and 16 ka BP. Radiocarbon dates are pending.

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Trace elements in plants on landslide-affected slopes in Yamal Peninsula, Russia

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The landslide process widely distributed in a typical-tundra subzone of the Yamal Peninsula, actively changes the primary surface of the marine plains and terraces. The landslide affected slopes cover up to 70% territory. The cryogenic landslides are developing on the surfaces built of the fine-grained marine sediments with a high salinity (Dubikov 2002). Research is based on the data obtained from the station 'Vaskiny Dachi' since 1988. The monitoring of the landslides includes study of the trace element composition in plants on the landslide-affected slopes.

The process of the biological accumulation of trace elements is extremely uneven, and depends upon morphological elements of slope (B - shearing plain, C - landslide body), age of landslides, species and life forms of plants. The results of chemical analyses have shown that high willow canopy dominated on ancient landslide slopes is characterized by the maximum content of trace elements, especially zinc, strontium and boron (Ukraintseva et al. 2000). The trace element content (in ash) is essentially higher in willows than in grasses (Fig.).

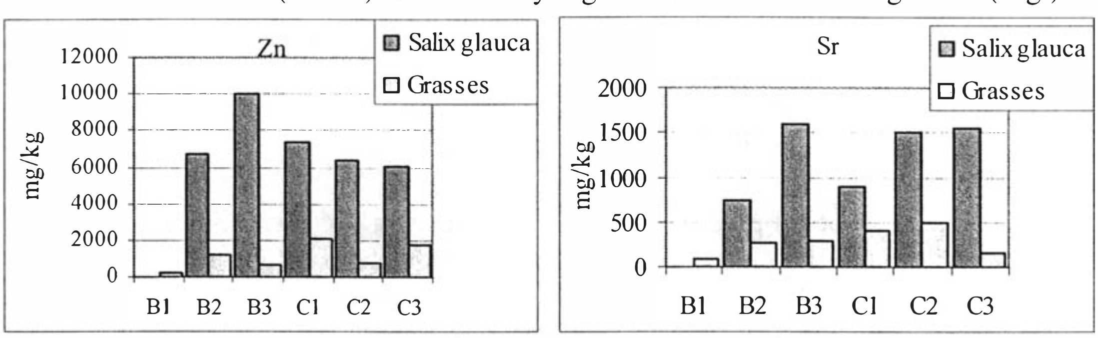

Figure. Zinc and Strontium in willow branches and in grasses on different ages landslides (1 – young, 2 – old, 3 – ancient)

Chemical composition of plants is determined by the period of their existence on landslide-disturbed surface and can serve to determine the relative age of landslide events. Trace elements in the willow branches may be increased or decreased with age (fig). The latter obviously has to do with the mobility of one or other element and its migration-rate in an active layer (Table).

Table. Trace elements in willow branches as the indicators of landslide age

Shearing plains	Trace elements	Landslide bodies	Trace elements
B+*	Zn , Sr, V **	**C+**	Sr, Ni, Cu
B–	Ni, Co, (Cu)	**C–**	Zn, Co, V

* + content of trace elements increases with age, – content of trace elements decreases with age. ** – significance decreases from left to right, poor-informative elements are parenthesized.

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Connection between deglaciation and seismotectonics of the Kola region (NW Russia)

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The most complete of information is obtained on the Late Valdaian (Weichselian) glaciation, having reached maximum distribution in the Kola region ca. 16 000 years BP. In the first step of deglaciation that lasted approximately 5 000 years, areal deglaciation took place. During interstadial warmings extensive peripheral covers were cut off from the main ice mass and thick glaciofluvial deposits accumulated in periglacial basins near the edge of the active ice. Dead ice melting was going on for a long time including several interstadial warmings. The glacier that advanced during the phases of stadial coolings deformed interstadial deposits and built mainly push moraine ridges. Thus, a marginal belt was formed during each interstadial-stadial climatic cycle at the edge of active ice. Three marginal belts were formed during the period between the Last Glacial Maximum in the Kola region and the Preboreal. In the second step dissected deglaciation took place. The ice sheet was dissected by extended marine gulfs during the warming at the beginning of the Holocene. In these gulfs glaciomarine sediments were superseded by marine deposits, probably due to final ice melting about 9 000 years BP.

Typical paleoseismic dislocations have been detected by field observations in the Kola Peninsula. They are expressed in topography in the form of seismic ditches, scarps, gorges, landslides and disturbances in Quaternary sediments bedding. The dislocations are accompanied by such phenomena as collapses, pillars and other seismic signatures, which are not found outside the seismogenous structures, and are confined to active fault zones. The map of ancient earthquake epicenters was made on the basis of geological data and aerophoto interpretation. These are distributed unevenly. The epicenters mainly concentrate in the west and in the center of the Kola Peninsula, in the area, which has been occupied by active ice during the Older and Younger Dryas or near the distal side of the Older Dryas marginal ridges. Such a distribution of dislocations is explained probably by fast deglaciation of the territory occupied by the Younger Dryas ice cover, and by the sharpest ice and topographic gradient in some places in the area which was covered by active ice in the Older Dryas. The epicenters of ancient earthquakes and the epicenters of most of historical (recorded in historical manuscripts) and recent earthquakes coincide. This apparently testifies to the inherited nature of the historical and modern ones.

Variation of IRD in Van Mijenfjorden (Svalbard) during the Holocene

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The objective of this study is to elucidate the variation of ice-rafted debris (IRD) in Van Mijenfjorden (Svalbard). Van Mijenfjorden is the second largest fjord in western Svalbard, being 50 km long and about 10 km wide. The island Akseløya crosses almost the entire fjord width in the outer parts. At present, sediment contribution to the fjord occurs from several rivers, as well as from glaciers at the fjord head and close to the fjord mouth, respectively.

The IMAGES core MD99-2305 was sampled about 10 km in-fjord from Akseløya. It is 18 meters long. The uppermost c. 16 m of the core comprise Holocene mud, whereas the lowermost 2 m are composed of glacimarine muds and diamictons. 10 radiocarbon dates provide the chronology of the core, indicating that the uppermost 16 m represent the last c. 11 000 cal. years. X-radiographs from half-core sections were analysed, and grains coarser than 1 mm were defined as IRD. Results are presented as IRD flux (number of grains$*cm^{-2}*ka^{-1}$).

Very high IRD flux (up to 900 grains$*cm^{-2}*ka^{-1}$) characterises the period between c. 11 000 and 10 700 cal. years BP. It is supposed that these high values reflect the final phase of the main deglaciation of the fjord. A distinct drop in IRD flux around 10 700 cal. years BP is suggested to indicate the end of major glacier retreat. Mean IRD flux of less than 20 grains$*cm^{-2}*ka^{-1}$ between 10 700 and 7000 cal. years BP is supposed to represent a relatively warm early Holocene with reduced glacial activity. The period between 7000 and 5000 cal. years BP is characterised by increasing IRD-flux, including two marked peaks (c. 50 grains$*cm^{-2}*ka^{-1}$) around 6300 and 5800 cal. years BP, representing the highest IRD-flux in the fjord after the deglaciation. The increasing IRD flux appears to reflect increasing glacial activity. After 5000 cal. years BP, mean IRD flux decreases from c. 15 grains$*cm^{-2}*ka^{-1}$ to less than 5 grains$*cm^{-2}*ka^{-1}$ within 1000 years. From 4000 cal. years BP to the present, IRD flux further decreases to the lowest values during the Holocene. One possible reason for decreasing IRD values can be an increasing amount of sea ice suppressing ice drift and hence the deposition of IRD (see Dowdeswell et al., 2000). However, within the period of general IRD-flux decrease, three marked peaks occur. These are correlated to a major surge of the Paula Glacier system around 1300 AD, as well as two subsequent IRD maxima around 1480 AD and 1580 AD, as mentioned by Hald et al. (2001).

Benthic foraminifera analysis, as well as $\delta^{18}O$ and $\delta^{13}C$ measurements (performed on the benthic foraminiferal species *Cassidulina reniforme*) support the inferred environmental changes in the fjord during the past c. 11 000 cal. years, based on IRD-analysis.

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Glacial inception and Quaternary mountain glaciations in Fennoscandia

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The aim of this study is twofold. First, the role of the Fennoscandian Mountains as nucleation centre for glacial inception is investigated. The second objective is to review glacial erosion by mountain glaciers throughout the Quaternary. All available field data and several modelling experiments show that the Fennoscandian Mountains seeded the last glaciation. Since the mountains seem to be of key importance for ice sheet inception, it is reasonable to assume a similar inception pattern throughout most of the major Pleistocene glaciations. This pattern also implies prolonged periods of glacial ice in the Fennoscandian mountains during late Cenozoic time. Mountain based glaciers thus have had a long time to act on their substratum resulting in a profound geomorphological impact.

Coastal erosion activization of Yenisey North rivers

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Field observations revealed the activization of of thermal erosion processes of Yenisey, Norilskaya, Valyok rivers banks. It seems likely to be a result of global climate warming causing ground ice and perennial snow patches melting as well as water level increasing after main flood-time.

A specific relief with block up to 25-30 m high and about 60 m wide have been formed in the Yenisey estuary where polygonal-wedge ice develop. Temporary or permanent water streams appear along melting ice-wedges forming gullies that are of inherited polygonal shape because of rapid ice melting.

In sites of ground sheet ice development, thermal erosion gives rise to cirques formation up to 50-80 m in diameter. Cirque walls are formed of ice and frozen ground. Sheet ice of injected or sometimes segregated origin is up to 3-3.5 m thick. Along the contact with surrounding ground, the zone of ice-reach ground of reticulate and ataxite cryogenic texture is observed. Rates of denudation are different within the cirque because thawed loam covers the ice surface unevenly. This tixotropic matherial fills up the cirque bottom and streams towards the river form. Ice-reach peat layer covering loams thaws slower than cirque walls and almost everywhere overhangs like caps up to 0.5-1 m wide. After caps collapse, the heat flow to the ice-reach contact zone and rate of denudation increase.

Presence of sheet ice decreases the geotechnical safety of constructions. Thus, the support of bridge over the river Norilskaya had been deformed. This bridge, about 1 km long, in the left part leans on the frozen river bank by the foundation. In the base of foundation ground layers are as follows: 0-14 m - artificial embankment of coarce matherial; 14-18 m - loam, ice content 0.2-0.4; 18-28 m - ice layer; 28 m and lower - clay, ice content 0.2. While the support was being constructed, the natural equilibrium of geocryological conditions had been disturbed and the ground ice began to melt out. For 20 years, the foundation was undergone complicated deformation: downwards (up to 1800 mm) and laterally with the river current (up to 650 mm). The deformation resulted in the destruction of the railroad and the highway, damage of vehicles.

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Late Holocene sedimentation and tephrochronology in the marine Skjálfandadjúp basin, Tjörnes Fracture Zone, North Iceland.

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The Tjörnes Fracture Zone lies across the North Icelandic Shelf. Active volcanic systems and tectonic activity have formed several north south trending basins which form sediment traps for marine sediments transported along the shelf. Iceland is located in an area of sharp oceanographic and atmospheric gradients. The northern part of the North Icelandic shelf is close to the boundary between the cold, low-salinity East Icelandic Current, and the relatively warm, saline Irminger Current, which flows clockwise around Iceland. The area is also periodically covered by seasonal sea ice, which extends from Greenland to Iceland. Palaeorecords and documentary records from Iceland show that changes in the position of the frontal systems have occurred in recent times. Core material from a 37 m long CALYPSO piston core was obtained on the 1999 RV Marion Dufresne IMAGES Cruise. The material is used to study the dynamics of the sediemntary basin east of Grimsey Island on the North Icelandic Shelf. The present-day water depth is 450 m. Ultra high resolution in the shelf sediments (up to 2.5 mm/yr) and the presence of terrestrially dated air-fall tephra markers from Icelandic volcanoes, as well as radiocarbon dates of marine molluscs in the core material yields a time resolution of 10-50 years per one cm thick core slice sample. The multidisciplinary study of the late Holocene record of predominantly muddy sediments in the Skjalfandadjup basin demonstrates that marked variations in the distribution of water masses have occurred repeatedly through the last 2000 cal. years. In addition to short- term fluctuations there is a clear indication of environmental changes corresponding in time to the Medieval Warm Period and the Little Ice Age. A higher frequency variability is reflected by changes in grain size properties and mineralogical composition of the sand fraction.

Recent environmental changes in western Spitsbergen inferred from lake sediments

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Analyses of gravity cores raised from four lakes in western Spitsbergen, Svalbard, show marked stratigraphical changes in recent (post Little Ice Age) sediments. The lakes have varied water chemistries (pH range: 6.3-7.4) and contrasting edaphic characteristics, one being coastal and three occupying upland basins. At Skardtjørna and Tjørnskardet on Nordenskiöldkysten, there is an apparent floristic change coupled to increased diatom concentrations in the uppermost 12 cm of sediment. At the former site, there is also evidence of increased sedimentation rates, suggesting accelerated catchment geomorphic activity in recent decades. At Istjørna and Istjornelva, 25 km southwest of Longyearbyen, striking changes occur in siliceous algal assemblages contained in the upper 3 and 6 cm of sediment, respectively. At both sites, diatom and chrysophyte cyst concentrations increase dramatically in the most recent sediments. Although few microfossils are present in older sediments, those observed show no signs of dissolution, eliminating this as the potential cause for the recent stratigraphic changes. Instead, we hypothesize that algal production has increased in all four lakes in the 20th century, most likely as a synergistic response to climate warming (longer growing seasons) and atmospheric nutrient deposition. These results are compatible with observations from both northern Scandinavia and Arctic Canada.

Ice sheet history of the Eurasian North reflected in genetic variation of arctic plants

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Recent efforts under the international QUEEN programme (*Quaternary Environments of the Eurasian North*) have defined, mapped and dated ice-marginal zones across the Russian high arctic, from the White Sea area in the west to the Taimyr Peninsula in the east, for highlighting the ice sheet history during the last > 150,000 years. The program defines four periods with extensive glaciations: (1) A Late Saalian glaciation (older than 130,000 years) was one of the most extensive glaciation during the Quaternary, with immense areas in Eurasia covered by huge glaciers; (2) An extensive glaciation during the Early Weichselian (ca. 90,000 years ago); (3) successively smaller glaciations during early Middle Weichselian (60-50,000 years ago) and (4) the Late Wichselian (21-18,000 years ago). The Early Weichselian glaciation covered the coastal northern Russia and western Siberia and extended eastwards over the Kara Sea and the Yamal and Taimyr peninsulas, whereas later, during the Middle and Late Weichselian glaciations, the centre of glaciation shifted westwards and areas east of the Kara Sea basin were mostly ice-free.

A separate study of the structure of genetic variation within and among populations in four closely-related arctic clonal sedges was carried out on a west-east transect along the northern Russian and Siberian coast (Fig. 1) during the Swedish-Russian Tundra Ecology-94 Expedition. The sedges studied were *Carex bigelowii*, *C. ensifolia*, ssp. *arctisibirica C. lugens* and *C. stans.* The studied taxa all had high levels of genetic variation, both within populations and taxa. Genetic variation observed could not be related to any tested environmental variable, but showed significant correlation to the length of time each area had been ice free: the highest genetic variation was found in population growing in easternmost areas, that were ice free throughout the last glacial cycle, and the lowest variation occurs in populations growing along the coast of the Arctic Ocean in Northern Russia, in areas glaciated or in close proximity to ice sheets during the Middle and Late Weichselian.

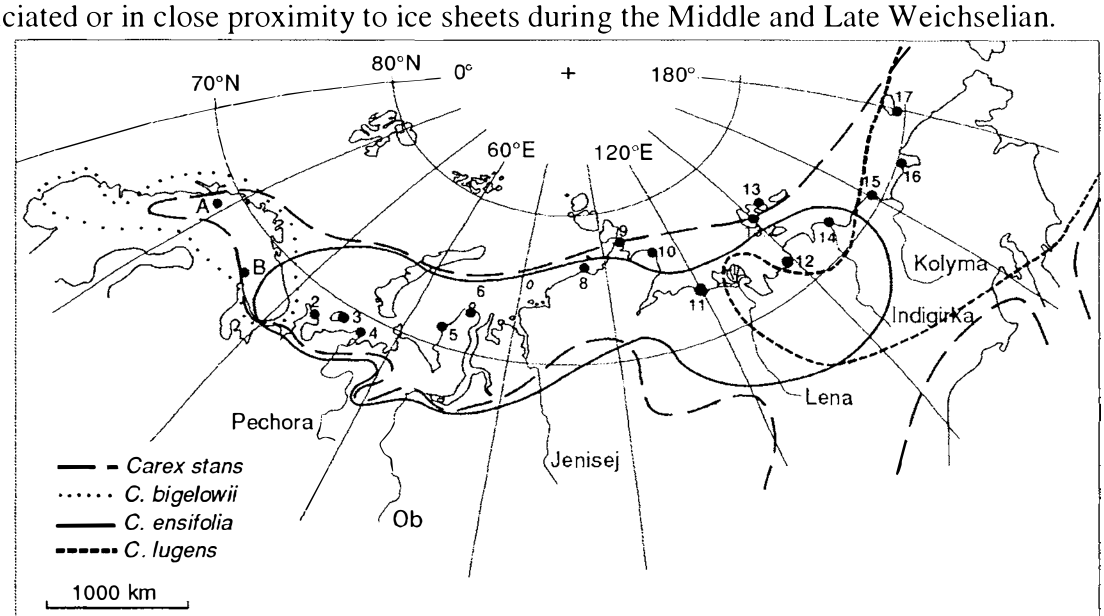

Fig. 1. Study sites and distribution of Carex taxa along the Arctic Ocean.

Ice cores from Svalbard - useful archives of past climate and pollution history

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Ice cores from the relatively low-lying ice caps in Svalbard have not been widely exploited in climatic and environmental studies due to uncertainties about the effect of melt water percolation. However, results from two recent Svalbard ice cores, at Lomonosovfonna and Austfonna, have shown that with careful site selection, high-resolution sampling and multiple chemical analyses, it is possible to recover ice cores with preserved annual signals. These cores are estimated to cover at least the past 600 years and have been dated using a combination of known reference horizons and glacial modeling. The □^{18}O data from both Lomonosovfonna and Austfonna ice cores suggest that the 20^{ieth} century was the warmest century during the past 600 years. The anthropogenic influence on Svalbard environment is illustrated by increased levels of non sea-salt sulphate, nitrate, acidity, fly-ash and organic contaminants particularly during the second half of 1900s. Decreased concentrations of some components in recent decades most likely reflect emission and use restrictions. However, some current-use organic pesticide compounds show growing concentrations in near surface layers. The distribution of species in these two Svalbard ice cores has probably been altered to some degree by melt but the records still provide information about major trends in atmospheric variability of both climate parameters and pollution history.

A tephra study of marine sediment cores and terrestrial sequences on the Vestfirdir Peninsula, NW Iceland; preliminary results.

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Geochemical study of tephra layers in soil sections and lake sediments on the Vestfirdir Peninsula, and marine sediment cores from the surrounding shelf, provide a basis for developing precise correlations between terrestrial sequences with marine records during the last deglaciation of Iceland. The marine sediments are well constrained by numerous AMS ^{14}C dates. The magnitude of the marine reservoir correction in the area is established, by comparing the radiocarbon dates obtained from marine cores and terrestrial sequences containing the same tephra layers. The presence of two marker layers has been confirmed **in our sites**; the Vedde tephra (10300 ^{14}C yr; 11980±80 cal. yrs BP) and the Saksunarvatn tephra (9000 ^{14}C yr; 10180±60 cal yrs BP).

The available radiocarbon dates bracket the age of the Vedde tephra in the cores. In the marine core MD99-2264 from the Djúpáll trough, a sample taken just above the Vedde tephra resulted in an AMS radiocarbon age of 11170±90, and a sample taken approx. 155 cm below the tephra shows an age of 12080±90. Reworked grains with geochemical signatures similar to the Vedde tephra have also been identified at the base of an 18 m long fjord core MD99-2265. This fjord core has a basal date of 10700±120 ^{14}C yr. In both the trough and the fjord, seismic data show that the Vedde tephra coincides with a prominent reflector interpreted as an erosional boundary. This boundary lies just below the base of our fjord core. Based on the 10300 ^{14}C yr age of the Vedde tephra, the uncorrected ^{14}C dates that most explicitly date the base of the tephra in our cores, suggest an 800 yr ocean reservoir correction on the northwest Iceland shelf. This is consistent with the ocean reservoir correction calculated from sediments containing the Vedde tephra taken from the north Iceland shelf (Eiríksson et al., 2000).

The Saksunarvatn tephra is a very distinct layer in cores MD99-2264 and MD99-2265. Extensive ^{14}C dating above and below this tephra layer in each core restricts the age to an uncorrected AMS date of 9400 ^{14}C yr BP. The Saksunarvatn tephra is also present on land, both in lake sediments and soil sections close to the shore of Jökulfirdir and in Nordurfjordur. Comparing -AMS ^{14}C ages of this tephra on land and in the marine cores suggests a reservoir correction of 400 years, which is consistent with the conclusion of Andrews et al. (2002).

Both the Vedde tephra and the Saksunarvatn tephra fit well into the age-depth model of the marine cores providing credibility to the AMS radiocarbon dates. Work on additional tephra layers found both in the marine environment and on land is in progress and will further aid in the correlation between terrestrial and marine sequences-during this sensitive time in the glacial history of Iceland.

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Arctic Ocean freshwater outbursts during Saalian and Early Weichselian ice-sheet collapse

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Improved multi-parameter records from the northern Barents Sea margin show two prominent freshwater pulses into the Arctic Ocean during MIS 5 that significantly disturbed the regional oceanic regime and probably affected global climate. Both pulses are associated with major IRD events, revealing intensive iceberg/sea ice melting. The older meltwater pulse occurred near the MIS 5/6 boundary (~ 131,000 yr B.P.); Its ~ 2000 year duration and high IRD input accompanied by high illite content suggest a collapse of large-scale Saalian Glaciation in the Arctic Ocean. Movement of this meltwater with the Transpolar Drift current into Fram Strait probably promoted freshening of Nordic Seas surface water, which may have increased sea-ice formation and significantly reduced deep water formation. A second pulse of freshwater occurred within MIS 5a (~77,000 yr B.P.); Its high smectite content and relatively short duration is possibly consistent with sudden discharge of Early Weichselian ice-dammed lakes in northern Siberia as suggested by terrestrial glacial geologic data. The influence of this MIS 5a meltwater pulse has been observed at a number of sites along the Transpolar Drift, through Fram Strait, and into the Nordic Seas; it may well have been a trigger for the North Atlantic cooling event C20.

Late glacial paleoceanography of Hinlopen strait, Northern Svalbard

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Timing and structure of the late and post glacial development of the northern Svalbard margin, together with the initial influx of the Atlantic water into the Arctic Ocean are still very poorly constrained. We investigated a sediment core (NP94-51) from a high accumulation area on the continental shelf north of Hinlopen Strait with the purpose of resolving the timing and structure of the last deglaciation. Detailed analyses of ice rafted detritus, benthic and planktic foraminiferal fauna, diatom flora, grain size and radiocarbon dates are used to reconstruct the paleoceanographic evolution of the area. Our results indicate that the disintegration of Hinlopen Strait ice and possibly the northern margin of the Svalbard ice sheet commenced between 13.7 – 13.9 ^{14}C Ky BP. Influx of subsurface Atlantic waters into the area (12.6 ^{14}C Ky BP) and the retreat of the sea-ice cover with the accompanying opening of the surface waters (10.8 ^{14}C Ky BP) happened at different times and both much later than the disintegration of the ice sheets. Climatic transition from the YD to the Holocene happened at 10.1 ^{14}C Ky BP at this site accompanied by increases of *M. barleeanus* and *I. norcrossi/helenae*. However, the lack of significant increase in *C. neoteretis* implies that significant bottom water warming is not evident at the transition to the Holocene at the northern Svalbard margin. This is true also for the surface waters. Whereas, in the eastern Nordic Seas this transition involves surface water temperature increases between 5 to 9°C (Koç et al. 1996). The return of *N. labradorica* at 9.8 ^{14}C Ky BP could reflect a return of the Polar Front and hence, deterioration of the climate during the PB. This would indicate the presence of a possible Preboreal Oscillation at this area and a two-step warming at the start of the Holocene as documented from the Nordic Seas.

Postglacial glacio-isostatic movements of the Kola Region, Russia

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The relative sea-level change of Barents and White Seas' coastal line during Late Pleistocene and Holocene was studied for the estimation of glacio-isostatic emergence of Kola region. Reconstruction of sea-level change has been made for different parts of the region using the relative sea-level (RSL) curves .

The three RSL curves for the Barents coast (Snyder et al., 1996, Corner et al., 1999, 2001) show a pattern of uplift which conforms predictably with the position of each site relative to the margin of the retreating Fennoscandia ice sheet.

The form of RSL curves of Barents Sea coast testifies to the following. During the period between 10000 and 9000 years ago the rapid relative emergence (4-5 cm per year^{-}) of territory took place. The stillstand or relative sea-level rise from 8000 to 6000 years BP correlates with the regional Tapes transgression. During the last 6000 years the territory emerged with moderate (<0.5 cm year^{-}) velocity.

The two RSL curves have been derived for the White Sea coast (Kolka et al., 1998, 2000). The form of RSL curves for Lesozavod area (SW coast of Kandalaksha bay) testifies about the high velocity (4-5 cm per year^{-}) of a relative emergence of coast during the period from 10000 up to 9000 years BP and about moderate velocity (~1 cm per year^{-}) of a emergence during the younger period of a geological history.

The RSL curve for Umba area (Tersky Coast of White Sea) shows the relative sea-level rise betveen ~ 11000 and ~10000 years BP. However, at present the time frameworks of late-glacial transgression are outlined only and the late-glacial transgression maximum is not established. In Holocene the Umba section of White Sea coast emerged with moderate (~1 cm per year^{-}) velocity.

On the basis of the analysis of RSL curves of Barents and White Seas and the position of isobases for Holocene transgression maximum is concluded, that in late-glacial and in Holocene time the coasts of Kola Peninsula have possibly endured the fading of glacio-isostatic emergence in time. The last one had most likely the dome-shaped form. It occurred simultaneously with eustatic rising of the Ocean level and, usually, exceeded it on velocity. The position of coastal line of Barents and White Seas in each particular site of coast is caused by a difference in velocities of glacio-isostatic and eustatic risings. These differences depend, probably, on rate of glacial loading and intensity of melted water inflow to Ocean.

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Chlorine as a geochemical indicator of the marine influence in tundra plants of the Lower Yenisey

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It is known that the chemical composition of plants considerably depends upon their phylogenetic specialization and the living form. The ecotope geochemical environment is however also significant. The coastal and estuarine ecosystems are developing under the evident impact of the marine air and water masses that is reflected in the chemical composition of their components, and plants in particular. Marine impact on the terrestrial environment can be followed in concentration of the typical "marine" elements such as chlorine. It was suggested that the remote watershed areas received less chlorine input by air while the flood plain islands could be subjected to additional marine impact due to seawater ingression.

Chlorine content has been studied in plant species collected during the field studies performed in the framework of the INCO-COPERNICUS project «ESTABLISH» devoted to the biogeochemical interactions in the estuary areas. Sampling sites were located in the Yenisey delta and gulf areas. Plant species were presented by the most widespread species of lichens, mosses, willow, herbs, and horsetail growing in typical watershed and flood plain conditions. Air-dry plant samples were milled and analyzed for chlorine with the help of XRF spectrometer ORTEC-TEFA by Dr. Sorokin (Dokuchaev Institute). Determination error did not exceed 2-7%.

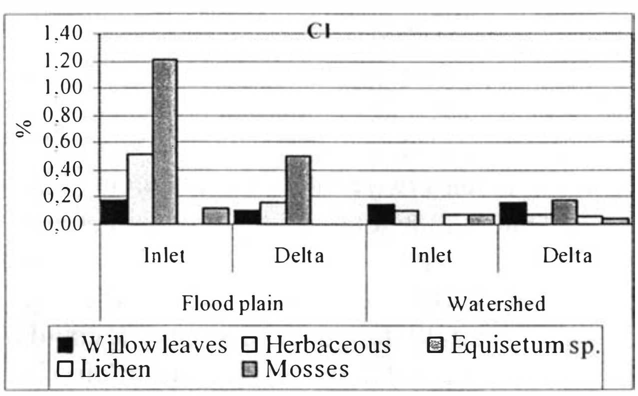

Figure. Chlorine in dominating species of tundra landscape.

Obtained results showed that the chlorine content is higher in all studied plant groups and species of the flood plain area compared to the Yenisey watershed terraces (Fig.). Site-specific variation in chlorine concentration is most pronounced in horsetail and herbs (grasses, sedges). In these plant groups the element content increases 2-3 times in seaward direction, e.g. from 0.5% (horsetail) and 0.15% (grasses, delta area) to 1.2% and 0.5% (the same plant groups, gulf area). Willow species (leaves) had low chlorine concentration at all sites (0.1-0.2%). Lichens and mosses collected on the Yenisey terraces were noted for the lowest chlorine content however higher in the inlet area compared to the delta site.

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Distribution of Salinity and Some Water-Exchangeable Ions in the Yenisey Inlet and Delta Soils

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Salinity of the soils formed in the estuarine area is of particular interest contributing to the knowledge of the recent and historical interaction processes in the ocean-land transitional zone. This publication discusses some preliminary data on water-exchangeable ions determined in several soil profiles investigated in the island and coastal parts of the Yenisey delta and inlet to reveal the bilateral influence of the river discharge and the marine environment on landscape geochemistry. Detailed landscape observation, test soil boring and leveling helped to select sites comparable in geomorphology and lithology of sediments. Particular attention was paid to accumulative zones with the soddy gley loamy soils containing enhanced concentration of fine particles. Salinity was determined as the total sum of the main ions in the analysed filtered soil water extraction using standard chemical methods of soil analysis (Arinushkina, 1961, analyst - R.V. Grishina). Ion determination error did not exceeded 10%.

Concentration of the water-exchangeable ions varied in soil samples from 0.008% to 0.066% (six profiles, 46 samples). Maximum value within soil profile was found on the low-level flood plain situated at the beginning of the Yenisey delta (Fig. 1, PSH1-3, 0.049±0.009%, n=10). The total ion concentration was lower 1)in the analogous soil profile located in the central delta part (e.g. TS1-8, 0.037±0.005%, n=8) and 2)in the similar soil profiles sampled on the adjacent coastal flood plain relative to the island part (average values 0.020 and 0.025%). These two observations support the idea that the accumulative island part of the flood plain and its frontal part in particular have zones most enriched in water exchangeable ions due to the most active accumulation of the suspended load with a higher water-exchangeable capacity. Vertical distribution of the water extraction salinity exhibits at least two peaks corresponding to the depths of approx. 10 and 40 cm (Fig.1). Independently of the total salinity the distinctness of both peaks drops in seaward direction that is also suggested to be related to the river discharge parameters. The peaks may indicate some historically correlated flooding events noted for enhanced sedimentation of particular river deposits naturally fading downstream. It could also indicate the sea-river interaction. This hypothesis was supported by depth distribution of the ion concentration ratio (Ca''+Mg'')/(Na'+K') also showing peaks at the corresponding depths. The ratio factor distinctly separated the inlet profile more subjected to marine impact from the delta ones. In the inlet profile its value equaled to 2, while in the delta soils varied from 7 to 9.
The work was performed in the framework of the INCO project ESTABLISH.

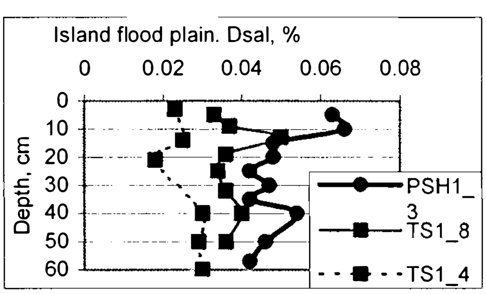

Fig.1. Selected soil salinity depth profiles

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Oligocene-Holocene evolution of White Sea and adjacent areas in respects to diamond placers' formations

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The region of White Sea depression was denudation and removal area since the Devonian time of the regional kimberlitic magmatism, during the Mesozoic and up to the beginning of the Cenozoic.

The trough of the White Sea was formed in Oligocene as midland depression. The revealed in White Sea seabed sediments are represented only by Quaternary deposits. These are deposits of two last glaciations, Moscow and Valdai ones, and divided by interglacial deposits. During the last interglacial time the White Sea was a part of the vast basin, uniting the Barents and Baltic seas, the last ones were jointed by the wide channel.

The Kara (Novaya Zemlja?) ice sheet was actively developed in region during the Moscow and Early Walday glaciations. It transported the material in general southwest and western direction. It means that the material from the Arkhangelsk kimberlitic province could be transported to the White Sea depression and to the easternmost Kola part of its shelf at that time. Noteworthy, that there are the number of diamond-bearing pipes, overlapped only by Quaternary deposits (the commercial pipes of Zolotitzky field, the diamondiferous pipes of Kepinsky field). Of interest are the similar compositional and genetic peculiarities of the pyropes and chrome-diopsides from the kimberlites of Arkhangelsk province and from the Holocene sediments of Tersky Coast, Kola Peninsula. The eastern and southeastern areas of the Kola Peninsula could be regarded as the one more possible source of diamonds (diamondiferous kimberlitic pipes of established Ermakovsky field and of inferred Makeevsky, Pyalitzky, Pulongsky and Snezhnitzky fields) (Sorokhtin et al., 1996, Gavrilenko et al., 2002) The material was supplied in depression of the White Sea by glaciers, ancient glaciofluvial and river streams.

Numerous sea transgressions and regressions are authentically established and the several stages of sea basins' development in depression of the White Sea during the (terminations) interglacial periods are also revealed. In accordance with this fact, the migration of the coastal line and of the littoral zone happened that is favorable for accumulation of heavy minerals, including the diamonds. The most promising placer-bearing sediments are the marine deposits of the last interglacial in the Tersky Coast of the Kola Peninsula.

Interglacial deposits of different genesis can be regarded also as the intermediate collectors for Holocene diamond-bearing placers.

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Molecular study of the foraminiferan *Elphidium williamsoni* reveals a promising paleogeographic tool in the European Arctic

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The littoral fauna of foraminifera of the North Atlantic is thoroughly studied (Alve & Murray 1999) and has been broadly used in paleo-reconstructions, e.g. sea-level change (Horton et al. 1999). By contrast, little is known of the Arctic intertidal foraminifera.

The calcitic (and thus readily fossilizable) constituent of the intertidal fauna of the Atlantic European Coast includes three major foraminiferal taxa: *Haynesina germanica, Ammonia* spp. and *Elphidium williamsoni*. Here we demonstrate that the former two decline somewhere along the Norwegian Coast, whereas *E.williamsoni* penetrates into the southern Barents Sea and the White Sea (with the northernmost locations at 69°20' N). Further north and east, where severe fast-ice cripples benthic communities, no littoral foraminifera have been observed. *E.williamsoni* is the only calcareous foraminiferan restricted to the intertidal zone in the Arctic, and therefore is a good marker in sea-level studies.

In the present study, we have obtained the sequences of small subunit ribosomal RNA gene from several specimens of *E.williamsoni* collected in the North Sea, Barents Sea and White Sea. Phylogenetic analysis of these sequences reveals high genetic similarity of all examined specimens suggesting that the European *E.williamsoni* represents a single genetic species.

Judging on reconstructions of the last glacial maximum (LGM), the species must have been eliminated from the southern Barents Sea. For the White Sea, the reconstructions are less certain. Postglacial colonization progressed either from the North Sea along northern Fennoscandia or, unlikely, from hypothetical refuges in the White or eastern Barents seas.

In the Barents and White seas, the species dwells on tidal mudflats, which exist only in inner bays protected from the surf. Thus, the subpopulation of a mudflat is distanced from a next one by several kilometers of uninhabitable rocky shores. The most probable dispersal agent is floating kelp, transported by the eastward coastal currents; however, short-distance transport by birds or broken fast ice is also possible (but not observed). As the Arctic range of the species is linearly punctuated, gene flow between subpopulations is likely to comply with the "stepping-stone" mode, which is ideal for population-genetic studies. The small subunit rRNA gene is too conservative to be suitable for population genetics. Hopefully, new genes that are more variable will be sequenced in the near future, thus enabling us to reveal the direction of postglacial colonization and to elucidate the glacial history of the White Sea.

High-resolution Holocene foraminiferal and bivalve stratigraphy in van Mijenfjord, Svalbard, Arctic

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Fjords with their thick sediment packages potentially provide high-resolution records of the Holocene climate. A main challenge is to detect climatic change and variability during the Holocene in this Arctic setting, and to discriminate local and regional signals. The study area is affected by an end-member of the Gulf Stream and thus is especially sensitive to variations in the North Atlantic heat flux. We present a complete 16-m-long Holocene sequence – core MD99-2305 – retrieved in the deepest part of the fjord basin, 115 mwd; the modern sill depth is 25 m. The age model, based on 15 radiocarbon dates, demonstrates a steady decrease of sedimentation rate from 0.5 to 0.1 cm/yr from 11 cal. kyr to the present

Benthic foraminiferal flux decreases upcore from 30 to 1 test cm^{-2} yr^{-1}. The most common species throughout the core are *Elphidium excavatum* and *Cassidulina reniforme*, which account together for 30-80% of the benthic assemblage. In the lower part of the core (between 11 and approximately 7 cal. kyr BP), other abundant foraminifera are *Cibicides lobatulus, Buccella frigida* and *Nonionellina labradorica*, each subsequently peaking (40-50%) at around 10, 9 and 7.5 cal. kyr respectively. Rare planktonic foraminifera (essentially *N.pachy*.sin) are present in this lower part and almost disappear upcore. Bivalve mollusks also occur mainly in the lower part; the most frequent of them are the epifaunal selective deposit-feeder *Yoldia hyperborea* and the shallow infaunal unselective deposit feeder *Nuculoma tenuis*. Foraminiferal assemblages of the upper part of the core (<7 cal. kyr) are characterized by the dominance of *E.excavatum* and *C.reniforme*, the increasing percentage of *Islandiella norcrossi* and the occurrences of shallow/brackish foraminifera *Haynesina orbiculare* and *Elphidium incertum*. Boreal taxa, such as *Hyalinea balthica*, are nearly absent in the core.

Through the Holocene, the fjord basin has undergone progressing isolation resulting from postglacial rebound of the sill. The faunal evidence indicates that from 11 to 8 cal. kyr the coring site had a good ventilation and was bathed by moderate bottom currents (probably 1-5 cm/sec). By 7 cal. kyr, the oceanography of the fjord came to its modern state: brine rejection produces cold (–1.5°C) and stagnant bottom water; a hyposaline surface water layer forms during summer.

The entire absence of the glacier-proximal marker species *Quinqueloculina stalkeri* and the non-existence of significant declines in species diversity suggest that re-advancing glaciers have never approached the coring site during the Holocene.

Airborne Survey of Antarctic Glaciers and the Patagonian Ice Fields

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From November 26-December 12, 2002, we carried out airborne surveys of glaciers of particular interest in West Antarctica, the Antarctic Peninsula, and the Patagonian Icefields, onboard an Orion P-3 aircraft of the Chilean Navy.

In the Antarctic Peninsula, glaciers flowing into the Larsen Ice Shelf and over the southern portion of this ice shelf were surveyed in the east. In the west, surveys covered previously surveyed glaciers over islands located off the coast and also portions of the coast. In the Amundsen Sea Embayment, Pine Island, Thwaites, Smith and Kohler glaciers were surveyed. In the Northern Patagonia Icefield, surveys were performed over virtually the entire area. In the Southern Patagonia Icefield, the northernmost and southernmost portions were surveyed.

In spite of the traditionally bad weather in these regions, we achieved eight successful flights from Punta Arenas (each from seven to 12 hours duration) in 17 days of operation, giving us a total measurement time over the target areas of approximately 27 hours.

The sensors included: ice penetrating radar (CARDS, 150 MHz); scanning laser altimeter (ATM-2); geodetic GPS (Ashtech Z-12) real-time navigation system; digital photogrammetric camera (Nikon D-1X); magnetometer (Geometrics G-858). All data were correlated with precise GPS positioning. The radar returned ice thickness, internal stratigraphy, and bedrock topography from Antarctica, but no such information could be detected from the temperate ice in Patagonia. The laser altimeter will allow us to map the surface topography of virtually all the glaciers surveyed in Patagonia and Antarctica. The navigation system provided an accurate means to remeasure tracks previously surveyed. The digital camera generates digital elevation models from GPS positions of camera centers by using photogrammetric processing. The magnetometer data will generate maps of local and regional magnetic anomalies of the Earth's crust lying under the ice cover.

The regions studied in Antarctica and Patagonia are presently undergoing rapid changes. These studies will thus provide us with baseline determination of key parameters to allow accurate measurements of future changes. Some of the data from the Peninsula and Patagonia were collected over previously surveyed sites, to allow assessment of past changes. The analyses of the airborne surveys should provide important information for assessing the stability of the glaciers and ice shelves. This issue is of particular importance in Antarctica, where there is partial evidence that the disintegration of ice shelves is affecting the stability of the inland ice. Further information can be found at http://www.cecs.cl.

We wish to thank the Chilean Navy for their invaluable cooperation and for providing the Orion P-3 aircraft and flight crews used in these surveys. Valuable weather forecasts were provided by Dirección Meteorológica de Chile at Punta Arenas; NSF-supported Antarctic Mesoscale Prediction System (AMPS) at NCAR, Colorado, USA; and NOAA-AVHRR satellite imagery provided through the University of Wisconsin, USA. Dirección de Aeronáutica Civil at Punta Arenas provided essential office space and real-time aircraft weather observations at the airport in Punta Arenas. Office space and accommodations in Punta Arenas were provided by Hotel Faro Evangelistas of the Chilean Navy. We thank Mr. Marcelo Arévalo and Mr. Felipe Contreras for collaborating with logistics in Punta Arenas.

Landforms associated with glacier surge: Elisebreen, NW Spitsbergen

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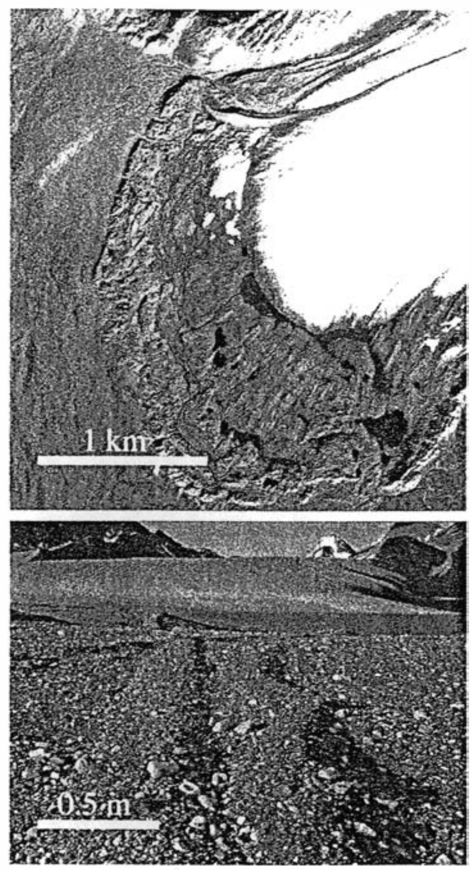
Retreat of Elisebreen, a glacier on Oscar II Land, NW Spitsbergen reveals a complex set of glacial landforms including drumlins, flutes, "till eskers", crack-fill ridges, hummocky and thrust moraines. Similar landform assemblages have been suggested to indicate glacier surge (Evans and Rea, 1999) and for these reasons we speculate that Elisebreen was a surging glacier.

The most profound landforms are:

1. Closely spaced **flutes** up to 1-m high and 200-m long with initiating boulders at their proximal ends.
2. **Crack-fill ridges** consisting of till, off-set consistently by 10-30° in relation to the ice movement. These ridges are typically 0.3-0.6 m high. They are superimposed on both flutes and "till eskers".
3. 30-35 m high **thrust moraine** with associated **hummocks** on the up-ice side.

Elisebreen rests on bedrock and raised marine mud and gravels in the marginal part. Striated bedrock surfaces occasionally protrude through the < 5 m thick succession of unconsolidated sediments. It is suggested that this soft sediment affected the trigger mechanism of the surge due to its different rheological behaviour in comparison with bedrock.

Sharp boundaries between the basal till and the underlying undeformed sediments suggest that the fast forward motion was facilitated by basal sliding or subglacial deformation restricted to a thin zone. The latter is considered more likely because it is evident that the till was mobile to some extent as indicated by the occurrence of flutes and crack-fill ridges.



Upper: Aerial photograph of major geomorphic elements: drumlins and moraines.

Lower: minor landforms: flute (left) and "till esker" (right) superimposed by a crack-fill ridge.

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The impact of ice sheet fluctuations on the Northern North Sea – South Norwegian margin from 40 ka to 10 ka BP.

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The Northern North Sea – South Norwegian margin is characterized by large-scale geological processes during the Late Quaternary, such as glacigenic debris flows, turbidites, huge translational slides, contourites and large-scale hemipelagic deposits (Bugge *et al.*,1987, Haflidason *et al.*, 1998; Hjelstuen et al., *in press*; King *et al.*, 1996, 1998). By using high resolution cores and seismic data these processes are further characterized and both their timing and interrelation are presented for the last 40 ka.

It has been found that the deposition of glacigenic debris flows is associated with advances of the Norwegian Channel Ice Stream (NCIS). These events are followed by large scale meltwater plume deposition. The influence of meltwater on the oxygen isotope records is widely shown within the region (e.g. Sarnthein *et al.*, 1995) and large plumite deposits have been recognized from X-ray and high resolution seismic profiles (Berstad *et al.*, *in prep.*; Hjelstuen *et al.*, *in press.*). It has been suggested that northward currents shaped the sediment plume along the Mid Norwegian margin (Hjelstuen *et al.*, *in press*).

The sedimentation rates and bulk accumulation rates show the variability of deposition and input to the margin and are mainly governed by the changes in deglaciation rate of the Fennoscandian ice sheet and the regional weathering rate on the surrounding mainland. A detailed study of the petrology of the IRD enables the distinction between source areas. Distinct changes in both Fennoscandian and British ice sheet suggest a time relationship with the Heinrich events in the North Atlantic, as proposed by Berstad *et al.* (*in prep.*) for the Norwegian Ice Stream and more in general by for example Elliot *et al.* (1998).

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Cold-water Coral Reefs along the Norwegian Margin: Possible Hydrocarbon Indicators and Potential Paleoclimatic Archives

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Cold-water coral reefs along the Norwegian margin have been known for some time, but only recently has research revealed their surprisingly great abundance and importance as a habitat for many marine species. The largest complexes extend over >10 km with continuous reef growth (Sula Reef and Røst Reef), and can reach more than 50 m in height (Fugløy Reefs). Reefs are found both out on the shelf and in fjords, as shallow as 40 m in the Trondheimsfjord, and consist mainly of the reef-building scleractinian ahermatypic coral *Lophelia pertusa*. The reefs are connected with influx of Atlantic water through the Norwegian Current, and are found in places with high relief, elevated currents, and availability of hard substrate. Indicators of fluid venting by light hydrocarbons or other agents are often, but not always, seen in connection with reefs, e.g. bright spots, pockmarks, elevated hydrocarbon levels in the sediments etc. The reefs established themselves on the Norwegian margin after retreat of the ice-sheet, and the oldest dated fragments are ~8 ka. Paleoceanographic information is stored in the coral skeleton as they grow, and reef fragments can provide accurate windows of paleoclimatic information through O- and C-isotope analyzes. Furthermore ^{14}C-dating (revealing the age with reservoir effect included) can, compared with U/Th dating (giving 'true age') provide an age of the water masses in the area.

Genesis of a massive ground ice body at Cape Shpindler, Arctic Russia

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Thick bodies of massive ground ice are described from the northern permafrost zone of northern North America and Siberia. Among the various geneses discussed for these ice bodies the one favoured is formation through segregation and injection processes, where excess of pore water freeze within the sediments. Another theory was put forward by Kaplyanskaya and Tarnogradsky (1986) and Astakhov and Isayeva (1988), where they interpret massive ice in the north-western Siberia to be buried remnants of Pleistocene ice sheets. Indeed most finds of massive ground ice in the western Arctic are within and proximal to the limits of formerly glaciated areas. Although both segregation and glacier ice in the modern environment can be distinguished on the basis of diagnostic criteria such as crystallography and geochemistry, and nature of the contacts between the ice body and surrounding sediments, bodies of buried massive ground ice often have undergone post-burial chemical and structural alterations. This makes any field determination between massive segregated ice and glacier ice very complicated. It is therefore important to consider as many criteria as possible before a genetic interpretation of a massive ice body can be made.

A massive ground ice body at Cape Shpindler, Yugorski Peninsula, arctic Russia, was studied with regard to large-scale internal structures, its stratigraphical context and contacts to surrounding sediments.

Leibman et al. (2000, 2001) investigated studied its chrystallography, chemistry and isotopic composition. We conclude that the massive ground ice at Cape Shpindler is relict glacier ice, possibly with some regelation ice or segregation ice at the base. The chronology for the Shpindler Cape sequence implies that the glacier ice might be of Marine Oxygen Isotope Stage (MOIS) 8 age, >200 ka, and consequently that it has been preserved by the permafrost for the duration of at least three interglacials (Holstein, Eem and Holocene).

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Clay mineral distribution in surface sediments from the Greenland Sea

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Clay minerals may be sensitive indicators for transport processes and pathways of terrigenous sediments. The fine fraction of sediments may easily be transported by e.g. bottom currents and /or sea-ice (e.g. Pfirman et al., 1997; Wahsner et al., 1999). Despite this potential for paleoenvironmental studies, relatively little is known about the distribution of clay minerals in surface sediments from the Nordic Seas. In this study, we analysed the distribution of clay minerals in surface sediments from East Greenland fjords, the continental shelf and slope and the adjacent deep-sea between 70° and 75° N. Four clay minerals were identified using the standard method outlined by Wahsner et al. (1999). Illite and chlorite are the dominant clay minerals in most sediments and show a relatively even distribution. Kaolinite and smectite contents are more variable and they are obviously related to specific source areas. The clay mineral associations are relatively uniform in most samples from the shelf, slope and deep-sea basin, while fjords sediment show a stronger variability. Some fjords have a specific clay mineral association that is clearly related to the sediments and rocks of the adjacent coastal areas. The clay minerals are further dispersed from these point sources in the fjords resulting in a relatively even distribution in the deep sea.

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Nitrogen mineralization and heterotrophic respiration in soils of tundra ecosystems

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During the last decades, tundra ecosystems have changed from strong sinks to strong sources of CO_2 to the atmosphere, indicating an increase in mineralization of soil organic matter (Shaver et al. 2000). We here report on a study on carbon and nitrogen mineralization in soils of two tundra ecosystems in arctic Russia, which aimes at better understanding long-term changes in net primary productivity and carbon sequestration due to *global warming*. The results of these investigations are compared to those from a South-North transect through Western Siberia.

Heterotrophic respiration rates, as well as the microbial biomass were higher in the organic soil layers compared to the mineral horizons in both tundra ecosystems, and in the taiga and steppe. However, gross nitrogen mineralization rates were found to be higher in the mineral layers (A horizons) of the soils, calculated on a dry weight basis (Fig. 1), as well as on a areal basis at the arctic sites. Comparisons with other ecosystems revealed that this decoupling of N and C mineralization was typical for tundra ecosystems and was not found in taiga or steppe. While the reason for this pattern is unclear, the low mineralization rates in organic horizons may be highly significant for predicting the response of tundra ecosystems to global warming. Elevated air temperatures, which first lead to warming of upper soil layers, may differently affect these two processes in the short-term, leading to a higher initial loss of carbon to the atmosphere, as has been reported for arctic ecosystems (Oechel et al. 1993).

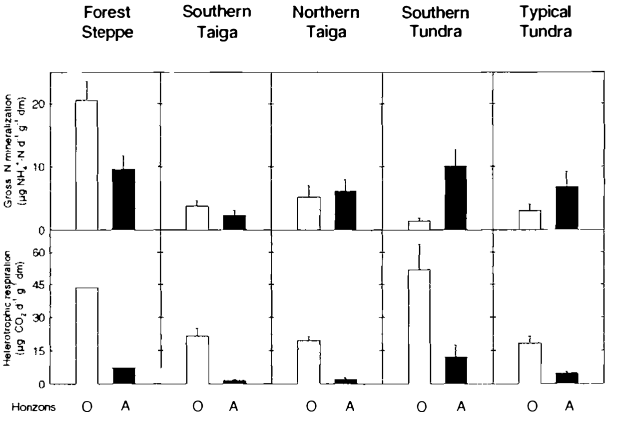

Figure 1: Rates of gross mineralization and heterotrophic respiration in organic (O) and mineral soil horizons (A) of different vegetation zones along a South-North transect in Western Siberia.
Forest Steppe 55°12'N, 72°24'E
Southern Taiga 58°18'N, 68°37'E
Northern Taiga 65°55'N, 78°08'E
Southern Tundra 67°55'N, 74°58'E
Typical Tundra 69°43'N, 74°38'E.

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High Resolution Fjord Records From Norway Reflecting Temperature Changes in the Norwegian Current the Last 1000 Years.

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Two deep-silled fjord basins with a direct connection to the Norwegian Current have been investigated with respect to age and $\delta^{18}O$ in benthic foraminfera. One basin is located in western Norway (Sognesjøen) and one in northern Norway (Malangen). Both basins have instrumental temperature and salinity records spanning the last 75 years (western Norway) and 22 years (northern Norway). The basin water masses follow the same temperature trends as recorded for the Norwegian Current . Thus these fjord basins are likely to detect changes in the Norwegian Current back in time.

Variations of $\delta^{18}O$ measured on foraminiferal tests depend on temperature, salinity and isotopic composition of the ambient water. Changes of the latter is mainly linked to the ice volume effect and can be neglected for the time interval discussed here. A temperature change of 1°C corresponds to 0.23‰ in the $\delta^{18}O$ and a salinity change of 1 unit corresponds to an $\delta^{18}O$ change of c. 0.31 (western Norway) to 0.43‰ (northern Norway). By comparing the instrumental temperature and salinity records it is evident that temperature completely will dominate the $\delta^{18}O$ signal.

The record of $\delta^{18}O$ in benthic foraminifera in the sediment core from western Norway spans the last 4500 years with 6 to 25 years resolution throughout the last 1000 years. It shows periods with colder waters (1 to 1.5°C) appearing every 360 to 400 years throughout the last 1000 years with a c. 210 year variability superimposed on this trend.

The record e from northern Norway spans the last 230 years with 1 to 3 year resolution and shows cold temperatures from AD 1770 to AD 1900. From AD 1900 to present there has been an increase of c. 0.5°C. The yearly variability of the record is up to 2.5°C.

Both records indicate that changes in solar irradience is an important forcing mechanism for the changes seen in the records. The yearly variability in the Malangen record seems to be controlled by changes in the NAO (North Atlantic Oscillation). There is also an correlation to volcanic aerosol particles.

Water and sediment discharge in Kuannersuit, Disko, West Greenland; an arctic drainage area dominated by a recently surging glacier.

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High temporal resolution data are presented on water and sediment discharge from the river Kuannersuit Kuussuat, draining a catchment area (533 km^2) on Disko, West Greenland. The catchment area is dominated by an outlet glacier of the Sermersuaq Ice Cap which have surged. Satellite images document that the surged lasted from August/September 1995 to the spring 1998, reducing the down valley distance to the head of the fjord from 22 km to 12 km.

In 2001 a hydrometrical station was established, c. 4 km from the front of the surged glacier, in order to automatically measure the discharge of water in the braided river Kuannersuit Kuussuat. Coherent measurements of water discharge, turbidity and a range of climate parameters were conducted from the 6th of July to the 31st of August 2001. Additional single spot measurements of water discharge exist from 1997, 1999 and 2000. The sedimentation rates in the receiving fjord, Kuannersuit Sulluat, were measured using a number of cylindrical sediment traps during the majority of the open water seasons in 2000-2002. Documentation of the duration of the melt water period is supported by pictures from an automatic digital camera at the delta.

The water discharge decrease during the season and is superimposed by large daily fluctuations (from 60 to 100 m^3s^{-1}). Peak discharge events are in the order of 150 m^3s^{-1}. During periods with consistent temperatures below 0 C° discharge events has been observed from the daily digital photos. The duration of the melt water season in 2001 is confined to c. 150 days from the 1st of June, based on automatically digital photos from the delta and on-site observations. Total run-off during the monitored period is 154 l s^{-1} km^2. Suspended sediment concentration (SSC) in the river is between 3-5g l^{-1} at the hydrological station and 12 g l^{-1} at the glacier front. Total transport of suspended sediment during the period is calculated to 1.46×10^6 t. Corresponding measurements of sedimentation rates using sediment traps were conducted in the fjord approximately 2 km from the delta from the 11th of July to the 28th of October 40 m above the fjord floor. Assuming minor sedimentation before and after trap deployment and uniform sedimentation within 0-2 km from the delta the deposition during the period is estimated to 0.19×10^6 t.

Based on the discharge measurements the river regime is classified as an Arctic, Nival regime. The rates of suspended sediment concentration and annual sediment transport are high compared with other proglacial rivers in comparable drainage areas on Disko and Greenland in general (Hasholt B., 1996) and can be ascribed to the glacier surge. Decrease in SSC in the river with increasing distance from the glacier indicates deposition within the valley. Build up of the valley floor are observed and documented. The large divergence between river transported suspended sediment and deposited sediment in the fjord indicates deposition within the valley and at the proximal part of the fjord. Recent marine geological studies report pronounced increased sedimentation rates in the fjord ascribed to the glacier surge (Gilbert et al., 2002).

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A Changing Climate in the Arctic inferred from palynological studies of Laptev Sea sediments (Siberia)

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For the first time high-resolution pollen record of marine sediment sequence from Siberian shelf was received. Using the radiocarbon dated sediment core from the southeastern Laptev Sea
the first detailed account on the land-ocean linkage from this region on the basis of pollen analysis was obtained. The chronology of the core goes back to 9.4 cal.ka, yielding an average sample resolution of ~100 years (Bauch et al., 1999).

The trends observed in the shelf data seem to be in good agreement with the major Holocene changes of the coastal hinterland. Climatic warming in the early Holocene caused a change in the hydrological situation and soil with vegetation development on land. This change also caused enhanced riverine runoff that could explain the high sedimentation rate that persisted in core from 7.6 to 4.0 cal.ka (Bauch et al., 2001). This inferred increase in river activity may correlate with the period for which pollen and organic runoff data indicate warmest conditions,
with a fully developed forest just south of the Lena Delta. An enhanced transfer of arboreal pollen onto the shelf during the middle Holocene began around 7.5 cal.ka and is interpreted as the result of The northernmost advance of the treeline between 9 and 3.8 cal.ka. Pollen records indicate that warmest conditions occurred in the Atlantic period.

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Holocene Southern Ocean climate variability

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The site TN057-17 (50°S 6°E) from the Atlantic sector of the Southern Ocean is today located right on the Antarctic Polar Front (APF), and is therefere in an ideal position for reconstructing past climate changes. By combining the sedimentary record of Holocene changes in Summer Sea Surface Temperature (SSST) and sea-ice cover, based on diatom transfer functions. With 11 14C-AMS dates from both TN057-17 cores, the resulting record is capable of resolving high-frequency variability in the Holocene climate. The record gives evidence for an oceanic climate controlled mainly by the insolation on the atmospheric circulation. This is overlain by prominent cycles with multicentennial- and millenial-scale periods. The cyclicity is possibly linked to solar variability through both the atmospheric circulation in the southern hemisphere and the North Atlantic through the Thermohaline Circulation (THC). The correclation of the SSST changed from northern to southern hemisphere summer insolation in the beginning of Late Holocene, perhaps indicating a weakening influence of the THC on the climate of the Southern Ocean.

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Megascale glacial lineations recording palaeo-ice stream flow to the Barents Sea margin during the Late Cenozoic.

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Late Cenozoic erosion surfaces have been studied based on 3-D seismic data from the south-western end of the Bjørnøyrenna glacial trough at the SW Barents Sea continental margin. The 3-D data cover an area of ~ 2000 km^2. The survey was primarily designed to image deeper targets, and the vertical resolution is low compared to high-resolution 2-D seismic data that is commonly used to study the upper glacigenic sediments. The horizontal resolution is, however very good due to high spatial sample rate, and the data provide detailed images of palaeo surfaces, revealing lineations with a relief of around 2.5 m.

Seven seismic reflectors, which can be correlated regionally over the western Barents Sea have been identified and mapped in the upper Cenozoic sedimentary succession. Mega scale streamlined lineations occur on most of the mapped horizons. The lineations are 0.8-25 km long, around 100-200 m wide, have a relief of about 3 m, and are taken as indications of fast-flowing ice-streams.

The study area has been influenced by westwards moving glaciers occupying the Bjørnøyrenna and north-westwards moving glaciers from the Scandinavian mainland. The lineations on the oldest reflectors are weak, and only one orientation is observed on each reflector, indicating ice streaming westwards out Børnøyrenna. The younger reflectors show pronounced lineations with different orientations and with a significant amount of cross-cutting by different flow-sets, indicating more dynamic ice, with input of ice from Bjørnøyrenna as well as the Scandinavian mainland.

The mega-scale glacial lineations provide direct evidence of grounded glaciers extending to the SW Barents Sea margin at least seven times during the Late Cenozoic.

A problem of atmospheric ozone formation over the Arctic regions.

V.Osetchkin.

It is known that the atmospheric ozone problem has an ecological and climatic changes - related meaning.

To solve any of practical problems connected to an atmospheric ozone one should have knowledge of all the aspects of the photochemical ozone formation theory. However, there is up to date a considerable gap between some of observational ozone data and numerical modelling results. The spring total ozone maximum observed over the Arctic belongs to unexplained feature of the atmostheric ozone problem. The present author may show that a very
weak flax of the galactic space rays (GSR) is an essential one if to regard its accumulative effect over a long enough period (over a polar night).

If to follow that way the energetic contribution of the GSR to the ozone formation process will be on the average as much considerable as that of sun. The mechanism offered by the the author may explain the spring polar total ozone maximum and an excess of total ozone over polar regions compared to that over the equatorial ones.

Vegetation changes in the Lena Delta area for past 8,500 yrs.

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Modern vegetation of the main Lena delta territory presents in general the dwarf shrub and herbaceous-dwarf shrub (*Dryas octopetala, Salix glauca, Carex stans, Poa arctica, Luzula nivalis, Papaver pulvinatum, Valeriana capitata, Saxifraga foliolosa*) moss (*Hylocomnium splendens, Aulocomnium turgidum, Tomenthypnum nitens*) and lichen northern sub-arctic tundra, in places in combination with herbaceous-hypnum and polygonal bogs.

The northwestern and northeastern delta segments belong to herbaceous-dwarf shrub (*Dryas octopetala, Salix polaris, S. nummularia, S. reptans, Carex stans, Poa arctica, Luzula nivalis, L. confusa, Saxifraga foliolosa*) moss (*Hylocomium splendens, Drepanocladus unsinatus, Tomenthypnum nitens, Sphagnum orientale*) and lichen southern arctic tundra in combination with herbaceous-hypnum and polygonal bogs.

The reconstruction of vegetation changes in the Lena delta for the last 8000 years is based on the results of palinological analysis, plant remains analysis and radiocarbon dating of several sections of alluvial deposits comprising a high floodplain and the first above the floodplain terrace. The investigated sections located in the central, northern, northwestern and southwestern parts of the Lena delta have a good cross-correlation by radiocarbon datings and paleofloristic composition of vegetation macro-remains from the deposits. The available spore-pollen diagrams allow us to significantly supplement the characteristics of vegetation for some time intervals.

In the Boreal period (BO) – 8500 yrs. BP, shrub (*Betula* sect. *Nanae*, *Salix* sp., *Alnaster fruticosa, Alnus hirsute*) and herbaceous-cotton-grass (*Eriophorum* sp., *Carex* sp., *Calamagrostis* sp., *Equisetum* sp.) plant communities were developed in the Lena delta. The boundary pf pre-tundra larch (*Larix sibirica*) open woods passed probably in direct proximity to the central delta area.

At the boundary of 8000 yr BP, shrub-herbaceous sedge-cotton-grass and cotton-grass-sedge associations with *Betula* sect. *Nanae*, *Salix* sp., *Alnaster fruticosa*, *Alnus hirsute* were developed in the Lena delta. The moss cover consisting of hypnum mosses was extremely sparse.

In the Atlantic period (AT) – 5000-8000 yrs. BP, shrub-dwarf shrub herbaceous sedge and cotton-grass-sedge associations) were widespread. The interval 6000-7000 yr BP is the most favorable time for the process of peat formation in the Lena delta. (This is indicated by radiocarbon datings referring to the base of peat deposits with a thickness of 1.5 m and more that are observed everywhere in the shore precipices of the branches in different delta parts).
In the Subboreal period (SB) – 2300-5000 yrs. BP, dwarf shrub herbaceous-sedge plant communities comprised of *Carex* sp., *Eriophorum* sp., *Equisetum* sp., and *Betula* sect. *Nanae*, *Salix* sp. are widespread. A typical feature of the SB is the increased participation of hypnum mosses in the plant communites until the appearance of hypnum-sedge biocoenosises (*Drepanocladus* sp., *Calliergon* sp., *Tomenthypnum* sp., *Carex* sp.) by the end of the SB.

The Subatlantic period (SA) – 2300-300 yrs. BP is characterized by a universal development of sedge-hypnum and hypnum plant communites (*Carex* sp., *Eriophorum* sp., *Aulacomnium palustre, A.turgidum, Bryum pseudotriquetrum, Drepanocladus exannulatus, D. aduncus, D. Sendtneri, Scorpidium scorpioides, Tomenthypnum nitens,* etc.).

Glacigenic deposits in Spitsbergen fjords

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In most of the Svalbard area, the "Little Ice Age" represents the Holocene glacial maximum. The glaciers retreated from their maximum positions at around 1900 AD. Based on high-resolution acoustic data and sediment cores, sedimentation patterns in four tidewater glacier dominated inlets of Isfjorden (Tempelfjorden, Billefjorden, Yoldiabukta and Borebukta), western Spitsbergen, were investigated, and a model for sedimentation of tidewater glaciers in these subpolar environments is proposed.

Glacigenic deposits are represented in proximal and distal basins. The proximal basins include end and hummocky moraines, bounded by an outer end moraine marking the "Little Ice Age" glacial margin. The distal basins include debris lobes and draping stratified glacimarine sediments outside, and to some extent beneath and above the lobes. Tempelfjorden and Billefjorden are presently characterised by one terminating glacier front and small proximal basins with several end moraine ridges. Yoldiabukta and Borebukta are characterised by two terminating glacier fronts and large proximal basins.

The lobe sediments in Tempelfjorden comprise massive clayey silt with scattered clasts. Distal glacimarine sediments comprise stratified clayey silt with a low content of ice-rafted debris (IRD). Average sedimentation rate for the glacimarine sediments in Tempelfjorden is 1.7 cm/yr during the last 130 yr. Similar conditions prevail in Billefjorden. Massive clayey silt rich in clasts composes the lobe sediments in Borebukta. Distal glacimarine sediments in Yoldiabukta comprise clayey silt with a high content of IRD. Average sedimentation rate for these sediments is 0.06 cm/yr during the last 2.3 cal. ka. Similar conditions prevail in Borebukta.

Relatively low amounts of clasts in the distal sediments in Tempelfjorden, compared to Yoldiabukta, are explained by higher accumulation of suspension fallout sediments, masking the IRD in Tempelfjorden. The high distal sedimentation rate in Tempelfjorden (and Billefjorden), compared to Yoldiabukta (and Borebukta), are explained by high sediment supply from subaerial rivers, in addition to suspension fallout from glacial meltwater runoff and icebergs. In Yoldiabukta (and Borebukta), the sediment supply is mainly limited to meltwater runoff from glaciers and icebergs.

3-D seismic data reveal palaeo-ice flow pattern from glacigenic sediments, southwestern Barents Sea

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The section of glacigenic sediments between the upper regional unconformity (URU) and the sea floor, up to 120 m of sediment, have been interpreted from industry 3-D seismic data. The study area, covering totally 2870 km^2, is located in the south-western Barents Sea. Our 3-D seismic data have a good vertical and horizontal resolution, thus providing detailed maps of palaeo surfaces, revealing lineations with a relief of down to 2.5 m. The interpreted 3-D seismic data sets suggest a more complex glacial history than previously described.

One of the seismic cubes reveals a ridge complex on the seafloor, being 12 km long, 500 m wide, 24 m high, and steeper in the west than in the east. The ridge complex is interpreted to be a glaciotectonic ridge formed sub- or pro-glacially, thus indicating that the direction of ice flow was from west towards east. Proximal to the ridge complex a depressed area, being topographically lower then the rest of the sea floor, may suggest from where the sediments in the ridge complex originate.

In the glacigenic section, imbricated structures appearing crescentic in map view, occur. They consist of 300-700 m long and around 300 m wide sediment sheets that are stacked upon one another for distances of 0.5 to 5 km. In vertical cross-sections these features have the appearance of imbricated trust sheets which downwards seem to sole out along a basal decollement zone. Some of them even reach the sea floor, while other go as deep as down to the URU. These imbricated crescentic thrust sheets are interpreted to be of glaciotectonic origin, indicating a direction of ice flow towards east and west. 146 imbricated structures have been mapped in the study area.

Several generations of large-scale lineations, observed on four different palaeo-surfaces are interpreted to reflect ice flow patterns of palaeo glaciers. Earlier studies in nearby areas suggest an ice flow direction in the Bjørnøyrenna towards west during the last glacial maximum. The main pattern of the lineations in our data set trends N-S on all four palaeo-surfaces, suggesting a dominant ice flow direction from south to north across the Barents shelf at least four times during the last 0.8 Ma. Our data indicate that if the flow of grounded ice in Bjørnøyrenna has been towards west, there may have been a convergence-zone in the southern part of Bjørnøyrenna. A second possibility is that the grooves in our data set were formed while the ice was retreating. In the latter case the N-S-trending grooves in our data-set may have been formed while Bjørnøyrenna was ice-free and acted as a major calving bay for the ice moving from south towards north. This suggests that evidence from the ice advances my have been obscured during the retreat of the ice. Thirdly, the grounded ice covering the south-western Barents Sea may have had a dominant direction of ice flow towards north or south.

Lateglacial Palaeoclimate in Scotland and Finnmark

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The northwest European continental margin has a maritime climate, variations in which are driven by changes in the circulation and temperature of the North Atlantic Ocean. The limits of this sea board lie close to the north-easternmost and south-westernmost extent of the influences of the warm North Atlantic surface currents during the last deglaciation, and were, therefore, potentially very sensitive to the climatic fluctuations that took place at that time.

This study investigates the terrestrial record from two sites, representing the extremes of this margin: Lochan An Druim in northern Scotland; and Nikkupierjav'ri in the far north of Varanger Halvøya, in Finnmark (northern Norway). High-resolution pollen analysis of lacustrine sediments provides data as a proxy for palaeoclimate. Independent chronologies are being developed through radioisotopic and tephrochronological age determinations; these will provide a secure basis for correlation with records from other lacustrine sites, as well as with marine and ice core records.

Pollen analysis at Lochan An Druim has thus far provided a characteristic profile of the Lateglacial and early Holocene vegetation progression which has been wiggle matched to the Grip $\delta^{18}O$ record. The palaeoclimate reconstructions have demonstrated basic trends in important climate variables, with climate conditions in the Lateglacial shown to be similar to those that prevail in northern Alaska today, and the early Holocene climate similar to that of northern Scotland at present. The palaeobiome reconstructions have provided an objective characterisation of the vegetation associated with these critical climatic conditions. Preliminary pollen analysis at Nikkupierjav'ri has distinguished the Younger Dryas and the transition into the early Holocene.

Together, these palynological studies will provide important evidence as to the variations in the northerly extent of warm water penetration during the Lateglacial and the transition to the Holocene.

Temperature effects on ^{13}C of soil-respired CO_2: an incubation study with arctic soils

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During the historical past arctic ecosystems accumulated huge amounts of atmospheric carbon, that are now, in a warming world, a potential source of CO_2 to the atmosphere. Indeed, net CO_2 efflux was reported from tundra ecosystems since the late 1980s (Oechel et al. 1993). However, little information exists about the nature of soil organic matter (SOM) respired. In terms of potential negative feedback effects to further climatic change it will be of crucial importance to know whether microorganisms are able to utilize the stable, recalcitrant C pools, that dominate the SOM inventory of the soils. In order to investigate the decomposability of SOM at various temperatures we incubated soil cores of a typical tundra at temperatures between 2°C and 24°C and measured respiration rates and the isotopic signature of CO_2 respired as an indicator of the utilized substrates (Amundson et al. 1998).

Results and Conclusion

- Substrate limitation of microorganisms occured at 24°C in mineral horizons, whereas organic horizons exhibited no substrate limitation and a linear increase of respiration rates across the entire temperature range was observed.
- The $\delta^{13}C$ values of CO_2 respired were negatively correlated with temperature, indicating the utilization of substrates low in ^{13}C at higher temperatures (Fig.1). According to the literature these substrates comprise more stable compounds (Benner et al. 1987). **Microorganisms therefore may be able to also mobilize recalcitrant soil carbon pools** at elevated temperatures.
- When the $\delta^{13}C$ values of respired CO_2 of soils which were incubated either at 2°C or 24°C were measurd at 12°C, the isotopic signature shifted to values normally found at this temperature. This suggests that certain groups of soil microbes exhibit characteristic temperature optima and preferences for specific C compounds.

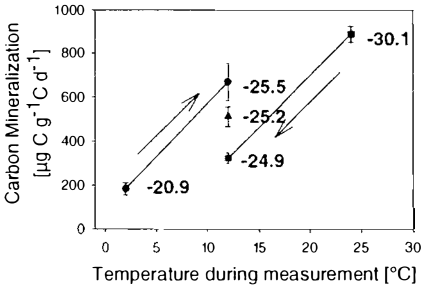

Figure 1: Respiration rates of soil cores from a typical tundra ecosystem. Numbers adjacent to symbols indicate $\delta^{13}C$ values of CO_2 respired. Intact soil cores of organic horizons were incubated at 2°C (circles), at 12°C (triangle) and at 24°C (squares), and measured at the temperature indicated.

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The effect of geomorphological setting on Holocene sediment variability; examples from two small alpine lakes, northern Swedish Lapland

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Analyses and comparison of geomorphological setting and sediment characteristics in two small neighbouring alpine lakes show that the minerogenic influx into the lakes has varied significantly during the Holocene, both within and between the lakes. X-ray radiographs of the sediments are used to visualise lithostratigraphical structures and measure high-resolution density variations. The smaller lake contains a homogenous organic-rich sediment sequence while the larger lake shows laminated sediments with higher minerogenic content. Variations in sediment composition are interpreted to reflect differences in geomorphological process activity in the catchment, which regulate the amount of fine sediment available to fluvial surface erosion.

We find that moderate differences in geomorphological setting and process activity around alpine lakes may significantly affect lake sediment composition. We also find that non-glacial processes can produce minerogenic sediment layers with similar characteristics as layers supposed to represent glacier advances in proglacial lakes. Minerogenic sedimentation rates are shown to vary over time depending on depositional process, which might affect age model constructions.

Our results indicate that erosion of surface soils characterised the first part of the Holocene. This general erosion was possibly enhanced during shorter time periods with climate deterioration, for example around 8300 cal yr BP. Minerogenic inflow into Lake 865 was low and constant during the middle Holocene indicating stable environmental conditions in the catchment. The variability of sediment composition increase in the late Holocene, possibly caused by short-term climate fluctuations occurring during a general climate deterioration.

A high resolution record from Isotope stage 2 in the Ne Nordic Seas

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The main task of this study is to quantify sea surface temperatures (SSTs) during marine isotope stage 2 (last glacial maximum). It has previously been shown that seasonally ice-free waters existed in the high northern latitudes during this period providing a source for heat and moister supporting the build-up and disintegration of the Fennoscandinand –and Barents Sea ice sheet. We are currently performing stratigraphic analyses from sediment core MD99-2294 including % $CaCO_3$, planctic foraminiferal fauna, oxygen isotopic measurements, and content of ice rafted debris. These proxies have proven to be reliable indications of sea surface temperatures, relative sea ice distribution and flux of Atlantic water into the region. MD99-2294 comprise the upper 24m of the Lofoten Contourite Drift. Several contourite drifts have been identified on the Norwegian continental margin, including the Lofoten Drift studied in detail here. The drifts on the Norwegian margin owe their origin to sediment transport by and deposition from surface and intermediate water masses. Sediment transport along the slope has provided the main sediment input during the Neogene, with sedimentation rate as high as 190 cm/ka during late Weichelian. This high resolution has the potential to provide a paleoclimatic time series up to 5 year. Previous studies have proven periods having Atlantic Water advection, termed HP-zones (HP = high productivity) with active deep-water formation. We focus on HP1 (14.5-19.5 ^{14}C kyr BP) which is reflected in the % $CaCO_3$ record. The % $CaCO_3$ record indicates that HP1 can be divided into three parts. The early and late part have maximum $CaCO_3$ values suggesting elevated SSTs.

Problems of semantic compositions with rock elk inscriptions in the Siberian taiga zone

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For the first time in this research on the rock art monuments of the Siberian taiga territory one could define 670 composition with elk image. The classification developed in research allowed to present systematically the whole picture and local variants of spreading the basic descriptive plot complexes. In this research the attempt was made for correction and interpretation of some plot groups with elk images on account of biological characteristic of this particular type and also data of ethnology and mythology of Siberian people. In framework of this research the semantic blocks of all elk's compositions combined by complexes of basic leading ideas of primitive unites in Siberian taiga territory have been picked out. Also in this paper the author divides semantic categories of rock monuments with elk's inscriptions depending on their supposed functional operation and purpose of drawings pictures.

As our research data shows the elk in rock art of ancient Siberian taiga people was not the God, but it was an important component in the system of views nature, surrounding world and an universal, sociocultural, sacral, cosmic and astral symbol connected from the one hand with the sun, stars, moving, life, fertility and from the other with death and the world of the dead.

Commander Islands as the significant point for monitoring some dangerous changes in Beringia Ecosystem.

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Web Site: http://www.az.com/~katrinat/island/

As you may be aware, the number of sea otters has dramatically declined during the last seven years in some parts of the Northern Pacific.

At this time, we can foresee a really catastrophical reduction in the population of sea otters near the Aleutian Islands. They seem to disappear for unknown reasons.

Almost the same situation is occurring with Steller Sea Lions and some other species which are in the top level of the feeding chain.

For the time being is a very dangerous situation with the Arctic fox (Medniy subspecies – the biggest , native one in the World).Hardly imagine, that it may be completely destroyed by extensive epizootic lasting for the last 20 years.

But most dangerous signal we had in 2000, when on the Commander Islands fond on the beach five dead whales and in 2001, again on the Bering Island was fond 1 dead Right whale.

All these facts clearly display that something is drastically wrong with the natural functions in the whole ecosystem of the Bering Sea.

In this case, I'm quite confident that the Commander Islands will be a most significant focal point of the North Pacific, for better understanding the changes which have been occurring in the ecosystem of Berengia.

Where are the Commander Islands ?
Please, have a look at a map of the Northern part of the Pacific Ocean and You will easily notice between the two continents, Eurasia and America the chain of the Islands. It's the Aleutians. Two small Islands, closing the Aleutian's chain on the east and Kamchatka are the Bering and Medniy Islands. That's righ, it's the Commander Islands Archipelago.
So, geographically the Commander Islands are located approximately 200 miles (333 km) from the Attu Islands off Aleutians in the Bering Sea and about 1000 miles (3350 km) from Anchorage, Alaska. It means - 166 E ; 55 N .
Why they so unique ?

1. Historical aspect :
As you know for now, the Commander Islands, better known as Bering and Medniy Islands, played an important role in Vitus Bering's expedition to Alaska and the Aleutian Islands.

Even at the tern of the 18th centery, nobody knew about the strait separating America from Asia as well as about the terrain east of Kamchatka.
On 29 May 1741,the "Saint Peter" and "Saint Paul" packet boats left the Petropavlovsk-Kamchatskiy (Avacha bay) and sailed into Pacific. It was the Second Russian Great

Kamchatka Expedition.Vitus Bering,Captain-Commander was the head of expedition. Captain Alexsey Chirikov and famous German naturalist George Steller was also among the participants.

On their way back, the boat was caught by severe storm that lasted for 17 days. On 4 November 1741, the seamens noticed high shore at a distance. The land resembled as the Kamchatka, but examination of the shore proved that the crew landed not to the Kamchatka coast. It was the coast of unknown Island. The seamens were doomed to winter on the unfriendly desert shore. Only 46 persons out of 70 stayed alive. Vitus Bering died on 8 December 1741.Alive members of the "Saint Peter" crew decided to name the discovered Island after their Commander.

2. Ethnographical and Archeological aspects :
The Aleuts appeared on the Commander Islands early in the 19th century. They were settlers from the Aleutian Islands. Most of the Aleuts inhabiting Bering Island came from Atka Island (USA in present time), and those who lived on Medniy Island originated from Attu Island (USA in present time). Different origin of the settlers was reflected in both the linguistic and cultural distinctions of the two Islands. The culture of the Commander Aleuts is original and uncommon.
The Nikolskoye village (Bering Island, founded in 1826) and Preobrazhenskoye village (Medniy Island) are the largest settlements on the Commander Islands.
More than twenty wooden houses were built by the Gutchinson Company (USA) in Nikolskoye village in the second half of the 18th century. Several buildings of that period have been preserved in the village till present.
Nowadays on the Commander Islands exists only Nikolskoye village.It is an administrative centre of the Aleution national area with the small population of the people about 600-650. Most of them unemployed, others are engaged in a hunt and fishery. The small part of their population works in the Nature Reserve.

By the way, the Commander Islands are really one and native area in Russia for this small population of aboriginal people.

3. Biodiversity aspect :
Actually, the waters between Russia and USA (Alaska and Aleutians) lies a sea so rich in wildlife and so varied in coastal and subsea habitats that it's considered one of most biologically productive and diverse marine environments. Covering almost a million square miles of subarctic waters, the Bering Sea supports vast populations of fish and shellfish, birds from every continents and countless numbers of the whales, porpoises, dolphins, walruses, sea lions, fur seals, sea otters and seals.

But only on the Commander Islands we can found the full picture of that.

The main reason are in unique combination some geological and hydrological factors around this small area.

Climate of the Islands is typically oceanic and high breadthes. Average temperature of the most cold month (January) a minus of 5,4 degrees Celsius, warmest (August) plus of 10,4 degrees Celsius. Average of cloudiness is 81 percents. The high humidity of air is characteristic. The sea near Commander Islands is quietest in summer and most stormy from November to March. The force of a wind during storm quite often reaches 35 - 40 meters per second. The ice around the Commander Islands has been not formed at all. It's explained by action warm ocean of currents, wich reaching the Islands from the Japanese sea.

Also, near Commander Islands there are a few huge and active under water volcanoes.

All together its form the most favorable conditions for phito and zoo plankton which formed the base of living for the other high range organisms at the Ecosystem.

It`s the main factors of the huge biodiversity of the seaweeds near the coastal line of the Islands too. Actually, it's one of the richest area of seaweeds by species and biomass in the World.

Furthermore, the Commander and Aleutian Islands connect Asia and Northern America. In fact, its form a bridge which ensured the dispersal of plants and animals. Flora and fauna of the Islands are represented by queer combination of species of the Asian and American origin. That's why the Commanders are the extreme eastern point of the range of Asian species.

Migration routes of many whale species pass along the Islands shores. In the coastal waters, the fattening or wintering areas of 15 toothed whale species and 6 whale-bone whale species (sperm whales, killer whales, Bering Sea and Cuvier's beaked whales, porpoises, lesser finbacks, seiwhales, finwhale, humpback and northen right whales) are located.

189 bird species were registered on the Commander Islands;57 of them were proved to nest there.The birds associated with water,sea colonial birds in particular, are most abundant and diverse on the Islands.

Many inhibitions of the Commander Islands are rare and listed in the Russian and IUCN Red Data Books. They are harbor seals, sea otters, Artic foxes (subspecies from Medniy Island), practically all whale species, glaucous-wnged gulls, red legged kittiwakes, peregrine falcons, gyrfalcons and emperor geese.

Almost all known marine mammal's families are represented there. Sea-otters (about 4-4,5 thousands),harbor (flower) seals and largas (about 10-15 thousands) are the residents of the Islands; rookeries of northern fur seals (about 250 thousands) and Steller's sea lions (about 5 thouthands) are being restored.

The terrestrial vegetation of the Commander Islands is extremely original. The mountain tundra, covering most of the territory, developed in the absence of permafrost. This is not characteristic of such communities. In addition, it has been never seriously affected by the vegetarian animals (rodents and ungulates).These animals do actually create the appearance of tundra on the mainland. Mushrooms are also abundant on the Commanders.

4. Ecological and Nature Protection aspects :

The history of mastering and exploiting the Commander Islands is abundant in irreversible losses. Merciless whaling, sealing, and harvest of the sea birds actually began since the moment of the Islands discovery. In 1755, more then thirteen years after the islands were discovered, a trader by the name of Piotr Yakovlev visited the Commander Islands and wrote a report about the urgency of banning the manatee harvest. His warning was neglected and the last sea cow was killed in 1768.

It's really most of the dramatic point why the nature of the northern insular communities is extremely vulnerable. Any imprudent human interference in this fragile world may result in severe deterioration of its harmony and unity.

Since the 1958 Russian Government highly prohibit the 30 miles area the sea water around the Commander Islands for commercial fishing. As a result, more then 40 years this area doesn't have so distraction influence from it. In mean time it's only one area for whole

Beringia. That's why, from the point of view to further safety and study natural marine eco-system, the Commander Islands extremely impotent too.

In 1993, the Commander Islands Nature Preserve was established. By Russian federal law, a large percentage of the Islands, as well as a 30-mile radius of ocean around them, became primary conservation areas. In the same year, the Gore-Chernomirdin Commission (USA - Russia) highlighted the Commander Islands Nature Preserve as a key zone for conservation in the North Pacific. It's well display how the Commander Islands play the impotent role for the USA, Russia, Japan, Canada, China, Korea and many others.

5. The World Human Being aspect :
In the mean time, a few an American's companies, which have been doing some eco--tourist expedition at the North Pacific.

The first one was " Zegrahm & Eco Expedition " (Seattle, USA). In 1997 they organized some short landing on the Commander Islands with huge success. After all, another an American firm such the " Society Expeditions " (Seattle, USA), was following.

They have been doing some successful eco - tourist expeditions at the North Pacific, included the Commander Islands in their distention from Japan to Alaska. The Commander Islands were always high light of the trip for all people around the World indeed!

Resume

My colleagues and I have been doing intensive research work in the Commander Islands for more than 20 years. From that experience, I can establish beyond doubt that for many natural, historical, economic and other reasons the Commander Islands is an essential focal point for field expedition work and finally for conservation projects in the unique ecosystem of the North Pacific.

Evidence gathered and projects originating there will be of vital importance for all countries: the USA, Russia, Canada, Japan, Korea and many others.

As you know, this process may be most typical mark for the present condition of Beringia Ecosystem, because the Commander Islands itself is a keystone of that.

That's why, in meantime very important to organize on the Commander a very careful monitoring by field expeditions all year's around and organize with the Commander Nature Reserve some special, scientific bases for permanent research activities.

Finally, our Association and the Commander Islands Nature Reserve have been inviting all colleagues to share with us unique opportunity to work together on the Commander Islands in near future.

Holocene climate changes at the northern Svalbard continental margin.

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The study was based on the core NP94-51 SC2 (80° 21,346 N, 16° 17,970 E, 400 m water depth, 513 cm long) retrieved from the mouth of the Hinlopen Strait in the Arctic Ocean, north of Svalbard. We have chosen Svalbard archipelago for our study, because of its location in the high Arctic at the northernmost reach of the warmer West Spitsbergen Current, which forms the continuation of the North Atlantic Current. In this specific setting, close to the Polar Front, even small variations in the current system are expected to have a large effect on the regional climate. Thus, the Svalbard area is ideal for monitoring past changes in the ocean circulation.

We aimed to reconstruct the timing and the development of the Holocene at the northern Svalbard margin. Radiocarbon dates (AMS C^{14}) give the age of approximately 9650 BP for the bottom of the core. A detailed analysis of several oceanographic proxies such as: studies of ice-rafted debris (IRD) in the core (based on rapid X-ray diffraction analysis on bulk material), saturation isothermal remanent magnetisation (SIRM), oxygen and carbon isotopes, benthic and planktic foraminiferal faunas, grain size distributions, spectral reflectance (L*a*b scale) and AMS C^{14} dates were used to reconstruct the paleoceanographic evolution of the study area.

In comparison to the Late Deglaciation, where very rapid changes occurred (Koç et al. 2002), results of IRD and magnetic susceptibility indicate relatively low variability in the environmental conditions in the Holocene, especially during the Mid-Late Holocene period. However, the oxygen isotope data show low-amplitude variations during the entire Holocene with a gradual trend towards lower $\delta\, O^{18}$ values in the Late Holocene. The foraminifera distribution patterns show more variations during the Holocene than the physical parameters. In the lower Holocene the data of *Nonionellina labradorica, Cassidulina reniforme* and *Elphidium excavatum* is characterized by significant variations with a tendency towards more stability during the Holocene thermal optimum. The distribution of *E. excavatum* shows changes at the beginning of the Holocene and its relative abundance increases towards the Late Holocene. *Cibicides lobatulus* data show a very strong peak between 9380 – 9815 BP just after the transition into the Holocene, indicating stronger bottom currents. The Holocene results of *N. labradorica, C. reniforme, E. excavatum* and *Islandiella norcrossi* display significant variations, indicating relatively large changes in the ocean circulation.

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Organic carbon records from the Kara Sea (Arctic Ocean): Distribution, sources, burial, and variability during Holocene times.

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The Kara Sea surface sediments display organic carbon contents between 0.2 and up to 3%, with maximum values in the Ob and Yenisei estuaries, submarine channels, and the St. Anna and Voronin troughs. The organic carbon preserved in the sediments is predominantly of terrigenous origin. Towards the open Kara Sea, with increasing distance from the estuaries, a decrease in amount of terrigenous matter is indicated by decreasing C/N ratios, increasing $\delta^{13}C_{org}$ values, and decreasing long-chain *n*-alkanes. The post-glacial to Holocene organic carbon input have been strongly influenced by sea-level rise and related changes in river discharge and coastal erosion. For the entire Kara Sea, we estimate an average Holocene (0-11 Cal. kyrs. BP) accumulation of 2.1 x 10^6 t y^{-1} of total organic carbon. The organic carbon burial rate can be divided into 1.7 x 10^6 t y^{-1} of terrigenous and 0.4 x 10^6 t y^{-1} marine organic carbon. For the late Holocene time interval (0 – 6 Cal. kyrs. BP), a mass balance for terrigenous organic carbon implies that 1.2 x 10^6 t y^{-1} (about 50 % of the input) is buried on the Kara Sea shelf, and 0.8 x 10^6 t y^{-1} (about 36% of the input) is exported towards the interior ocean via currents. The export via sea ice is < 1% of the input. During the late Holocene, only 0.23 x 10^6 t y^{-1} (or <1% of the primary production) are buried in the sediments which implies that > 99% of the marine organic carbon is remineralized or exported.

Late Weichselian and Early Holocene oceanographic changes off North Iceland

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Late Glacial and Holocene high-resolution sedimentary records has been obtained from piston cores and gravity cores on the North Icelandic shelf. The shelf region north of Iceland is oceanographically a very sensitive region. At the present time, the region is characterised by the oceanographic Polar Front running along the north Icelandic shelf, separating the cold, low-salinity East Icelandic Current to the north, and down to at least 500 m water depth as reflected by the present foraminiferal fauna distribution the relatively warm, saline Irminger Current that flows clockwise around Iceland. The record of shelf sediments penetrated by the sediment cores extends beyond the Last Glacial Maximum. Tephra layers have been identified and are used for correlation between cores and also in combination with radiocarbon dates for construction of age-models. Several larger palaeoceanographic shifts occurred in the area during the Late Glacial and early Holocene. Incursion of relatively warm and Atlantic waters to the shelf region during the pre-Bölling is manifested by benthic foraminiferal assemblages (*A. weddellensis*, *C. neoteretis* and Miliolida). Similar environmental signals are repeated during part of the Younger Dryas around the level of the Vedde tephra marker. A total dominance of the high arctic planktonic *N. pachyderma* sinistral in the same pre-Bölling interval indicate that the surface waters must have been influenced by the cold East Icelandic Current and that the water masses were stratified. The record of Late Weichselian and Early Holocene bottom waters on the North Icelandic shelf shows a clear antiphase relationship with sharply reduced flow of Atlantic waters at the beginning of the Bölling and the Preboreal in contrast with the increased strength of North Atlantic Current inflow into the eastern part of the Nordic Seas and warming events in the GRIP temperature reconstructions.

Managing Multiple Stressor: Climate Change Vulnerability in the Barents Sea

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The Barents Sea is a particularly vulnerable region to climate change due to its geographic location and sensitive biological environment. The region is home to over 150 fish species including cod and herring, important seabird colonies and mammals such as whales, polar bears and seals. However, climate vulnerability is also influenced by economic activities. The Barents Sea region is an important international fishery, has plentiful tourism opportunities, and has considerable oil and gas reserves for potential development. These activities are likely to exacerbate climate vulnerability in some cases, and reduce it in others. This poster presents a framework for examining the effects of multiple stressors on climate vulnerability in the Barents Sea, with the objective of identifying possible adaptation strategies.

The poster will include information about the following components of the study:

- Definition of vulnerability and resilience in the context of the Barents Sea.
- Identification of climate change impacts (based on existing studies and climate modeling results).
- Identification of multiple stressors and their impacts.
- Development of adaptation strategies for the Barents Sea.

Analysis of a submarine channels system in the Greenland Basin

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The Greenland basin extends from the shelf at around 500m to water depths exceeding 3500m and is bordered by topographic boundaries as the Jan Mayen Fracture Zone in the South, the Greenland Fracture Zone in the North and the Mohns Ridge to the East. Along the continental margin, southward flowing currents (East Greenland Current and Arctic Intermediate Waters) transport cold water masses from the Arctic Ocean into the North Atlantic, resulting in an along-slope transport of sediments. Additionally, calving of glaciers from the East-Greenland ice-sheet and sea ice production on the shelf may entrain large amounts of sediments across the shelf and down-slope due to meltwater production and brine formation.

During several geological and geophysical surveys (side-scan sonar, seismic profiling, gravity coring) we investigated the sediment dynamics of deep-sea channels in the Greenland Basin and adjacent margin, in particular with regard to their response to climatic driven ice sheet advances and retreats. Our studies focus on the largest, over 400km long deep-sea channel and fan system of the set of channel systems in the Greenland Basin (Mienert et al., 1993). The channel and fan system extends from the upper slope to the deepest part of the basin. The upper slope has a well-developed system of shallow tributaries with a high order of branching suggesting initiation by cold water cascades. The side scan sonar data also reveal widespread fields of sediment waves along the continental slope and between the channels indicating down-slope flow and sediment transfer processes by near-bottom currents. Transparent units of debris flows observed on the seismic records from the continental slope as well as from the abyssal plain indicate phases of mass movements from the shelf edge to the deep-sea basin, probably at ice sheet advances during maximum glaciation.

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Marine Environmental Changes in the Holocene of the Faeroe Islands as Evidenced by Quantitative Diatom Analyses.

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Diatom analyses were performed on the sediment cores SKPC-01, SKPC-08, and SKPC-10 from the Skalafjord, Faeroe Islands. The sedimentary sequences show distinct changes with time with respect to the species composition of the diatom flora. Changes within diatom ecological groups allowed reconstruction of the paleogeographical development of the study area during the Holocene. Core SKPC-01 retrieved from the inner part of the Skalafjord provides evidence of a change from a lake environment to an intermediate-stage brackish-water lagoon, and the development of the still existing marine environment of the Skalafjord. The change from freshwater to marine conditions occurred between about 6400-7700 yrs B.P.

Cores SKPC-08 and SKPC-10 were retrieved from the mouths of the Kaldbaksfjord and Skalafjord, respectively. Diatom floral census data for the marine part of core SKPC-01 and cores SKPC-08, and SKPC-10, which are exclusively marine, have been generated. The marine interval of SKPC-01 encompasses the last 6400 years. For core SKPC-10 an exceptionally high resolution is obtainable for the interval 660 and 890 years A.D. where the sedimentation rate is nearly 3.5 mm/year. The chronology for core SKPC-08 has not yet been established. Multivariate-statistical analysis (maximum-likelihood factor analysis) based on the 19 most abundant species provides evidence of the most significant patterns of Holocene environmental changes in the Faeroe Islands.

Reconstructing Little Ice Age Snow and Ice Distribution in the Canadian High Arctic and its Paleoclimatic Significance

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Climate change during the 20th and 21st centuries has resulted in extensive modification of polar regions; this trend will continue as predicted temperature increases there exceed those elsewhere on the globe (IPCC, 2001). Accelerated melting of Alaskan and Yukon Glaciers, and associated sea level rise recently reported in the literature, alert us to this ongoing change (Arendt et al., 2002). It is imperative to expand our monitoring of Arctic environmental change, in order to assess both past and present climate variability. The Queen Elizabeth Islands (QEI), representing an area of ~410,000 km^2, contains ~5% of the terrestrial ice found in the Northern Hemisphere (Koerner, 1989); hence, it is a natural extension of neighbouring Alaskan/Yukon research, and complements studies of the alarming reduction of Arctic sea ice spanning the past three decades.

Evidence for an expanded Neoglacial ice cover in the QEI is recorded by the recent retreat of glaciers, small ice caps, and perennial snowfields following the Little Ice Age (LIA) (~1600 – 1900 AD), exposing prominent trimlines (Ives, 1962). In many cases, these trimlines mark the former equilibrium-line altitude (ELA), which indicates the position where annual accumulation equals annual ablation; consequently, the elevation above which snow persisted perennially on the landscape.

Mapping Neoglacial trimlines and reconstructing paleo-ELAs throughout the QEI provide: i) a measure of LIA snow and ice expansion and ELA lowering compared to modern conditions (Miller et al., 1975), ii) an opportunity to consider the LIA climate forcing that may have been responsible for it, such as changes in the trajectory of storm tracks (Lamoureux, 2000; Bradley and England, 1978), iii) a measure of the degree of melt that has occurred in the CAA since the onset of 20th century warming, and iv) a valuable dataset of snow and ice extent and related climatic conditions that can be used as input for coupled glacier/ice sheet climate models. These models can be used to assess predicted future climate change on Arctic ice masses, which is relevant to future sea level change. Eight locations throughout the QEI have been selected for this study (ranging from 3,600 km^2 to 10,800 km^2); preliminary results will be presented.

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