APEX Fifth International Conference and Workshop:

Quaternary Glacial and Climate Extremes

Hosted by The University Centre in Svalbard (UNIS)

Longyearbyen, Svalbard

June1st -4th 2011

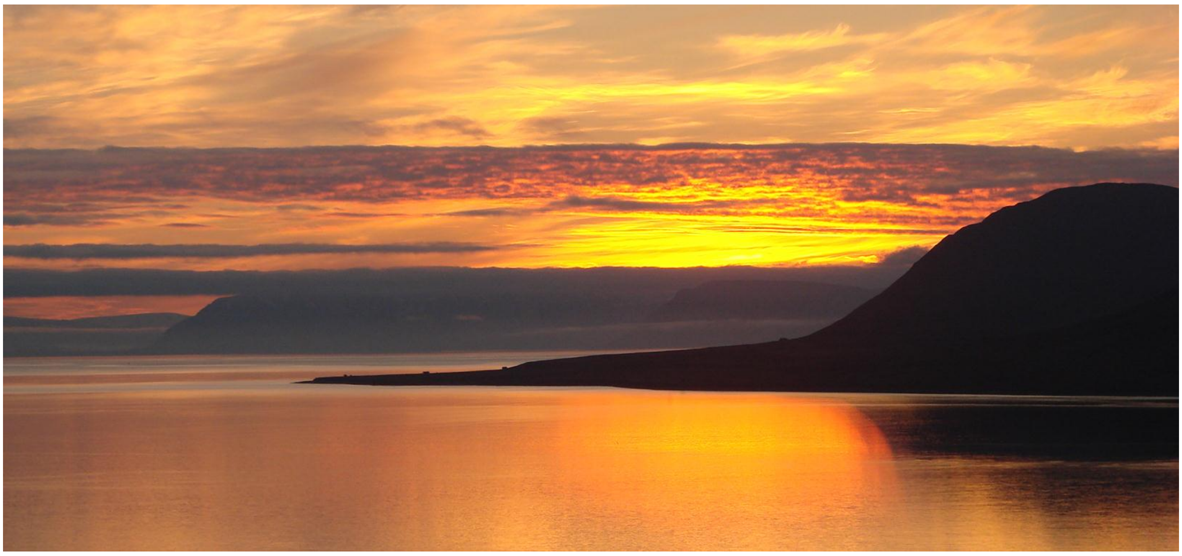
Conference and workshop supported by:

The University Centre in Svalbard (UNIS)
International Arctic Science Committee (IASC)
Bert Bolin Centre for Climate Research, Stockholm University
ESF European Polar Board (EPB)

Cover photo:Peaks of Spitsbergen

First sheet photo: Sunset at Revneset, Adventfjorden

Photos: Riko Noormets



Arctic Paleoclimate and its Extremes (APEX)
The Fifth International Conference and Workshop

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Table of Contents

Arctic Palaeoclimate and its Extremes (APEX)

APEX – Arctic Palaeoclimate and its Extremes - is a scientific network programme with a research focus aiming to understand the magnitude and frequency of past Arctic climate variability and, in particular, the "extremes" versus the "normal" conditions of the climate system. A key objective of the programme is to improve our understanding of the Arctic's role in the global climate system, knowledge that is particularly important due to the present rapid environmental changes attributed to enhanced global warming. APEX is an interdisciplinary programme that integrates marine and terrestrial science, combining modelling and field observations. It builds on the research legacy of the two previous ESF programmes PONAM (POlar North Atlantic Margins) and QUEEN (Quaternary Environments of the Eurasian North) and has been developed in consultation with the ESF European Polar Board as part of the European contribution to the International Polar Year (IPY) 2007/2008. Endorsed by the ICSU/WMO Joint Committee as an IPY "cluster" lead-coordinating programmer for palaeoclimate research, APEX includes 36 individual IPY research projects to-date with participating scientists from 15 European countries, Russia, Canada and USA.

APEX Steering Committee 2011

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Dmitry Subetto	Russia
Ólafur Ingólfson	Iceland
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Conference supported by:
International Arctic Science Committee (IASC)
The University Centre in Svalbard (UNIS)
Bert Bolin Centre for Climate Research (BBCCR)
ESF European Polar Board (EPB)

Organizers of the 5th APEX meeting:
Martin Jakobsson
Ólafur Ingólfsson
Riko Noormets
Maria Jensen

APEX 2011: Program – a snapshot

Day 1 Tuesday, 31st May 2011	**18^{00}**	**Registration and Ice breaker at UNIS**
Day 2 Wednesday, 1st June 2011	**08^{00}-18^{00}**	**Conference**
	19^{00}	**BBQ Dinner**
Day 3 Thursday, 2nd June 2011	**08^{30} - 18^{00}**	**Conference**
Day 4 Friday, 3rd June 2011	**08^{00} - 18^{00}**	**Boat Trip**
Day 5 Saturday, 4th June 2011	**09^{00} -15^{00}**	**Discussions in work groups**
	18^{00}	**Conference Dinner**
Day 6 Sunday, 5th June 2011		**Departure**

APEX 2011 Meeting Program

Tuesday, 31st May 2011.

18^{00} **Registration and Ice Breaker at UNIS**

Wednesday, 1st June 2011.

08^{00} **Registration at UNIS**

08^{30} **Conference Opening and Welcome address by** Gunnar Sand, Director of the University Centre in Svalbard

08^{35} **Welcome by the APEX Chairman**: Martin Jakobsson

08^{40} **Practical information by the organizers:** Riko Noormets

08^{45}- 12^{00} **Oral presentations on Cold Extremes**

08^{45} **Keynote: Svend Funder**

09^{15} *Tom Cronin:* Arctic Ocean Temperature History since 60 ka based on ostracode Mg/Ca ratios

09^{30} *Claude Hillaire-Marcel:* The AMOC slow-down during the Younger Dryas: Enhanced freshwater supplies from the northwestern LIS and/or enhanced sea-ice export from the Arctic?

09^{45} *Riko Noormets:* Aeolian deposits in Adventfjorden: implications for the Holocene environmental change on Spitsbergen, Svalbard

10^{00}-10^{30} **Coffee Break**

10^{30} *Ekaterina Ovsepyan:* Changes in the late Pleistocene-Holocene foraminiferal assemblages and sedimentary records from the Shirshov Ridge, Western Bering Sea: paleoceanographic implication

10^{45} *Marit-Solveig Seidenkrantz:* Ocean circulation and glacial ice marginal history offshore West Greenland during the last glacial period

11^{00} *Antony J. Long:* Relative sea-level change in Greenland during the last 800 years and ice sheet response to the Little Ice Age

11^{15} *Ívar Örn Benediktsson* : The quest for the Kara Sea Ice Sheet margins: current status and future plans.

11^{30} *Endre F. Gjermundsen:* Late Weichselian Ice sheet configuration and thickness in Northwest Spitsbergen from ^{10}Be dating and lithological studies of erratic boulders and bedrock

11^{45} *Bernhard Diekmann:* Late Quaternary Landscape and Climate Dynamics of the Verkhoyansk Mountains, eastern Siberia

12^{00} – 13^{30} **Lunch**

13^{30} – 16^{30} Oral presentations on Warm Extremes

13^{30} *Martin Jakobsson:* The history of Arctic Ocean Sea Ice: A review

13^{45} *Dennis A. Darby:* Evidence for the Arctic perennial ice pack reforming several times in the past

14^{00} *Robert F. Spielhagen:* Contrasting interglacials in the Arctic Ocean – an Eemian-Late Holocene comparison based on stable oxygen and carbon isotopes

14^{15} *Jochen Knies:* Fresh news from an old ODP record – Neogene climate dynamics and hydrocarbon migrations on the Yermak Plateau, NW Spitsbergen

14^{30} *Juliane Müller:* Neoglacial sea ice fluctuation in eastern FramStrait

14^{45} – 15^{30} Coffee Break.

15^{30} *Yaroslav Ovsepyan:* High-resolution record of the Late Saalian–Eemian environmental changes in the northeastern White Sea Region (Bychye section) inferred from benthic foraminifers

15^{45} *Volker Wennrich:* Hot times in the Beringian Arctic – Pliocene and Quaternary warm extremes in the 3.6 Ma record of LakeEl'gygytgyn/ NE Russia

16^{00} *Bernhard Diekmann:* Holocene Lake Records of Subarctic Palaeoenvironments on Kamchatka, Russia

16^{15} *Matt Strzelecki:* Response of paraglacial coastal sediment dynamics to post – LIA climate shifts – recent advances from Svalbard

16^{30}– 18^{00} Poster Session

Cold extremes

Aleksander Makarov: Evidences of high sea-level standing in the Russian Arctic during the Holocene

Eiliv Larsen: SciencePub in Russia: Latest glacial and lake reconstructions

Tatiana Klyuvitkina: Detail Reconstruction of Late-Pleistocene Marine Environments in the Western Laptev Sea based on Aquatic Palynomorph Assemblages

Kristian Kjeldsen: Isostacy in Greenland - deglaciation of an ice sheet

Wesley Myers: A refinement of Circum-Arctic mineralogy

Dorthe Klitgaard Kristensen: The flow of Atlantic Water and deglaciation of the Svalbard-Barents Sea ice-sheet east of Svalbard during the last 16,500 years

Warm extremes

Thomas Opel: Late Holocene climate change in the Russian Arctic – seasonal trends from glacier and ground ice

Jesse Farmer: Ocean temperature variability in the Western Arctic Ocean during the last 7000 years

Carolyn Wegner: The Arctic in Rapid Transition (ART) Initiative: Integrating priorities for Arctic Marine Science over the next decade

*Helena Alexanderson:*Holocene sea-level change in Kongsfjorden, NW Svalbard

Rina Garcia: Terrestrial organic matter deposition on the Lomonosov Ridge, central Arctic Ocean

Renata G. Lucchi: Extreme episodic marine sediment deposition during deglaciation of Storfjorden and Kveithola (western Barents Sea)

Thursday, 2nd June 2011.

08^{30} – 10^{00} **Oral presentations on Glaciodynamic Extremes**

08^{30} **Keynote: Ólafur Ingólfsson**

09^{00} *Jon Y. Landvik*: The last Svalbard/Barents Sea Ice Sheet – New understanding of ice sheet dynamics from western Svalbard

09^{15} *Nina Kirchner:* Svalbard's Ice Streams: spatial ice sheet reconstructions vs. numerical modeling

09^{30} *Svend Funder:* The Greenland ice sheet during LGM – a model based on field observations

09^{45} *Jerry Lloyd:* Timing and driving mechanism of deglaciation of central west Greenland

10^{00}-10^{30} **Coffee Break**

10^{30}– 12^{00} **Glaciodynamic Extremes**

10^{30} *Patrick Applegate:* Parametric uncertainty and the evolution of the Greenland Ice Sheet

10^{45} *Hreggvidur Norddahl:* Younger Dryas – Preboreal glacier oscillations in Iceland, a very dynamic response to a climate change

11^{00} *Denise Christina Rüther:* Sedimentary environments in Kveithola, Barents Sea, during Latest Weichselian deglaciation and Holocene

11^{15} *Anne Hormes:* Ice sheet configuration during MIS 2 on Nordaustlandet, Svalbard

11^{30} *Matthias Forwick:* Dynamics of the Lomonosovfonna ice field, central Spitsbergen, since the last glacial

11^{45} *Esther Ruth Gudmundsdottir*: Tephrochronology a tool for dating the extremes

12^{00} – 13^{30} **Lunch**

13:30 - 15:00 **Oral presentations on Hydrological and Permafrost Extremes**

13:30 *Ludvig Löwemark*: Manganese cycles and bioturbation as a stratigraphic tool in Arctic Ocean sediments

13:45 *Hanno Meyer:* Winter climate reconstruction from Radiocarbon-dated ice wedges – examples from Siberia and Alaska

14:00 *Lutz Schirrmeister:* Late Quaternary landscape and climate variability in the East Siberian Arctic recorded in permafrost

14:15 *Georg Schwamborn:* Palaeo-permafrost dynamics in El´gygytgyn Crater core data

14:30 *Kari Strand:* Mineralogical content of a catastrophic flooding deposit of the Arctic Ocean: implications for provenance and sediment transport pathways during MIS 4

14:45 – 15:30 **Coffee Break**

15:30 – 12:00 **Oral presentations on Biotic Change Extremes**

15:30 *Jan Mangerud:* Breaking news on Ice Age Humans in Northern Russia

15:45 *Frank Kienast:* Vegetation and climate during the Early Holocene warm phase at the Seward Peninsula, Alaska, Central Beringia

16:00 *Kirstin Werner:* Holocene variability of surface and subsurface Atlantic Water inflow on the West Spitsbergen continental margin

16:15 *BorisBiskaborn:*Holocene palaeoenvironmental variability inferred by lake records of extreme continental climates in the Siberian Arctic

16:30 *Koen Verhoeven:*Northern migration through the Bering Strait during Zanclean times: evidence from dinoflagellate cyst biostratigraphy in Tjörnes (northern Iceland)

16:45 - 18:00 Poster Session

Biotic change

*Steffen Aagaard-Sørensen:*Mg/Ca paleotemperature reconstructions of Atlantic Water advected to the European subarctic and arctic margins the past 14.000 cal yr B.P.

*Svend Funder:*The Kapp Ekholm section – the molluscs' tale

Anna Ludikova: Diatom-inferred history of one of the northernmost Greenland lakes

*Denis Kuznetsov:*Sedimentary records of Lake Onega level changes in the postglacial times

Koen Verhoeven: Warm or Cold? Ecological signals of a Plio - Pleistocene pollen and dinoflagellate cyst record from the Tjörnes section (northern Iceland)

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Osip Kokin: The evidences of the Pre-Holocene glacier advance in West Spitsbergen

Nina Kirchner: Novaya Zemlya - a nucleus for glaciation in the Barents-Kara Sea during MIS 3-2?

Matthias Forwick: A Late Weichselian and Holocene stratigraphy for Spitsbergen fjords

Michail Anisimov: Pleistocene Ice Sheet in the East part of the Russian Arctic Shelf

Hydrological extremes

Kristian Kjeldsen: A causal link between drainage of ice-dammed lakes and glacier retreat

Miscellaneous

Svend Funder: The APEX-related RINK project in Greenland in 2010 and 2011 – a report

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Abstracts

TALK

The quest for the Kara Sea Ice Sheet margins: current status and future plans

Ívar Örn Benediktsson[1], Per Möller[2]

[1]Institute of Earth Sciences, University of Iceland; [2]Department of Earth and Ecosystem Sciences, Division of Geology, Lund University, Sweden

It has been proposed that the growth of the Kara Sea Ice Sheet (KSIS) during repeated glacial cycles was initiated by the expansion of local ice caps around the Kara Sea. Later, these ice caps merged on the shallow shelf and grew and behaved as an ice sheet. This ice sheet flowed to the north onto the Severnaya Zemlya archipelago, and to the south across the Byrranga mountains on the Taymyr peninsula (e.g. Möller et al., 2007; Ingólfsson et al., 2008). Prominent moraine ridge complexes – up to 15 km wide, 100-150 m high and traceable laterally for 100's of kilometres – now represent either terminal positions of different KSIS stages or halts in retreat from maximum positions during overall recession. Some ridges form distinct morainal loops while others are more diffuse. The northernmost of those moraine ridge complexes, lying north of the Byrranga mts., has a complex structure resulting from the Early Weichselian ice recession, Middle Weichselian ice expansion, and Late Weichselian ice advance (Alexanderson et al. 2002). South of the Byrranga Mountains, eight moraine ridge complexes have been documented (Kind and Leonov, 1982) and later identified on Landsat satellite images and associated Digital Elevation Models (Möller and Sallaba, 2010). However, the age of those moraines is poorly constrained and their structure is inadequately understood. The main aim of this project is to constrain the age of those moraine complexes and, thereby, to gain information about the extent of the southern KSIS margins in time and space. A 7-week expedition to the Taymyr peninsula was carried out in 2010 and another is planned in 2012. During the 2010 expedition, the focus was on the ice-marginal zones south of Lake Taymyr. The stratigraphy and sediments in between the different moraine ridges was investigated at 17 different sites along the Bolshaya Balaknya River, covering a distance of ~250 km. The stratigraphy showed alternating units of fluvial, marine and glacial origin, indicating oscillations of the KSIS margins. Preliminary results from structural measurements of till and glaciotectonized sediments adjacent to the Severokokorsk moraine (BBR 15 and 16) indicate ice flow from southerly directions at some stage. This is yet to be confirmed with further analysis of the data accompanied by upcoming results from datings. Samples of sediments, mollusks, and organic matter were collected for dating (^{14}C, OSL, ESR) and analysis of sediments and marine fauna. During a two-day helicopter reconnaissance flight over the moraine ridges, samples of erratics sitting on top of the ridges were collected for radionuclide exposure dating (^{36}Cl). In total, about 160 kg of samples were collected. Currently, majority of the samples is "stuck" in Russia due to bureaucratic problems but is anticipated to arrive to Sweden in mid-year 2011. Therefore, the only preliminary results so far come from raw sedimentological and structural data. Yet those results are limitedly reliable as the age of the stratigraphic units and associated events is still unknown.

Another expedition is planned in summer 2012, during which the ice-marginal zones southwest of Lake Taymyr will be investigated. Similar methods will be used as during the first expedition.

References

Alexanderson, H., Adrielsson, L., Hjort, C., Möller, P., Antonov, O., Eriksson, S., Pavlov, M., 2002. The depositional history of the North Taymyr ice-marginal zone, Siberia - a landsystem approach. Journal of Quaternary Science 17, 361-382.

Ingólfsson, Ó., Möller, P., Lokrantz, H., 2008: Late Quaternary marine-based Kara Sea ice sheets: review of terrestrial stratigraphic data highlighting their formation. Polar Research 27, 152-161.

Kind, N.V., Leonov, B.N., 1982. Antropogen Taimyra (The Antropogen of the Taimyr Peninsula), Nauka. Moscow, 184 pp (in Russian).

Möller, P., Lubinski, D., Ingólfsson, Ó., Forman, S.L., Siedenkrantz, M-S., Bolshiyanov, D. Yu., Lokrantz, H., Antonov, O., Pavlov, M., Ljung, K., Zeeberg, J.J. & Andreev, A., 2007. Erratum to: Severnaya Zemlya, Arctic Russia: a nucleation area for Kara Sea ice sheets during the Middle to Late Quaternary: [Quaternary Science Reviews 25(21–22) (2006) 2894–2936]. Quaternary Science Reviews 26, 1149-1191.

Möller, P., Sallaba, F. 2010. Ice marginal zones on the Taymyr Peninsula from the last glacial cycles, as interpreted from Landsat and digital elevation (ASTER) data. APEX Fourth International Conference and Workshop, Höfn, Iceland 26-30 May 2010

TALK

Arctic Ocean Temperature History since 60 ka based on ostracode Mg/Ca ratios

T. M. Cronin[1], G. S. Dwyer[2], W. M. Briggs, Jr.[3], J. Farmer[1], H. Bauch[4], M. Jakobsson[5], R. Spielhagen[4], A. Stepanova[6]

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Proxy records from Arctic Ocean sediment cores show that major paleogeographic changes occurred during the last glacial-interglacial cycle, but there is minimal data on Arctic Ocean temperature history. Mg/Ca ratios in the calcitic shells of *Krithe*, a benthic marine ostracode characteristic of deep-sea and Arctic continental shelf environments, have been used to reconstruct bottom water temperature (BWT) in the North Atlantic (Dwyer et al. 1995, Cronin et al. 1996). We analyzed Mg/Ca and Sr/Ca ratios in more than 500 specimens of *K. glacialis* and *K. minima* from 114 coretops in the Arctic Ocean and Nordic Seas to improve the Mg/Ca – temperature calibration and to evaluate the influence of other factors on Mg/Ca and Sr/Ca ratios (e.g. vital effects, carbonate ion concentration). Mg/Ca concentrations range from 6 to 13 mmol/mol and exhibit a positive correlation to temperature from -1.5 to 0.5ºC (r^2=0.4) with a sensitivity of 0.471 mmol/mol/ºC. Temperature, or temperature-related factors affecting physiology, molting and/or calcification processes, appear to be an influence on Mg/Ca variability. Carbonate ion shows no apparent relationship to Mg/Ca at $\Delta[CO_3^{2-}]$ values from -20 to 70 µmol/kg, however Sr/Ca ratios are positively correlated to $\Delta[CO_3^{2-}]$ (r^2=0.5).

We applied Mg/Ca paleothermometry for *K. glacialis* and *K. minima* to 32 sediment cores from the central Arctic Ocean (Lomonosov, Mendeleyev, Gakkel Ridges) and the Iceland Plateau. Marine Isotope Stage 3 (MIS3, 60-25 ka) Mg/Ca ratios at mid-depth sites (1000-2600 m water depth) average 2 to 8 mmol/mol higher than those in the late Holocene suggesting MIS3 BWTs were 1-3˚C warmer. In contrast, at core sites below 3000 meters, Mg/Ca ratios indicate little or no BWT change during MIS 3. Warmer mid-depth MIS 3 BWTs are consistent with oxygen isotope evidence for glacial-age elevated BWTs in the Iceland Sea (Bauch et al. 2001). Mid-depth Arctic Ocean warming most likely involves changes in the depth, circulation or temperature of the warm Atlantic Layer (AL). Possible mechanisms include AL depth suppression due to ice cover (Jakobsson et al. 2010) and/or higher AL temperatures due to enhanced Atlantic Meridional Overturning Circulation. Hypothesized elevated Arctic and Nordic Sea MIS3 BWTs can be tested against other proxies, with better radiocarbon chronology to determine if BWT warming occurred during interstadials or stadials, and in comparison to extra-Arctic paleoclimate records.

References

Bauch, H. et al. 2001. A multiproxy reconstruction of the evolution of deep and surface waters in the subarctic Nordic seas over the last 30,000 yr. Quaternary Science Reviews 20:659-678.

Cronin, T. M., et al. 1996. Deep-sea ostracode shell chemistry (Mg:Ca ratios) and late Quaternary Arctic Ocean history. In J. T. Andrews, W. E. N. Austin, H. Bergsten, A. E. Jennings eds. Late Quaternary Paleoceanography of North Atlantic Margins, Geological Society (London) Special Publication No. 111, p. 117-134.

Dwyer, G.S., et al. 1995. Late Pliocene and Quaternary bottom water temperature change in the deep North Atlantic. Science 270: 1347-1351.

Jakobsson, M., et al. 2010. An Arctic Ocean ice shelf during MIS 6 constrained by new geophysical and geological data. Quaternary Science Reviews 29: 3505-3517.

TALK

Late Quaternary Landscape and Climate Dynamics of the Verkhoyansk Mountains, eastern Siberia

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The northeastern part of Eurasia represents one of Earth's most extreme periglacial climate regions, characterized by the strongest seasonal temperature amplitudes on the northern hemisphere. The region is occupied by deep-reaching permafrost and covered by widespread taiga and tundra vegetation (Müller et al., 2010). Paleoenvironmental studies have been conducted close to the northern polar cycle in the Verkhoyansk Mountain Range and its western foreland to infer periglacial landscape dynamics in response to late Quaternary climate change. The distribution of preserved terminal moraines reveal several mountain glacier advances in the past (Stauch and Lehmkuhl, 2010). According to luminescence dating, the widest geologically documented glacial advence took place during the Saalian stage around 135 ka. Less extended glaciations to the foreland appeared during the early Weichselian at 100-120 ka and at 85-90 ka, while the youngest glaciation (>50 ka) was confined to the mountain area. No regional glacial advance is evident for the late Weichselian and the last glacial maximum, a time which was characterized by aeolian loess formation (Stauch et al., 2007, Popp et al., 2007). Sediment cores from the 25 m deep Lake Billyakh (340 m a.s.l.), a former proglacial basin, document environmental changes of the last 50 kyr (Diekmann et al., 2007). Pollen records indicate a dry climate for the late Weichselian, indicated by a change from tundra towards cold steppe vegetation after 32 ka until 13.5 ka BP (Müller et al., 2009, 2010). For the same time, sedimentological and diatom data indicate a lake level drop. Modelling experiments with a general circulation model suggest that the consecutive decline in the extent of mountain glaciers and increase in dryness through the Weichselian was dictated by the growing shielding effect of the western Eurasian ice sheets that prevented the supply of moist Atlantic air masses to eastern Siberia (Krinner et al., 2011). In addition, enhanced deposition of dust reduced the albedo and promoted ice and snow melting during summer (Krinner et al., 2011). Environmental changes towards interglacial conditions of the Holocene are documented in the Lake Billyakh deposits (Müller et al., 2009) as well as in a peat section at Dyanushka River (Werner et al., 2009). Both records show that climate amelioration started after 13.5 ka BP with the quick return of larch trees that also persisted during the Younger Dryas cold spell, suggesting that the Verkhoyansk Mountain area possibly represented a plant refugium during the climate extremes of the last ice age (Tarasov et al., 2009). Reforestation continued since 11.4 ka BP with the spread of boreal cold deciduous and taiga forests and reached a maximum extent after 7 ka BP. Limnological conditions of Lake Billyakh changed to a higher lake-level and increased biological productivity consistent with climate warming and increased humidity. Mean July air temperatures reconstructed by fossil aquatic chironomids, using a regional inference model (Nazarova et al., 2011), indicate warmest summer temperatures between roughly 9.0 and 6.6 ka BP. The stable-isotope composition of ice wedges in permafrost soils point to warmer winters during the early Holocene compared to the late Holocene (Popp et al, 2006). The recognition of a regional early Holocene climate optimum is consistent with long-term Holocene climate development in wide parts of northern Eurasia.

References

Diekmann, B., Andreev, A.A., Müller, G., Lüpfert, H., Pestryakova, L., Subetto, D., 2007. Expedition 'Verkhoyansk 2005' - Limnogeological studies at Lake Billyakh, Verkhoyansk Mountains, Yakutia. In: Schirrmeister, L. (ed.): Expeditions in Sibiria in 2005, Reports on Polar and Marine Research, 550: 247-258.

Krinner, G., Diekmann, B., Colleoni, F., Stauch, G., 2011. Global, regional and local scale factors determining glaciation. Quaternary Science Reviews, 30: 821-831.

Müller, S., Tarasov, P. E., Andreev, A., Diekmann, B., 2009. Late Glacial to Holocene environments in the present-day coldest region of the Northern Hemisphere inferred from a pollen record of Lake Billyakh, Verkhoyansk Mts., NE Siberia. Climate of the Past 5: 73-84.

Müller, S., Tarasov, P.E., Andreev, A.A., Tuetken, T., Gartz, S., Diekmann, B., 2010. Late Quaternary vegetation and environments in the Verkhoyansk Mountains region (NE Asia) reconstructed from a 50-kyr fossil pollen record from Lake Billyakh. Quaternary Science Reviews, 29: 2071-2086.

Nazarova, L., Herzschuh, U., Wetterich, S., Kumke, T., Pestryakova, L., 2011. Chironomid-based inference models for estimating mean July air temperature and water depth from lakes in Yakutia, northeastern Russia. Journal of Paleolimnology, 45(1): 57-71.

Popp, S., Belolyubsky, I., Lehmkuhl, F., Prokopiev, A., Siegert, C., Spektor, V., Stauch, G., Diekmann, B. (2007): Sediment provenance of late Quaternary morainic, fluvial and loess-like deposits in the southwestern Verkhoyansk Mountains (eastern Siberia) and implications for regional palaeoenvironmental reconstructions. Geological Journal, 42: 477-497.

Popp, S., Diekmann, B., Meyer, H., Siegert, C., Syromyatnikov, I., Hubberten, H.W., 2006. Palaeoclimate signals as inferred from stable-isotope composition of ground ice in the Verkhoyansk foreland, Central Yakutia. Permafrost and Periglacial Processes, 17: 119-132.

Stauch, G., Lehmkuhl, F., 2010. Quaternary glaciations in the Verkhoyansk Mountains, Northeast Siberia. Quaternary Research, 74: 145-155.

Stauch, G., Lehmkuhl, F., Frechen, M., 2007. Luminescence chronology from the Verkhoyansk Mountains (North-Eastern Siberia). Quaternary Geochronology, 2: 255-259.

Tarasov, P., Müller, S., Andreev, A., Werner, K., Diekmann, B., 2009. Younger Dryas Larix in eastern Siberia: A migrant or survivor? PAGES News, 17(3): 122-123.

Werner, K., Tarasov, P.E., Andreev, A.A., Müller, S., Kienast, F., Zech, M., Zech, W., Diekmann, B., 2009. A 12.5-kyr history of vegetation dynamics and mire development with evidence of Younger Dryas larch presence in the Verkhoyansk Mountains, East Siberia, Russia. Boreas, 39(1): 56-68.

TALK

Late Weichselian Ice sheet configuration and thickness in Northwest Spitsbergen from ^{10}Be dating and lithological studies of erratic boulders and bedrock

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By integrating cosmogenic nuclide dating (^{10}Be), with lithological studies we reconstruct the configuration and deglaciation of the Late Weichselian ice sheet in Northwest Spitsbergen, Svalbard. Investigations of erratic boulders on the northern extremity of our area - at the flat, low-elevation peninsula of Reinsdyrflya, and on the southern extremity of the National Park - at Mitrahalvøya, lead us to suggest a local ice dome in Northwest Spitsbergen. Our reconstruction fits well with the hypothesis of a complex multi-dome-ice-sheet-configuration over Svalbard and the Barents Sea during the Late Weichselian glaciation, with numerous drainage basins feeding fast ice streams, separated by slow flow, possibly cold based, inter-ice-stream areas.

Lithological studies of erratic boulders on Mitrahalvøya and Reinsdyrsflya indicate one common source region - the Smeerenburgfjorden complex, consisting primarily of migmatites. The lithology of these boulders points towards a main ice dome covering the Smeerenburg complex in the central part of Northwest Spitsbergen with drainages towards NNE along Liefdefjorden and southwards along Krossfjorden.

^{10}Be results from 7 well spread erratic boulders from Reinsdyrflya provide deglaciation ages and range from 9.8±1.1 ka to 19.1±1.1 ka, indicating an active ice stream on Reinsdyrflya during LGM and deglaciation before the Holocene onset.

Three high elevated erratic boulders, two on Auriviliusfjellet (16.7± 0.9 and 18.3±1.1) and one on Kaffitoppen (20.5± 0.9) suggests that the more central parts of this local ice dome was at least 300 m thicker than the ice coverage in the area at present.

POSTER

Isostacy in Greenland - deglaciation of an ice sheet

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The large continental ice sheets left a legacy of isostatic upheaval, which is generally aligned in a rather simple pattern consisting of a dome of uplift with its maximum at the centre of the former ice sheet. Owing to the incomplete deglaciation the isostatic signal left by the LGM ice sheet in Greenland is not simple, but composed of several domes with high uplift separated by swales with low uplift. This pattern, which reflects both unloading after LGM and reloading during Neoglacial ice sheet growth, shows that different sectors of the ice sheet responded differently to Holocene warming and subsequent cooling where such factors as local climate, topography, and general drainage conditions modified the effect of the overall temperature signal. We present an updated model of the Holocene isostatic uplift in Greenland based on a compilation of c.700 field observations from all parts of the country, and discuss the implications for deglaciation history. The complex behaviour of the ice margin in different sectors is relevant to the predictions of the ice sheet's future response to global warming.

POSTER (Withdrawn)

Detail Reconstruction of Late-Pleistocene Marine Environments in the Western Laptev Sea based on Aquatic Palynomorph Assemblages

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In the Late Pleistocene the shallow Laptev Sea shelf was sub-aerially exposed, and during rapid postglacial sea-level rise, the landscape gradually changed from terrestrial-fluvial to marine environments (e.g., Bauch et al., 2001). A southward retreat of the coastline caused a dramatic change in depositional environment in the Laptev Sea.

Cores PS 51/159-10 and PS 51/154-11 were obtained from the west part of the Laptev Sea at a water depths of 60 and 270 m correspondingly during the Russian-German TRANSDRIFT V expedition (Kassens et al., 1998). The core PS 51/159-10 is 415 cm long, and covers the time interval 12.2–0 ka BP according to AMS^{14} dates (Bauch et al., 2001). The core PS 51/154-11 is 670 cm long, and covers the time interval 17.5–0 ka BP. Cores PS 51/159-10 and PS 51/154-11 were sampled for aquatic palynomorphs analysis at 7 and 10 cm interval correspondingly. Freeze-dried samples were prepared with standard palynological preparation methods.

On the basis of aquatic palynomorph assemblage patterns from sediment cores major stages in environmental changes associated with last postglacial sea level rise were reconstructed for the time since 17.5 cal. ka. Aquatic palynomorphs established in the core sedimentsof the Laptev Sea include marine dinoflagellate cysts, freshwater green algae, as well as acritarchs organic remains of various zooplankton species. According to changes in the species composition the following major events in the development of paleoenvironmental conditions were established:

On the Western continental slope time interval 17.5-13.3 cal. ka was characterized by low concentrations of dinoflagellate cysts and predominance of euryhaline cold-water species such us Islandinium minutum, Brigantedinium sp., Echinidinium karaense and cyst of Polykrikos sp. Arctic morphotype. Probably this time span was characterized by heavy sea-ice conditions.

The first occurrence of autotrophic dinocyst species was marked out since 13.3 cal. ka. Relatively warm-water and Atlantic water indicative species (Operculodinium centrocarpum, Spiniferites elongatus and cyst of Pentapharsodinium dalei) appeared in core sediments since approximately 11.2 cal. ka, thus indicating influence of Atlantic water.

High concentrations of freshwater green algae indicate strong influence of Khatanga river input at the site of core PS51/159-10 (paleodepth 60 m) on the Western outer Laptev Sea shelf at the time interval between 12.2 and 11.2 cal. ka.

A pronounced change in dinoflagellate cyst assemblage composition between 11.2 and 7.0 cal. ka is characterized by a strong increase in total concentration and proportions of Operculodinium centrocarpum (up to 80%) together with the appearance of relatively warm water and Atlantic water indicative species such as cyst of Pentapharsodinium dalei, Spiniferites elongatus and Nematosphaeropsis labyrinthus as well as extremely increasing of AH-ratio values. Probably this time span is characterized by increasing summer temperature, probable reduction of annual sea-ice cover and enhanced influence of warm Atlantic water which are in good correspondence to our data from the eastern Laptev Sea shelf (Polyakova et al., 2005; Klyuvitkina, Bauch, 2006). Further time interval was characterized by establishment of modern-like conditions.

References

Bauch H.A., Mueller-Lupp T., Taldenkova E., Spielhagen R.F., Kassens H., Grootes P.M., Thiede J., Heinemeier J., Petryashov V.V. 2001. Chronology of the Holocene transgression at the North Siberian margin. Global and Planetary Change, 31, 125–139.

Kassens, H., Dmitrenko, I.A., Rachold, V., Thiede, J., Timokhov, L., 1998. Russian and German scientists explore the Arctic's Laptev Sea and its climate system. EOS Transaction American Geophisical Union, 79, 317–323.

Polyakova Ye.I., Bauch H.A., Klyuvitkina T.S., 2005. Early to middle Holocene changes in Laptev Sea water masses deduced from diatom and aquatic palynomorph assemblages. Global and Planetary Change, 48, 208–222.

Klyuvitkina T.S., Bauch H.A., 2006. Holocene changes in paleohydrological conditions in the Laptev Sea based on aquatic palynomorph assemblages Oceanology, 46, 6, 859–868.

The flow of Atlantic Water and deglaciation of the Svalbard-Barents Sea ice-sheet east of Svalbard during the last 16,500 years.

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The extent of the western Svalbard-Barents Sea ice sheet and timing of retreat during the last deglaciation has been outlined in several studies over the past couple of decades using data from both land and marine records. However, detailed investigations of the timing of the retreat of the Svalbard-Barents Sea ice sheet and its extention in the eastern part of the Svalbard region are lacking. The eastern part of the Svalbard archipelago is dominated by cold, polar surface water flowing out from the Arctic Ocean and has until recently been largely inaccessible due to extensive sea ice cover. In 2005 several sediment cores were retrieved from the area. The present study is based on gravity core NP05-71GC from 360 m of water depth south of Kvitøya and in a distal position to the present Nordaustfonna glacier front on Nordaustlandet. The 469 cm long gravity core was investigated based on its sedimentological properties, content of benthic and planktic foramininfera, and stable isotopes. A detailed chronology was obtained from six AMS ^{14}C dates. The results show that prior to the Younger Dryas until 12,800 years BP the benthic faunal development was similar to the changes found in the Hinlopen Trough north of Svalbard and with similar timing. In both areas strong inflow of Atlantic water began at the beginning of the warmer Bølling interstadial and continued through the Allerød interstadial period. South of Kvitøya in the cold Younger Dryas period the benthic foraminifera fauna was dominated by a sparse agglutinated species assemblage indicating near-perennial sea ice cover. This is in contrast to the benthic foraminifera fauna in Hinlopen north of Svalbard, where a rich calcareous fauna indicated seasonally open waters.

Glacimarine sedimentation began south of Kvitøya from before 16,500 years BP showing that the ice-sheet had retreated from the core site before that time. The retreat was apparently very rapid allowing for a strong inflow of Atlantic water at 15,500 years BP. During the Younger Dryas our study area was probably sea ice covered, but the benthic foraminifera faunas indicated continued, but strongly reduced inflow of Atlantic water and no advance of the ice sheet over the core site. Our results thus support the reconstructed position of the Younger Dryas ice margin by Mangerud and Landvik (2007).

POSTER

SciencePub in Russia: Latest glacial and lake reconstructions

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SciencePub was an extensive communication and research project sponsored by the Research Council of Norway. The consortium consisted of ten Norwegian research institutions in addition to foreign partners. The project organized 17 land expeditions and marine voyages. These set out to North West Russia, Finnmark, Svalbard and several other areas in the Barents Sea, as well as northern areas of the Norwegian Sea.

In Russia the work was centered on glacial dynamics and associated lake and marine events. We have used optical remote sensing data and a newly constructed high quality digital elevation model to map terrestrial *ice marginal landforms* from the western Russia (~20ºE) to Taymyr in the east (~110 ºE), covering an area of about 6 Mkm^2 (Fredin et al., in press). We have documented more than 1700 end moraines, several of which are previously unknown (Fredin et al., in press). In the Arkhangelsk area this mapping, validated through several years of field work, demonstrated end moraines beyond what has previously been mapped as the last glacial maximum position. Numerous dates below and above a till bed confirms that the maximum position was somewhat more extensive than published earlier (Svendsen et al. 2004; Larsen et al. 2006). Larsen et al. (1999) pointed out that the maximum position of the Scandinavian ice sheet in NW Russia was some 10,000 years delayed compared with the maximum position in its SW perimeters. This means that the ice sheet at its maximum never looked like we usually portray it (Svendsen et al. 2004; Larsen et al. 2006). For the first time this asynchronous nature of glaciations has been taken into account when reconstructing the evolution of the Eurasian ice sheets in time and space through its last glacial maxima. The main points are:

1. Shrinking maritime and growing continental parts of the ice sheet after the SW maximum was attained.
2. A young eastern maximum contemporaneous with reduced ice over the Barents Sea, western Scandinavia and the British Isles.
3. Subsequent deglaciation of all parts of the ice sheet.

In the White Sea/Arkhangelsk area large ice-dammed lakes formed twice during the Weichselian in front of the ice sheet (Lyså et al. 2011). Three separate lakes ("LGM lakes") existed, the largest one with a water table at 135 m above present day sea level, having a volume about 1510 km^3. Stepwise and rapid lake drainage probably took place within less than 1000 years. When the lake was at its maximum level, water spilled southeastwards into the Volga basin. Later, but before the lake water finally drained into the White Sea, water was routed northeastwards into the southeastern part of the Barents/Kara Seas. The oldest lake, "the White Sea Lake," existed around 67-57 ka years BP. The extent of the lake was constrained by the Barents Sea ice-sheet margin in the north and topographic thresholds to the south with a drainage basin which later was eroded and lowered during the LGM lake drainage. The maximum lake level was about 115 m above present day sea level, and the lake covered an area of about 2.5 x 10^4 km^3 with a water volume around 4800 km^3.

References

Fredin, O., Rubensdotter, L., van Welden, A., Larsen, E. and Lyså, A. in press: Distribution of ice marginal moraines in NW Russian Federation and Eurasia. *Journal of Maps.*

Larsen, E., Kjær, K.H., Demidov, I., Funder, S., Grøsfjeld, K., Houmark-Nielsen, M., Jensen, M., Linge, H. & Lyså, A. 2006: Late Pleistocene glacial and lake history of northwestern Russia. *Boreas 35*, 394-424.

Larsen, E., Lyså, A., Demidov, I., Funder, S., Houmark-Nielsen, M., Kjær, K.H. & Murray, A.S. 1999: Age and extent of the Scandinavian ice sheet in northwest Russia. *Boreas 28,* 115-132.

Lyså, A., Jensen, M., Larsen, E., Fredin, O. & Demidov, I.N. 2011: Ice-distal landscape and sediment signatures evidencing damming and drainage of large pro-glacial lakes, northwest Russia. *Boreas 41*, in press.

Svendsen, J.I., Alexanderson, H., Astakhov, V.I., Demidov, I., Dowdeswell, J.A., Funder, S., Gataullin, V., Henriksen, M., Hjort, C., Houmark-Nielsen, M., Hubberten, H.W., Ingólfsson, Ó., Jakobsson, M., Kjær, K.H., Larsen, E., Lokrantz, H., Lunkka, J.P., Lyså, A., Mangerud, J., Matioushkov, A., Murray, A., Möller, P., Niessen, F., Nikolskaya, O., Polyak, L., Saarnisto, M., Siegert, C., Siegert, M.J., Spielhagen, R.F. & Stein, R. 2004: Late Quaternary ice sheet history of northern Eurasia. *Quaternary Science Reviews 23*, 1229-1271.

TALK

Relative sea-level change in Greenland during the last 800 years and ice sheet response to the Little Ice Age

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This paper presents new evidence regarding relative sea-level (RSL) changes and vertical land motions at four sites in Greenland since 1200 A.D., a time interval that spans the later part of the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA). We observe RSL rise at two sites located on the outer coast of central west Greenland from -0.80 ± 0.20 m at c. 1200 A.D. to 0 m ± 0.20 m at c. 1600 A.D., after which RSL slowed and then stabilised. At a further two sites located close to the ice sheet margin (in Disko Bugt and Nanortalik) we observe RSL rise from -1.40 ± 0.20 m at c. 1400 A.D. until c. 1750 A.D., after which RSL slowed and was stable during the 20th century. All four sites record a slow-down in RSL during the last several centuries although the timing varies; distant to the ice sheet it occurs c. 1600 AD and close to the margin from about 1900 A.D. onwards. The 1600 A.D. RSL slow-down seen at the two former sites is surprising since it occurs during the LIA when one might expect the ice sheet to be gaining mass and causing RSL to rise. We interpret this RSL slowdown to indicate a period of enhanced and sustained regional mass loss from the Greenland Ice Sheet since c. 1600 A.D and propose two hypotheses for this loss; first, a reduction in precipitation during cold and dry conditions and second, higher air temperatures and increased peripheral surface melt of the ice sheet from this date onwards. The latter hypothesis is compatible with a well-established temperature seesaw between western Greenland and northern Europe and, potentially, a previously identified shift from a positive to generally more negative NAO conditions from around 1400-1600 A.D. Our study shows how RSL data from Greenland can provide constraints on the timing of ice sheet fluctuations in the last millennium and challenges the notion that during cold periods in northern Europe the ice sheet in west Greenland gained mass.

POSTER (Withdrawn)

Evidences of high sea-level standing in the Russian Arctic during the Holocene.

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At present, the opinion on the progress of post-glacial transgression has been already formed. In the beginning of Holocene the level of the Ocean was below its contemporary level by 40-60 meters. Since then it was gradually rising and reached the present level 5000 years ago with the probable exceed of no more than 1-2 meters. The last 5-6 decades allowed to gain extensive materials, evidencing the possibility of higher sea level in the Arctic at Holocene. This fact requires clarification of ideas regarding variability processes in Arctic Seas during Holocene.

The standing of the sea level in the past can be reconstructed by a certain traces that can be provisionally divided as follows:

– Geomorphologic evidences of sea level standing. These are terrace levels on the sea coastal zones and in the river valleys, if the latter demonstrate its ingression position. The same interpretation is used for plane surfaces below the present sea level, identified by results of bathymetric survey.

– Sediments, which accumulated under sea conditions. This data is obtained from the researches of sea area boreholes and of marine sediments of the land, for instance, in lagoons and lakes.

It is essential to collate geologic and geomorphologic documents when studying the issue. Cartographic documents are desirable for reconstruction of sea level fluctuations during last centuries. Contemporary variability of the Ocean level (last 50-60 years) is being registered by tool methods. The age-related linkage of geomorphologic and geologic evidences of sea level standing during Holocene is mainly made by means of radiocarbon dating.

Comparison of research results of sea sediments cores and continental research results tend to be problematic. Multidirectional character of contemporary variability of arctic sea basin fluctuation level against its different regions adds more obstacles to creation of common scenario for the all-arctic basin sea level progress during Holocene.

The own research as well as literature sources allowed to identify fact of high sea level conditions in the Russian Arctic during 6500, 4500, 2000-1200, 200-300 years ago. The maximum of sea level rising was up 10 meters above modern level.

TALK

The AMOC slow-down during the Younger Dryas: Enhanced freshwater supplies from the northwestern LIS and/or enhanced sea-ice export from the Arctic?

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Based on data-calibrated glaciological modelling, Tarasov and Peltier (2005) demonstrated a large freshwater flux via the MackenzieBasin into the Arctic Ocean during the onset interval of the Younger Dryas (YD). They also argued that such a discharge routing could have been more efficient in shutting down the Atlantic Meridional Overturning Circulation (AMOC) during the Younger Dryas, compared to an eastern route. Recent work by Murton and others (2010) and Not and Hillaire-Marcel (2011) suggests that such a scenario involving a NW drainage stage of Lake Agassiz remains quite plausible, despite claims for other processes by Broecker et al. (2010). However, it seems unclear if subsequent enhanced sea-ice export from the Arctic might have been the most effective mechanism leading to freshening of North Atlantic sites of intermediate to deep water production during this interval, an issue we intend to address here, mostly based on cores raised from the Northern Mendeleiv Ridge, Central Lomonosov Ridge and western FramStrait area. Radiocarbon stratigraphies from cores illustrating LGM to present conditions in the central Arctic generally depict clusters of ages ranging from i) the YD to the Holocene (mostly early) and ii) the late MIS 3-early MIS 2 interval, with a hiatus during the LGM (often barely recorded in the sedimentary sequence). One may thus infer a thick ice-field occupying the central and western Arctic Ocean. The very low sedimentation rates observed, notably over the central Lomonosov ridge, suggest very sluggish sea-ice drifting if any, along the modern Beaufort gyre as well as along the Trans-Polar Drift (TPD) pathway from the East Siberian Sea. In this later case, the low sea-level of the interval might partly account for a lesser sea-ice production and subsequent ice drifting along the corresponding TPD route. However, eastward, on Lomonosov Ridge and in the FramStrait area, Ice Rafting Deposition (IRD) with a Russian margin geochemical signature, persisted during the LGM. Using an age-model developed by Hanslik and others (2010), we have found evidence in our Lomonosov Ridge record, for the fast deposition of sediments bearing a Canadian Arctic signature during the YD. They are illustrated by enhanced relative detrital carbonate supplies, with even amounts of calcite and dolomite, in fractions ranging from fine silts to sands. A peak of unsupported ^{230}Th ($^{230}Th_{xs}$) matches this interval, suggesting advection of the finer fractions of the sediment through a high turbidity event. The coarser fraction mineral composition indicate IRD from the north-western Canadian Arctic, thus a re-inception of an active Beaufort Gyre, whereas the pulse of $^{230}Th_{xs}$-rich fine fraction points to a major meltwater pulse, from the same area. The most plausible scenario here would be to link the freshwater pulse to a drainage event through the Mackenzie river valley, to enhanced sea-ice production in the Beaufort Sea coastal area, and the resumption of strong ice transport along the Beaufort Gyre, and subsequently along the western TPD route towards the North Atlantic. Here, both our Fram Strait and Lomonosov records show drastic changes in sediment sources at the very end of the YD, with increasing sedimentary supplies from Russian sources during the Holocene, thus a relative weakening of the Beaufort Gyre immediately afterwards. Our findings support both the scenarios of LakeAgassiz drainage event via the Mackenzie area, with a high sedimentary influx to the central Arctic Ocean, and of an Arctic routing of the meltwater/sea-ice towards the North Atlantic. Thus, the hypothesis of a major drainage event (through the Arctic Ocean) resulting in a slow-down of the AMOC, and likely in the YD cold spell by itself (Murton et al., 2010), is in no way disqualified, as suggested in some recent papers (e.g., Broecker et al., 2010), although the respective roles of the meltwater pulse or that of the enhanced subsequent sea-ice export has still to be deciphered. Worth of mention is the fact that based on Condron and Winsor [2011] model experiments based on a high resolution GCM, a northern route for meltwater/sea-ice export should likely have been more efficient in reducing the AMOC than any route, south of the Denmark-Iceland-Scotland sill, unlikely to export freshwater northward.

References

Broecker, W.S., Denton, G.H., Edwards, R.L., Cheng, H. Alley, R.B., Putnam, A.E., 2010. Putting the Younger Dryas cold event into context. *Quaternary Science Review* 29, 1078-1081.

Condron, A. and Winsor, P., 2011. A subtropical fate awaited freshwater discharged from glacial Lake Agassiz. Geophys. Res. Lett. 38, L03705,doi:10.1029/2010GL046011.

Hanslik, D., Jakobsson, M., Backman, J., Bjorck, S., Sellen, E., O'Regan, M., Fornaciari, E., Skog, G., 2010. Quaternary Arctic Ocean sea ice varaitions and deep water isolation times. *Quaternary Science Reviews*. 29, 3430-3441.

Murton, J.B., Bateman, M.D., Dallimore, S.R., Teller, J.T., Yang, Z., 2010. Identification of Younger Dryas outburst flood path from Lake Agassiz to the Arctic Ocean. *Nature* 464, 740-743.

Not, C., Hillaire-Marcel, C., 2011. Sedimentary evidence from Lomonosov Ridge for an Arctic trigger of the Younger Dryas. Submitted for publication.

Tarasov, L., Peltier, W.R., 2005. Arctic freshwater forcing of the Younger Dryas cold reversal. *Nature* 435, 662-665.

POSTER

A refinement of Circum-Arctic mineralogy

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X-ray diffraction mineralogical studies are a commonly used tool in the Arctic region for analyzing sediment records and determining provenance. (Stein et al., 1994, 2004; Strand et al., 2008; Vogt et al., 2001, 2008; Wahsner et al. 1999) The lack of adequate circum-Arctic mineralogical data can severely hamper the use of this provenance tool. Most mineralogical studies have focused on potential Eurasian sources, while there have been very few studies of North American sources. (Stein et al., 2002) Furthermore, these studies focus primarily on qualitative clay mineral data and ignore other mineral constituents (non-clay minerals). This work aims to redefine the circum-Arctic source mineralogy and show that certain assumptions are not necessarily straightforward. For instance, the clay mineralogy, specifically the smectite group, has been used as a provenance indicator for the western Laptev and Kara Sea regions. (Vogt and Stein, 2008) Our work however, shows that while the western Laptev/Kara Sea is most likely the primary smectite source, it is not the only source with >20% of this clay. (Darby et al., in press)

This study looks at twenty-nine samples from the circum-Arctic coastal plain and shallow shelves (<50m water depth where sea ice can entrain sediment) that have been analyzed for quantitative bulk (<45 µm) mineralogy. A suite of thirty-three minerals was determined for each sample using the Excel macroprogram RockJock. (Eberl, 2003) The mineralogy of potential circum-Arctic sources is very complex. In order to use mineralogy for provenance, there needs to be unique mineral types/assemblages or large differences in abundances. Some minerals such as different feldspar phases, carbonates, and chlorite show promise as potential source indicators, but mixing, winnowing, or selectiveentrainment can cause differences in mineral content between transported sediment and sources. These reasons highlight the need for future studies of Arctic mineralogy to use a standard method of analysis and data handling that provides consistent quantitative results.

References

Darby, D.A., Myers, W., Jakobsson, M., and Rigor, I., In press. Modern Dirty Sea Ice Characteristics and Sources: The Role of Anchor Ice. *Journal of Geophysical Research-Oceans*.

Eberl, D. D. (2003), User's guide to RockJock, a program for determining quantitative mineralogy from powder x-ray diffraction data, *Open-File Report 03-78,* pp. 56, U.S. Geological Survey, Boulder, Colo.

Stein, R., H. Grobe, and M. Wahsner (1994), Organic-Carbon, Carbonate, and Clay Mineral Distributions in Eastern Central Arctic-Ocean Surface Sediments, *Mar. Geol.*, 119, 269-285.

Stein, R., F. Niessen, D. Dittmers, M. Levitan, F. Schoster, J. Simstich, T. Steinke, and O. V. Stepanets (2002), Siberian River Run-Off and Late Quaternary Glaciation in the Southern Kara Sea, Arctic Ocean: Preliminary Results, *Polar Res.*, 21, 315-322.

Stein, R., K. Dittmers, K. Fahl, M. Kraus, J. Matthiessen, F. Niessen, M. Pirrung, Y. Polyakova, F. Schoster, T. Steinke, and D. K. Futterer, D.K. (2004), Arctic (palaeo) river discharge and environmental change: evidence from the Holocene Kara Sea sedimentary record, *Quat. Sci. Rev.*, 23, 1485-1511.

Vogt, C., and J. Knies (2008), Sediment dynamics in the Eurasian Arctic Ocean during the last deglaciation - The clay mineral group smectite perspective, *Mar. Geol.*, 250, 211-222.

Vogt, C., J. Knies, R. F. Spielhagen, and R. Stein (2001). Detailed mineralogical evidence for two nearly identical glacial/deglacial cycles and Atlantic Water advection to the Arctic Ocean during the last 90,000 years, *Global Planet. Change*, 31, 23-44.

Wahsner, M., C. Muller, R. Stein, G. Ivanov, M. Levitan, E. Shelekhova, and G. Tarasov (1999), Clay-mineral distribution in surface sediments of the Eurasian Arctic Ocean and continental margin as indicator for source areas and transport pathways - a synthesis, *Boreas*, 28, 215-233.

TALK

Aeolian deposits in Adventfjorden: implications for the Holocene environmental change on Spitsbergen, Svalbard.

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Aeolian dust in the deep sea sediments has been used widely to infer the past weather patterns and climate variations, for instance in West Africa and China (e.g. Rea, 1994; Stuut et al., 2002; Holtz et al., 2004).This study investigates the Holocene environmental changes using the variations of aeolian component of the marine sediments in Adventfjord, a small arctic fjord in the central part of the Isfjorden fjord system on Spitsbergen, Svalbard. Weather data (air temperature, wind speed and direction, and relative humidity/precipitation) from the local weather station have been analyzed and compared with the recorded occurrences of dust plumes in Adventdalen in order to understand the weather controls of the aeolian sediment transport into the adjacent fjord.

Grain size distribution of the terrigenous fractions of the aeolian dust collected in the Adventdalen during dust storms in 2009 is compared with that of the fjord sediments recovered in a 3-meter long gravity core from the mouth of Adventfjord. Age of the sediments and estimated sedimentation rates in the Adventfjord are based on three ^{14}C dates of benthic foraminifera extracted from the gravity core samples.

Terrigenous fractions of both, the aeolian and marine sediments showed characteristic polymodal grain size distribution with common dominating modes in the fine to medium silt fractions at 6-9 and 20-30 µm, although other modes with lower intensities were distinguished as well. The distinct presence of the two dominating modes in the samples from both locations suggests that these sediments originate in the outer part of the Adventdalen where they are picked up and blown out to the fjord during favorable hydrological and meteorological conditions. Although other mechanisms such as sea ice and bottom turbidity currents could potentially contribute to the sediment transport to the outer fjord, their role has been suggested to be minor (Zajaczkowski and Wlodarska-Kowalczuk, 2007) and would not explain the matching dominating grain size modes in the aeolian and marine deposits.

The preliminary results suggest that the dust storms generally occur in September-October months when the valley is dry, air temperature below freezing and snow cover is lacking. Weather conditions (air temperature, relative humidity and precipitation) control the timing of the dust storms on a more hourly basis. The dust storms are temporally and spatially very variable, single events lasting usually from a few hours up to 20-24 hours. The 1-2 µm mode in the fjord sediments seems to most consistently carry the dust storm signal whereas the intervals of increased 20-30 µm fraction represent the periods of severe dust storms occurring probably during the periods of increased aridity, below-freezing temperatures and strong winds. No overall trend of the aeolian component in the fjord sediments could be distinguished although 4 distinct peaks of the 20-30 µm fraction during the past c. 3500 years suggest increased aeolian sedimentation at these times.

References

Holz, C., Stuut, J.B. and Rüdiger, H., 2004. Terrigenous sedimentation processes along the continental margin off NW Africa: implications from grain-size analysis of seabed sediments. Sedimentology 51, 1145-1154.

Rea, D.K., 1994. The paleoclimatic record provided by eolian deposition in the deep sea: the geologic history of wind. Reviews of Geophysics 32, 159-195.

Stuut, J.-B.W., Prins, M.A., Schneider, R.R., Weltje, G.J., Jansen, J.H.F. and Postma, G., 2002. A 300-kyr record of aridity and wind strength in southwestern Africa: inferences from grain-size distributions of sediments on Walvis Ridge, SE Atlantic. Marine Geology 180, 221–233.

Zajaczkowski, M. and Wlodarska-Kowalczuk, M., 2007. Dynamic sedimentary environments of an Arctic glacier-fed river estuary (Adventfjorden, Svalbard). I. Flux, deposition and sediment dynamics. Estuarine, Coastal and Shelf Science 74, 285-296.

TALK

Changes in the late Pleistocene-Holocene foraminiferal assemblages and sedimentary records from the Shirshov Ridge, Western Bering Sea: paleoceanographic implication

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Benthic and planktic foraminiferal assemblages, grain size fractions and chlorine content are studied in the upper part of the core SO201-2-85KL (57°30.30 N, 170°24.79 E, w.d. 968 m) retrieved from the Shirshov Ridge, Western Bering Sea, that recovers 40 kyr BP according to the preliminary age model (Riethdorf et al., 2010). Factor analysis of variations in the faunal composition reveals two benthic foraminiferal assemblages. The glacial assemblage contains mainly *Alabaminella weddellensis, Islandiella norcrossi,Trifarina angulosa, Uvigerina akitaensis,Cassidulina reniforme* and *Islandiella californica*; the postglacial one is characterized by a strong dominance of *Buliminella tenuata* and *Bolivina seminuda* (Ovsepyan et al., 2010). According to ecological preference of benthic foraminifers of the glacial assemblage, moderate surface bioproductivity with high seasonal pulses and cold bottom-water conditions can be suggested for MIS 3-2 and the early deglaciation. Occurrence of ice rafted gravel-size rock fragments points to an intensive sea ice influence on the core site area during MIS 3-2. The sand fraction (>63 µm) content demonstrates significant variations during this time span whereas the relationship between fine fractions (<63 µm) does not show any considerable changes. The dominant planktic foraminiferal polar species *N. pachyderma* sin. and temperate species *G. bulloides* demonstrate an anti-phase millennial-scale variability in their relative abundance. The maximum content of the "oxic" benthic group (according to Kaiho, 1994) implies the moderate bottom-water ventilation during MIS 3 – early MIS2 with its intensification around the last glacial maximum (LGM). This seems to be linked to an intensive sea-ice formation on the northern shelf of the Bering Sea that culminated at LGM. Maximum abundance of planktic foraminifers and high values of benthic foraminifers occurred at the early deglaciation, just after the LGM. The relative abundance of the major species in the postglacial benthic assemblage shows two well pronounced peaks coeval to an increase in chlorine content and absolute abundance of benthic foraminifers during the so-called Northern Hemisphere melt-water pulses (MWP) 1a and 1b. It supposes a two-step rise in the sea surface productivity. The maximum percentages of the "dysoxic" benthic group within the same intervals support a strong oxygen depletion likely related to the enhanced O_2 consumption during an abundant deposition of phytodetritus onto the seafloor. A slight increase of oxygen content in bottom waters presumably at the Younger Dryas (YD) is inferred from a decrease in percentage of the "dysoxic" group and from a concurrent increase in the "oxic" group. Presence of gravel-size IRD grains and somewhat higher sand content also characterize the YD. This portrays a rather cold conditions and an intensification of the sea ice formation around the studied site location.

References

Kaiho, K. 1994. Benthic foraminiferal dissolved-oxygen index and dissolved-oxygen levels in the modern ocean. Geology, 22, pp. 719-722.

Ovsepyan, E., Ivanova, E., Max, L., Riethdorf, J., Tiedemann, R., Nürnberg, D., 2010. Reconstruction of bottom water ventilation and export production based on benthic foraminiferal assemblages from the Shirshov Ridge (Bering Sea) during MS1-2. Forams2010. International Symposium on Foraminifera. Rheinische Friedrich-Wilhelms-Universität Bonn, p. 152.

Riethdorf, J.-R., Max, L., Nürnberg, D., Tiedemann, R., 2010. Sea surface temperature, marine productivity and terrigenous fluxes in the western Bering Sea during the last 150 kyr. Abstracts of the ICP 10, La Jolla, USA, Aug 29-Sept 3, 2010.

TALK (Withdrawn)

High-Resolution Reconstruction of Sea-Ice and Hydrological Conditions in the South-Eastern Laptev Sea during the Holocene deduced from Microalgae Assemblages

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The Laptev Sea constitutes the central part of the wide Siberian shelf and is regarded as a key area for the freshwater and sea-ice balances of the Arctic Ocean. More than a quarter of the total continental freshwater runoff to the Arctic Ocean is discharged into the Laptev Sea, mainly via the LenaRiver (Gordeev, 2000). Furthermore, the Laptev Sea polynya is a major source area for sea ice, which is transported to the Siberian branch of the Transpolar Drift (e.g., Zakharov, 1996). Therefore, knowledge of the Holocene variability of the Laptev Sea hydrology is essential for understanding Arctic Ocean water circulation in the past.

Our paleoenvironmental reconstructions based on a detailed study on diatom and aquatic palynomorph assemblages and a detailed radiocarbon (AMS ^{14}C) chronology of sediment cores obtained from the south-eastern Laptev Sea adjacent to the Lena River Delta. Established linkages between hydrographical parameters (e.g., summer surface-water salinity, sea-ice conditions, Polyakova, 2003; Klyuvitkina, Bauch, 2006) and the composition of surface-sediment diatom and aquatic palynomorph assemblages were used to reconstruct environmental conditions under postglacial sea-level rise and climatic changes. Our records give evidences for inundation of the outer Laptev Sea shelf ($\geq$51 m water depth) approximately 11.3 cal. ka. River-proximal environment characterized by avalanche-like precipitation of river-loaded matter ("marginal filter") under water salinity <9. The time interval 10.7-9.2 cal. ka was marked by enhanced influence of Atlantic Water on the Laptev Sea hydrology. Because a continuously rising sea level resulted in the southward retreating coastline, surface-water salinities on the outer shelf approached modern values of about 15-16 around 8.6 cal. ka. Approximately 8.9-8.5 cal. ka, when the sea-level reached the position of the present-day isobaths of about 32-30 m, the inner-shelf was flooded. On the inner Laptev Sea shelf, modern-like environmental conditions were reached about 1 to 1.5 ky later, around 7.4 cal. ka. During the last 6 cal.ka in the area adjacent to the Lena Delta variations in surface water salinities, reconstructed using freshwater diatoms as a proxy (Polyakova, 2003) indicate the changes in the volume of the Lena River runoff through the major riverine channels Trofimovskaya, Bykovskaya and Tumatskaya. It was shown, that the Lena River outflow increased in north-eastward direction via Trofimovskaya and Bykovskaya channels 4.2-2.7 cal. ka. A general increasing trend in riverine discharge is observed between 2.7 and 1.2 cal. ka, and a steep decrease in outflow recorded for the last 1.2 cal. ka.

References

Gordeev V.V., 2000. River input of water, sediment, major ions, nutrients and trace metals from Russian territory to the Arctic Ocean. In: E.L.Lewis et al. (eds.) The freshwater budget of the Arctic Ocean, Kluwer, Amsterdam, 297-322.

Klyuvitkina T.S., Bauch H.A., 2006. Holocene changes in paleohydrological conditions in the Laptev Sea based on aquatic palynomorph assemblages. Oceanology, 6, 911-921.

Polyakova, Ye.I., 2003. Diatom assemblages in the surface sediments of the KaraSea (Siberian Arctic) and their relationship to oceanological conditions. In: Stein, R., Fahl, K, Fütterer, D. K., Galimov, E. M., Stepanets, O. V. (Eds.), Siberian River Run-off in the Kara Sea: Characterization, Quantification, Variability, and Environmental Significance, Proceedings in Marine Sciences, Elsevier, Amsterdam, 375-399.

Zakharov, V. F., 1996. Sea Ice in the Climatic system, St.-Petersburg, Gidrometeoizdat, 213 pp. (In Russian).

TALK

Ocean circulation and glacial ice marginal history offshore West Greenland during the last glacial period

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The large ice sheets and extensive sea-ice cover of the North Atlantic during the Last Glacial period had a significant influence on global ocean circulation. Many studies have indicated that convection in the North Atlantic was limited during the last Glacial Maximum (LGM) and that the Atlantic Meridional Overturning Circulation was slower than today. Although it is today believed that some deep-water production took place during the LGM; its strength and location is still a matter of debate. There are also large discrepancies in results from different model simulations ranging from significantly colder to anomalously warm LGM sea-surface conditions over parts of the North Atlantic region.

The Labrador Sea today plays a crucial role for North Atlantic deep-water formation as it affects the mid-latitude main core of the Gulf Stream warm-water transport route. Sea-surface temperatures and freshwater/iceberg export from the Arctic strongly affects the intensity of the deep convection in the Labrador Sea. We have carried out a multi-proxy study of gravity cores with the purpose of studying Arctic iceberg export and Labrador Sea oceanography during the last 60,000 years with special emphasis on Marine Isotope Stage 3 (MIS 3)= and the Last Glacial Maximum. The cores were retrieved from water depth of ~2400 and ~1000 m, respectively.

Our data reveal that the most extreme West Greenland Weichselian glaciations occurred during MIS 4, when an ice shelf may have extended beyond the SW Greenland shelf edge. Our results further suggest a long-term (intermittent) increase in Irminger Sea Water (ISW) transport by the West Greenland Current probably having controlled the extent of stadial shelf glaciations in course of the last glaciation. Brine-related deep convection during late MIS 3 and most of MIS 2 favoured subsurface ISW advection into the subpolar gyre – also during most of the LGM and H1. This means that both during parts of MIS 3 and during LGM deep water advection in the Labrador Sea was in fact stronger than at present.

B. WARM EXTREMES:

POSTER

Holocene sea-level change in Kongsfjorden, NW Svalbard

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The rapid relative sea-level fall after the last deglaciation is fairly well known on NW Svalbard (Forman et al., 2004) but information about sea level during the Holocene is more scarce. For most of the Holocene, the relative sea level was lower than present but a mid-Holocene transgression up to at most 7 m a.s.l. is indicated (Forman et al., 2004). Based on information from Tønsneset in the inner Kongsfjorden, we will provide some further data points on the Holocene sea-level curve for NW Svalbard, including signs of a modern transgression.

At Tønsneset, a prominent beach has been investigated by ground penetrating radar (GPR) profiling, hand-dug trenches and geomorphological mapping (e.g. Svensson, 2009). Beach sand has been dated by optically stimulated luminescence (OSL) dating, and associated mollusc shells and whale bones have been radiocarbon dated. The present-day beach at Tønsneset is dominated by a 3.5-m-high berm ridge, which is cut by streams in two places. The lagoons on the landward side of the berm ridge are fed by streams, partly originating from karst groundwater springs that occur on the ridge crest and backshore. The vegetated surface behind the beach can be mapped as a palaeosurface under the berm ridge at least to the present shoreline. GPR-profiles also reveal buried lagoons.

The extent and depth of the palaeosurface indicate a sea level at least a few metres below the present and OSL-ages place this event around 8500-8000 years ago, in agreement with previous reconstructions. The modern berm ridge had started to form by c. 1400 years ago, by which time the sea level must have been close to the present. An earlier mid-Holocene transgression is inferred from whale bone (dated to 6725±250 cal. yr BP) at 5 m a.s.l behind the Tønsneset beach (Forman et al., 1987; 2004). However, whale bone from a similar position was dated to 225±35 cal. yr BP in this study.

References

Forman, S.L., Mann, D.H. and Miller, G.H., 1987. Late Weichselian and Holocene relative sea-level history of Bröggerhalvöya, Spitsbergen. Quaternary Research 27 (1): 41-50.

Forman, S.L., Lubinski, D.J., Ingólfsson, Ó., Zeeberg, J.J., Snyder, J.A., Siegert, M.J. and Matishov, G.G., 2004. A review of postglacial emergence on Svalbard, Franz Josef Land and Novaya Zemlya, northern Eurasia. Quaternary Science Reviews 23 (11-13): 1391-1434.

Svensson, J., 2009. Beach processes and recent sea-level changes at Tönsneset, Kongsfjorden, northwestern Spitsbergen. Department of Physical Geography and Quaternary Geology, StockholmUniversity. Bachelor thesis KG2. 23 p.

Pease, V., and Vernikovsky, V., 1998.The Tectono-Magmatic Evolution of the Taimyr Peninsula:Further Constraints from New Ion-Microprobe Data. Polarforschung 68, 171 – 178.

Pokrovsky, O.S., Schott, J., Kudryavtzev, d.I., and Dupre, B., 2005. Basalt weathering in the Central Siberia under permafrost conditions. Geochimica et Cosmochimica Acta 69, 5659-5680.

TALK

Evidence for the Arctic perennial ice pack reforming several times in the past

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Projected warming of the Arctic is expected to result in the disappearance of perennial ice in the next few decades (Comiso, 2010). The climatic impact of this is largely unknown but models project an acceleration of global warming due to this. This anticipated event begs the question as to whether the perennial Arctic sea ice will reform anytime soon thereafter and whether global temperatures will have to drastically decline before this can occur. The recently drilled ACEX core from the Lomonosov Ridge provides a more or less continuous record of the last 18 my and below the hiatus from 18-44.4 myr to the early Eocene when no ice existed in the Arctic. Previous work on this core determined that ice-rafting began about 46 my ago based on the first occurrence of granules and pebbles (St. John, 2008). This study also reported sand (>150 µm) at the ~48 my core interval. Other work indicated the onset of perennial ice just above the hiatus at ~18 my (Krylov et al., 2008; Darby, 2008). Fe grain chemical fingerprinting by electron probe microanalysis and matching of individual grain chemistry to a circum-Arctic source database of more than 16,000 source area Fe grain analyses was used to determine precise sources for ~100 Fe grains in each ACEX core sample. A straight-forward calculation of the ice drift distance to the ACEX site was used to determine whether ice would require more than a year to reach the ACEX site (distal sources), thus indicating perennial ice. Samples throughout the ACEX core and even below the hiatus indicate that there might have been short intervals of perennial ice as old as 46.8 Ma and that there are several brief intervals where it appears that the perennial ice cover disappeared only to reform again. Whether the presence of Fe grains as IRD from distal sources such as Banks Island at the ACEX core site during the Eocene (44.4-46.84 Ma) indicates perennial ice depends on the drift path and drift speed of sea ice at this time when the Arctic was a much smaller ocean than today, but conservative estimates suggest that there was perennial ice at this time. During a few intervals such as between 6.5 and 6.2 Ma, 3.1 Ma, and a few times during the Pleistocene corresponding largely to warm isotope stages, the number of Fe grains from distal sources drops below the threshold of significance indicating that the perennial ice might have disappeared. Between 6.5 and 6.2 Ma the number of Fe grains from distal sources dropped below threshold levels four times. This suggests that this was a time of fluctuating conditions when the perennial ice disintegrated and reformed over time spans of less than 25 kyr. Unfortunately the sampling resolution of the ACEX core does not allow more definitive estimates of the time between seasonal or open ice conditions back to perennial ice.

References

Comiso, J., 2010. Polar oceans from space. Atmospheric and Oceanographic Sciences Library 41, Springer, NY, 507 p.

Darby, D. A. 2008. Arctic perennial ice cover over the last 14 million years, Paleoceanography, 23, PA1S07, doi:10.1029/2007PA001479.

Krylov, A., I. A. Andreeva, C. Vogt, J. Backman, V. V. Krupskaya, G. E. Grikurov, K.Moran, and H. Shoji, 2008. A shift in heavy and clay mineral provenance indicates a middle Miocene onset of a perennial sea-ice cover in the Arctic Ocean, Paleoceanography, doi:10.1029/2007PA001497.

St. John, K., 2008. Cenozoic ice-rafting history of the central Arctic Ocean: Terrigenous sands on the Lomonosov Ridge, Paleoceanography, 23, PA1S05, doi:10.1029/2007PA001483.

TALK

Holocene Lake Records of Subarctic Palaeoenvironments on Kamchatka, Russia

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Lacustrine sediment cores from three lakes of the central Kamchatka peninsula have been investigated by multi-proxy approaches to infer terrestrial environmental changes in the maritime-influenced setting of the subarctic realm of eastern Siberia. The reconstruction of vegetation dynamics (from pollen records) and palaeolimnological changes (from fossil diatoms and chironomids, and sedimentological data) give evidence of longterm climate changes that point to a warm and humid early Holocene climate optimum between 9.0 and 4.5 ka BP, with the occurrence of birch and alder forests. This time was followed by neoglacial summer cooling, changes in the position of the tree line, glacial advances, and enhanced continentality. Two strong cooling episodes appeared in the late Holocene between 4.5 and 3.5 ka BP and during the last millennium. This general development of Holocene climate on Kamchatka shows affinities to palaeooceanographic changes in the neighbouring Sea of Okhotsk, where the pattern of sea-ice dynamics and biological productivity is consistent with early Holocene warmth and Neoglacial climate cooling. The pattern of climate change resembles insolation-driven climate changes over subpolar Eurasia. The cooling episode during the last millennium is consistent with the Little Ice Age, a time of reduced solar activity.

POSTER

Ocean temperature variability in the Western Arctic Ocean during the last 7000 years

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Surface temperature warming and declining sea-ice cover in the Arctic Ocean over the past two decades have coincided with an observed 0.5 to 1.0ºC warming of Atlantic-sourced water in the subsurface Western Arctic Ocean. Warm Temperature Anomalies (WTA) have been observed in instrumental records for the past half-century, but the frequency and magnitude of these warming events need to be better understood within the context of Holocene variability. We present centennial-scale reconstructions of subsurface (~200-400m) and surface ocean temperature in the Canada Basin using foraminiferal $\delta^{18}O$, ostracode Mg/Ca ratios, and dinocyst assemblages from two sediment core records covering the last 7000 years. Results show centennial-scale shifts in mean temperature from -1.0 to 0.5˚C and -0.5 to 1.8˚C at 200 and 400m water depths, respectively, with summer sea surface temperatures ranging from 3.0 to 7.0˚C. Warmer-than-average subsurface temperatures characterize the middle-to-late Holocene from ~1.2 to 4.5ka, with pronounced cooling around 3ka. Over the last millennium, distinct warm periods punctuate the surface and subsurface temperature records during the 11th - 12th century Medieval Climate Anomaly (MCA) and the 16th century prior to cooling during Little Ice Age (LIA). This variability may reflect changes in the temperature or strength of Atlantic Layer water originating in the eastern Arctic Ocean near the Fram Strait. By comparison, the 2002-2007 WTA in the Canada Basin exceeded reconstructed Atlantic Layer temperature for the last 1200 years by about 0.5ºC.

Terrestrial organic matter deposition on the Lomonosov Ridge, central Arctic Ocean

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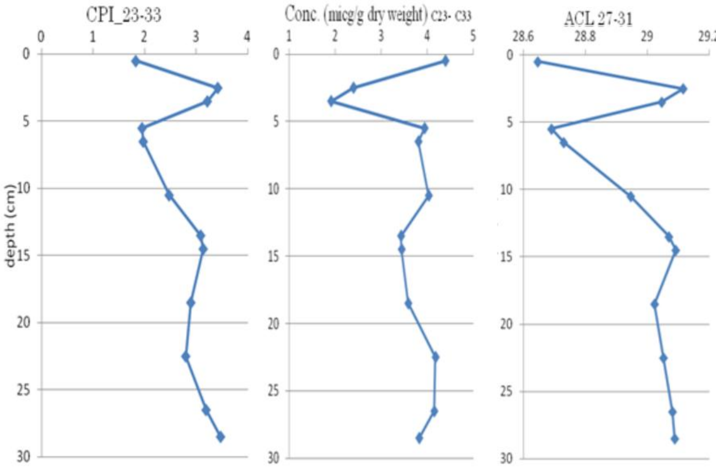
The *n*-alkane distributions in the short Holocene sediment core LOMROG09-TC09, retrieved from the central part of the Lomonosov Ridge, span from *n*-C_{13} to *n*-C_{33} and show a specific contribution of terrestrial plant-derived material, marked by the predominance of the *n*-C_{27} to *n*-C_{31} homologues in the analyzed samples. The concentration of the *n*-alkanes (*n*-C_{23} to n-C_{33}) is nearly stable down-core with a marked exception at 3.5 cm where they abruptly diminish. Nearby core HLY0503-18TC suggests Holocene sedimentation rates on the order of 1-3.5 cm/ka in this area of the Lomonosov Ridge (Hanslik et al., 2010). Inferring these sedimentation rates in LOMROG09-TC09 yields an age between 1 and 3.5 ka at 3.5 cm core depth. However, this age assignment must be considered highly speculative as core LOMROG09-TC09 is not readily correlated with HLY0503-18TC using neither physical properties nor grain size.

The Carbon Preference Index (CPI) varies from 1.8 to 3.5 with no clear predominance of odd over even carbon numbers. The CPI values of terrestrial higher plants normally fall between 5-10 (Kawamura, 1995). The observed values for this proxy may reflect the impact of microbial activity on the organic matter or a combination of higher plant lipids and fossil fuel hydrocarbons (Simoneit and Mazurek, 1982). The increasing trend that this proxy displays with depth suggests slight better preservation of long-chain n-alkanes with depth.

The average chain length (ACL) varies from 28.6 to 29.9 with a marked variability in the first 10 cm. After this depth the ACL increases again until the end of the profile. The ACL value is the concentration-weighted mean chain length of the *n*-C_{27}, *n*-C_{29} and *n*-C_{31}*n*-alkanes. Changes in this proxy are commonly related to changes in the temperature and moisture of the environment of the original plantsthat aresources of *n*-alkanes. Simoneit et al. (1991) suggest from studies of aerosols that in warmer climates plants produce higher molecular weight *n*-alkanes in order to avoid loss of water. More recently, the results of Sasche (2006) indicate that plants can minimize loss of water from their leaves by modifying the chain-lengths of their leaf waxes. In this core, changes in ACL may be determined by physiological responses of plants to the original environmental conditions and the transportation of organic matter until deposition.



References

Hanslik, D., Jakobsson, M., Backman, J., Björck, S., Sellén, E., O'Regan, M., Fornaciari, E., Skog, G., 2010. Quaternary Arctic Ocean sea ice variations and radiocarbon reservoir age corrections. Quaternary Science Reviews 29, 3430-3441.

Kawamura, K., 1995, Land-derived lipid class compounds in the deep-sea sediments and marine aerosols from North Pacific.: Biogeochemical Processes and Ocean Flux in the Western Pacific. Eds. H. Sakai and Y. Nozaki, p. 31-51.

Kawamura, K., Ishimura, Y., and Yamazaki, K., 2003, Four years' observations of terrestrial lipid class compounds in marine aerosols from the western North Pacific: Global Biogeochem. Cycles, v. 17, p. 1003.

Sachse, D., Radke, J., and Gleixner, G., 2006, [delta]D values of individual n-alkanes from terrestrial plants along a climatic gradient - Implications for the sedimentary biomarker record: Organic Geochemistry, v. 37, p. 469-483.

Simoneit, B.R.T., and Mazurek, M.A., 1982, Organic matter of the troposphere--II. Natural background of biogenic lipid matter in aerosols over the rural western united states: Atmospheric Environment (1967), v. 16, p. 2139-2159.

Simoneit, B.R.T., Sheng, G., Chen, X., Fu, J., Zhang, J., and Xu, Y., 1991, Molecular marker study of extractable organic matter in aerosols from urban areas of China: Atmospheric Environment. Part A. General Topics, v. 25, p. 2111-2129.

TALK

The history of Arctic Ocean Sea Ice: A review

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The Quaternary history of the Arctic Ocean sea ice was not one of the main research topics of neither PONAM nor QUEEN, although several studies within the two research programs addressed sea ice indirectly from studies of sediment archives. The minimum and maximum Quaternary extent of Arctic Ocean sea ice was, on the other hand, from the beginning defined as one of the main research topics of APEX. This is evident in the recent special APEX issues of *Quaternary Science Reviews* (Vol.29, Issues 25-26, 2010) which contain six articles addressing the Arctic Ocean Sea Ice from various perspectives.

The combined present paleo-data on Arctic Ocean sea ice extent generally suggest that the seasonal sea-ice cover was strongly reduced during most of the early Holocene and there appear to have been periods of ice free summers in the central Arctic Ocean. Placing the recent trend of declining sea ice in this longer time perspective emphasize the need for further research aiming to understand the causal links between Arctic climate and sea ice. This presentation reviews the present status on our knowledge on the history of the Arctic Ocean Sea Ice, with specific emphasis on the Quaternary, and discuss some future prospects of developing and applying new sea-ice proxies on both terrestrial and marine paleo-archives

TALK

Fresh news from an old ODP record – Neogene climate dynamics and hydrocarbon migrations on the Yermak Plateau, NW Spitsbergen

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Notwithstanding the recent IODP drilling on the Lomonosov Ridge, the Late Cenozoic history of the Arctic Ocean still remains elusive. The tectonic processes leading to the development of the only deep-water connection to the Arctic Ocean via the Fram Strait are still poorly understood. Also, the influence of the gateway region on changes in Arctic–Atlantic ocean circulation, uplift/erosion on the adjacent hinterland, as well as glacial initiation and its consequences for the petroleum systems in the regions, remain unclear. By revisiting Ocean Drilling Program (ODP) Leg 151, holes 911A and 910C and interpreting new multi-channel seismic data, we have now established a new comprehensive chronological framework for the Yermak Plateau and revealed important paleoenvironmental changes for the Atlantic–Arctic gateway during the late Cenozoic. The improved chronostratigraphic framework is established through continuous paleomagnetic and biostratigraphic data as well as selected intervals with stable $\delta^{18}O$ and $\delta^{13}C$ data derived from benthic foraminifera *Cassidulina teretis*. Supported by acoustic profiling, the new data indicate an early late Miocene age (~11 Ma) for the base of both holes. The depositional regime on the Yermak Plateau during the early late Miocene was rather shallow and water mass exchange between the Arctic and Atlantic was restricted. However, warm Atlantic water reached this high latitude site during the early late Miocene (~11 Ma) as reflected by the presence of the dinoflagellate cyst *Operculodinium centrocarpum* sensu Wall and Dale (1966) in ODP Hole 911A confirming the existence of a shallow passage between the Arctic and Atlantic. Dinoflagellate cyst and foraminiferal assemblages indicate a near-coastal environment with relatively warm (ice-free) surface water conditions. First indications of sea ice formation exist at ~6 Ma and may corroborate the establishment of the deep water passage of the Atlantic-Arctic gateway. This is consistent with tectonic modeling which reveals a shallow barrier on the Yermak Plateau until the late Miocene/early Pliocene. High-amplitude reflections corroborate the occurrence of greigite mineralization and stable carbon isotope excursions in planktic/benthic foraminifera during the late Miocene suggesting migration of hydrocarbons from deeper sources. Rapid sea-level drops, tectonic uplift, and re-activitation of faults during the late Miocene may be responsible for the leakage of hydrocarbons during the late Miocene.

POSTER

Extreme episodic marine sediment deposition during deglaciation of Storfjorden and Kveithola (western Barents Sea)

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Seafloor morphology and shallow sedimentary structure of the Storfjorden and Kveitehola Troughs Mouth Fans (TMFs) on the northwestern Barents Sea continental margin were investigated during two cruises (SVAIS, of the *BIO Hespérides* and EGLACOM of the *R/V OGS-Explora)* within the International Polar Year (IPY) Activity NICESTREAMS.

On the continental shelf, the Kveithola Trough seafloor is characterised by E-W trending mega-scale glacial lineations (MSGL) that record a fast flowing ice stream draining the Svalbard/Barents Sea Ice Sheet (SBIS) during the Last Glacial Maximum (LGM). MSGL are overprinted by transverse sediment ridges about 15 km apart which give rise to a staircase axial profile of the trough. Such transverse ridges are interpreted to be grounding-zone wedges (GZW) formed by deposition of subglacial till during episodic ice stream retreat. This present-day morphology, largely inherited from the palaeo-seafloor topography at the time of deglaciation, is diagnostic of episodic ice stream retreat (Rebesco et al., 2011). The sedimentary drape deposited on top is suggested to have accumulated at extemely high rate, (on average higher than 0.15 cm a^{-1}) and therefore may potentially preserve an extremely high resolution palaeoclimatic record of deglaciation and post-glacial conditions in this sector of the Barents Sea.

On the continental slope, different morphological patterns are observed within the Storfjorden and Kveitehola Trough-Mouth Fans (TMFs) and the inter-TMFs areas (Pedrosa et al., in press). The northern Storfjorden TMF is dominated by a network of gullies, whereas the southern part and the Kveitehola TMF are characterized by several submarine landslides (Rebesco et al., in press). Deep erosion of the continental slope with dendritic canyon systems more typical of low latitude continental slopes occurs in inter-TMFs areas.

The detachment surface of the observed landslides occurs at the boundary between the interlaminated sediments deposited during periods of deglaciation (plumites), and the underlying glacigenic debris flows deposited during the preceding glacial maximum.

Both sediment types represent extreme episodes of rapid accumulation in which the resulting deposits, however, largely differ in water content, and shear strength characteristics (Lucchi et al., in press). Plumites are deposited preferentially on the upper continental slope as a consequence of the initial subglacial meltwater outbursts when the ice stream is grounded at or near the continental shelf edge. The dating of top and bottom of the plumites suggests that deposition might have occurred in a few hundreds years with a sedimentation rate extremely high of 3.2 cm a^{-1} (Lucchi et al. 2010). The underlying diamicton is deposited massively during glacial maxima that may last a few thousands years, so that 45 m of deposit would also results in an extreme sediment accumulation rate of 1.1 cm a^{-1}. In contrast to the interlaminated facies, the resulting deposit is highly overconsolidated with low water content and high shear strength.

According to Lucchi et al. (in preparation) the proximity of the southern Storfjorden TMF to the local glacial source (Spitsbergen Banken) determined a longer persistence of the ice stream close to the shelf edge during the Middle and Late Weichselian, so that the upper continental slope received a prolonged input from subglacial meltwater plumes causing the deposition of an expanded plumite sequence. Conversely, in the central and northern part of Storfjorden TMF, the dominance of the thick continuous diamicton over the thin deglacial plumites determines overall stability in spite of the extremely rapid deposition of the glacially derived debris flows.

References

Lucchi, R.G., Camerlenghi, A., Colmenero-Hidalgo, E., Sierro, F.J., Bárcena, M.A., Flores, J.A., Urgeles, R., Macri, P. Sagnotti, L., and Caburlotto, A., 2010. Sedimentary processes on the Storfjorden trough-mouth fan during last deglaciation phase: the role of subglacial meltwater plumes on continental margin sedimentation. Geophysical Research Abstracts Vol. 12: EGU2010-5753-2, 2010.

Lucchi, R.G., Pedrosa, M.T., Camerlenghi, A., Urgeles, R., de Mol, B., and Rebesco, M., 2011. Recent submarine landslides on the continental slope of Storfjorden and Kveitehola Trough-Mouth Fans (Northwestern of Barents Sea), In: Mosher DC et al (Eds.) Submarine Mass Movements and Their Consequences IV, Springer, The Netherlands. In press.

Lucchi, R,G., Camerlenghi, A., Colmenero-Hidalgo E., Sierro, F.J., Bárcena, M.A., Flores, J.A., Macri, P., Sagnotti, L., Pedrosa, M., Urgeles R., and Rebesco M., in preparation. Post-LGM sedimentary processes on the Storfjorden TMF: the role of subglacial meltwater plumes.

Pedrosa, M., Camerlenghi, A., De Mol, B., Urgeles, R., Rebesco, M., Lucchi, R.G., and SVAIS - EGLACOM Cruises shipboard parties (2011) Seabed Morphology and Shallow Sedimentary Structure of the Storfjorden and Kveitehola Trough-Mouth Fans (north west Barents Sea). Marine Geology, in press.

Rebesco, M., Liu, Y., Camerlenghi, A., Winsborrow, M., Laberg, J.S., Caburlotto, A., Diviacco, P., Accettella, D., Sauli, C., Tomini, I., and Wardell, N., 2011. Deglaciation of the Barents Sea Ice Sheet - a swath bathymetric and sub-bottom seismic study from the Kveitehola Trough. Marine Geology, 279, 141-147.

Rebesco, M., Pedrosa, M.T., Camerlenghi, A., Lucchi, R.G., Sauli, C., De Mol, B., Madrussani, G., Urgeles, R., Rossi, G., Böhm, G., 2011. One million years of climatic generated landslide events on the southern Storfjorden Trough Mouth Fan (western Barents Sea). In: Mosher DC et al (Eds.) Submarine Mass Movements and Their Consequences IV, Springer, The Netherlands. In press.

TALK

Response of paraglacial coastal sediment dynamics to post – LIA climate shifts – recent advances from Svalbard

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Many of the existing intellectual paradigms regarding the functioning of polar coastal zones are now out-dated, based on descriptive geomorphology and a limited process-based understanding. The pristine coasts of Svalbard provide a superb opportunity to quantify how Arctic coasts are responding to rapid climate warming. My research project aims to address this deficiency in understanding by quantifying the mechanisms and patterns of recent adjustment of High Arctic coasts in Svalbard following the end of Little Ice Age. The work involves a combination of field based survey, conducted in summer and winter over several seasons, as well as remotely sensed data that uses time series analysis of remotely sensed data from the 20th century. The preliminary results document dramatic changes in sediment flux and coastal response under an interval characterized by a warming climate, retreating local ice masses, a shortened winter sea-ice season and melting permafrost. These (largely) terrestrial processes are interacting with an upwards trend in relative sea-level attributed to glacio-isostatic land subsidence and on-going global sea-level rise.
In this paper, I summarize my PhD research to date by presenting results from an analysis of digital aerial photogrammetry, combined with field-based geomorphological mapping.The geographical focus is Petunia Bay, one of the most protected bays of the Svalbard Archipelago, which is characterized by a semi-arid, sub-polar climate, limited wave fetch and tidal range, and rapid retreat rate of all surrounding glaciers. This work highlights the need for a greater understanding of the controls on polar coastal sediment budgets, especially given the potential for accelerated warming and sea-level rise in the coming decades and centuries.

This work is funded by the Polish Ministry of Science and Higher Education (grant no. N306 284335).

M.C. Strzelecki is supported by the Crescendum Est Polonia fellowship and AMU Foundation scholarship

TALK

Neoglacial sea ice fluctuation in eastern Fram Strait

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The reconstruction of palaeo sea ice coverage in the Arctic realm gained increasing interest throughout the past decades and approaches to identify ancient sea ice occurrences are manifold. By means of organic geochemical biomarker studies we reconstruct sea ice conditions in eastern Fram Strait, where the spatial and temporal distribution of sea ice is mainly controlled by the advection of warm Atlantic Water via the Norwegian and West Spitsbergen Current. Simultaneously, polar water and sea ice from the Arctic Ocean is transported southward by the East Greenland Current. Hence, variations in the strength of this oceanic circulation regime may either stimulate or reduce the sea ice extent. With high-resolution analyses of sediment cores from the western continental margin of Spitsbergen we provide new evidence for the highly variable character of the sea ice conditions in this area. The combination of the sea ice proxy IP_{25} (Belt et al., 2007) with phytoplankton-derived biomarkers (e.g. brassicasterol, dinosterol; Volkman, 2006) enables a reliable reconstruction of sea ice and sea surface conditions, respectively (Müller et al., 2009; in revision). By means of these biomarkers, we trace gradually increasing sea ice occurrences from the Mid to the Late Holocene – consistent with the neoglacial cooling trend. Throughout the past ca. 3,000 years (BP) we observe a significant short-term variability in the biomarker records, which points to rapid advances and retreats of sea ice at the continental margin of West Spitsbergen. The co-occurrence of IP_{25} and phytoplankton markerssuggests that the primary productivity benefited from these sea ice surges. To what extent a seesawing of temperate Atlantic Water may account for these sea ice fluctuations requires further investigation. Concurrent variations in Siberian river discharge (Stein et al., 2004) andin glacier extents in Scandinavia(Nesje et al., 2001; Svendsen and Mangerud, 1997), however, strengthen that these fluctuations may be influenced or even controlled by the North Atlantic/Arctic Oscillation (NAO/AO).

References

Belt, S.T., Massé, G., Rowland, S. J., Poulin, M., Michel, C., LeBlanc, B., 2007. A novel chemical fossil of palaeo sea ice: IP_{25}. Organic Geochemistry, 38(1): 16-27.

Müller, J., Massé, G., Stein, R. and Belt, S.T., 2009. Variability of sea-ice conditions in the Fram Strait over the past 30,000 years. Nature Geoscience, 2(11): 772-776.

Müller, J., Wagner, A., Fahl, K., Stein, R., Prange, M., Lohmann, G., in revision. Towards quantitative sea ice reconstructions in the northern North Atlantic: A combined biomarker and numerical modelling approach. Earth and Planetary Science Letters.

Nesje, A., Matthews, J.A., Dahl, S.O., Berrisford, M.S. and Andersson, C., 2001. Holocene glacier fluctuations of Flatebreen and winter-precipitation changes in the Jostedalsbreen region, western Norway, based on glaciolacustrine sediment records The Holocene, 11(3): 267-280.

Stein, R., Dittmers, K., Fahl, K., Kraus, M., Matthiessen, J., Niessen, F., Pirrung, M., Polyakova, Y., Schoster, F., Steinke, T., Fütterer, D. K., 2004. Arctic (palaeo) river discharge and environmental change: evidence from the Holocene Kara Sea sedimentary record. Quaternary Science Reviews, 23(11-13): 1485-1511.

Svendsen, J.I. and Mangerud, J., 1997. Holocene glacial and climatic variations on Spitsbergen, Svalbard. The Holocene, 7: 45-57.

Volkman, J.K., 2006. Lipid markers for marine organic matter. In: J.K. Volkman (Editor), Handbook of Environmental Chemistry. Springer-Verlag, Berlin, Heidelberg, pp. 27-70.

POSTER

Late Holocene climate change in the Russian Arctic – seasonal trends from glacier and ground ice

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The Arctic has a major impact on the global climate system and is more affected by ongoing climate change than other regions. As meteorological time series are scarce and short, climate archives are of particular importance for the assessment of past and recent variability of the Arctic climate system, and its causes and interactions.

We present Late Holocene stable water isotope records of glacier and ground ice from the Russian Arctic. Glacier ice cores are well known as one of the best climate archives. In Arctic non-glaciated permafrost areas, ice wedges are a widely distributed type of ground ice. Their stable water isotope composition is indicative for winter climate conditions as ice wedges are formed by the periodic repetition of frost cracking and subsequent crack filling mostly by melt water of winter snow.

The ice core was drilled at Akademii Nauk (AN) ice cap on Severnaya Zemlya (80.5°N, 94.8°E) in 1999-2001. According to the core chronology, which is based on annual layer counting (stable isotopes) and cross-checking with reference horizons (volcanic eruptions), the AN ice core provides high-resolution (annual to decadal) proxy data for the last about three millennia, although the ice cap is affected by summertime melt-water infiltration.

Holocene ice wedges were studied at the first Lena river terrace in the Central Lena Delta (LD; around 72.5°N, 126.5°E) in 2005 and at the Oyogos Yar (OY) coast of the Dmitrii Laptev Strait (72.7°N, 143.5°E) in 2007. Available dating results by means of AMS 14C of organic remains included in the ice samples allow climate reconstruction for the last three to four millennia in an up to centennial resolution.

AN ice core $\delta^{18}O$ data serve as proxy for Western Eurasian Arctic annual mean temperatures and reveal significant changes on different timescales. A long-term decrease, coinciding with a decreasing insolation, does not solely reflect climate cooling but probably also the growth of AN ice cap. Several abrupt decadal-scale warming and cooling events, e.g. in the 15th and 16th centuries, are a marked feature of this record. The coldest period occurred around AD 1800 followed by the strongest temperature increase to the absolute maximum around AD 1930 and cooler decades thereafter.

The OY and LD ice wedge $\delta^{18}O$ data indicate a general Late Holocene winter warming trend, consistent with an increasing winter insolation, and characterised by a marked variability. This warming trend culminates in a strong warming over the last decades reflecting ongoing Arctic warming, and leading to the Late Holocene maximum.

Both ice-core and ice-wedge records of deuterium excess ($d=\delta D-8*\delta^{18}O$) reveal decreasing trends, in particular over the last decades, indicating considerable changes in moisture generation and transport patterns, probably related to varying atmospheric circulation patterns and/or sea ice dynamics.

References

Opel T, Fritzsche D, Meyer H, Schütt R, Weiler K, Ruth U, Wilhelms F, Fischer H. 2009. 115 year ice-core data from Akademii Nauk ice cap, Severnaya Zemlya: high-resolution record of Eurasian Arctic climate change. Journal of Glaciology 55(189), 21-31. doi: 10.3189/002214309788609029.

Opel T, Dereviagin A, Meyer H, Schirrmeister L, Wetterich S. 2011. Paleoclimatic information from stable water isotopes of Holocene ice wedges on the DmitriiLaptevStrait, Northeast Siberia, Russia. Permafrost and Periglacial Processes. doi:10.1002/ppp.667.

TALK

High-resolution record of the Late Saalian–Eemian environmental changes in the northeastern White Sea Region (Bychye section) inferred from benthic foraminifers

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Paleoenvironmental history of the White Sea region during the late Saalian – Eemian transition is reconstructed on the basis of the high-resolution record of benthic foraminifers from a 4.5 m thick marine sediment sequence directly overlying Saalian till in the Bychye section on the Pyoza River, NE White Sea Region. Besides benthic foraminifers which are the most abundant microfossil group in the studied section, also ostracods, pollen, aquatic palynomorphs as well as lithology and benthic foraminiferal stable isotope composition ($\delta^{18}O$, $\delta^{13}C$) were investigated. Palynological correlation with the previously studied sections confirms the age estimation from c. 133 to 120 ka (Devyatova, 1982; Grøsfjeld et al., 2006). Paleoecological analysis of foraminiferal assemblages is based on ecological preferences of different benthic species distinguished in modern Barents and Kara seas (Polyak et al., 2002, Korsun et al., 1994) supported by factor analysis.

Five Ecozones were established which reflect rapid postglacial flooding of the territory after the disappearance of the Saalian ice sheet and consequent shallowing of the sea basin likely due to glacial rebound. Ecozone 1 corresponds to the earliest stage of inundation. Composition of microfossils suggests with the predominance of the arctic opportunistic species *Elphidium clavatum* among foraminifers suggests it was a cold Arctic coastal environment probably with turbid waters, high sedimentation rates and heavy seasonal sea-ice cover. Relative deepening of the shelf basin continued in Ecozone 2 as suggested by the high percentage of river-distal foraminifers indicating bottom water salinities above 30 and less heavy seasonal sea-ice cover. Foraminiferal assemblages are very similar to those occurring in the mid-shelf regions of the Laptev and Kara seas. The maximum flooding and deepening of the basin registered in Ecozone 3 as indicated by the highest percentage of the relatively deep-water species *Melonis barleeanus*. According to palynological composition, Ecozone 3 correlates with the early Eemian times (c. 128-130 ka). Maximum relative abundances of foraminiferal species *Nonion labradoricum* and *Cassidulina reniforme* indicate the warmest surface water conditions and high seasonal productivity. Marine environments resemble the Arctic outer shelf conditions with normal marine bottom water salinity and restricted sea ice cover. However these alternations are hardly a result of Atlantic water penetration since planktic foraminifers are absent and no indicative species are recorded among benthic foraminifers. Ecozone 4 represents the onset of regressive stage likely caused by isostatic crustal rebound as is witnessed by accumulation of sands, gradually decreasing taxonomic diversity and abundance of all microfossils, and introduction of subarctic ostracods and bivalves. Climatic conditions characterized as the most humid and warm gradually deteriorate towards the end of the record. Shallow-water nearshore environment in Ecozone 5 is supported by the abundance of river-proximal species and epifaunal foraminifers indicative of hydrodynamically active bottom waters.

References

Devyatova, E.I., 1982. Late Pleistocene environments as related to human migrations in the Dvina River basin and in Karelia. Petrozavodsk, 156 pp. (in Russian).

Grøsfjeld, K., Funder S., Seidenkrantz M.-S., Glaister C., 2006. Last Interglacial marine environments in the White Sea region, northwestern Russia. Boreas, 35, 493-520.

Korsun,S.A., Pogodina I.A., Tarasov G.A., Matishov G.G.,1994. Foraminifers from the Barents Sea (gidrobiology and quaternary paleoecology). Apatity, 136 pp. (in Russian).

Polyak, L., Korsun, S., Febo, L., Stanovoy, V., Khusid, T., Hald, M., Paulsen, B.E., Lubinski, D.A., 2002. Benthic foraminiferal assemblages from the southern KaraSea, a river-influenced arctic marine environment. J. of Foraminiferal Research, 32, 3, 252-273.

TALK

KZ Paleogeography and Sediments of the Kandalaksha Gulf of the White Sea (as revealed by seismoacoustic methods)

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Geological, paleoclimatic and paleogeographic exploration in the Arctic Ocean usually encounters a number of natural constraints and difficulties, These are particularly awesome when close examination of glacial sediment is the task. Addressing this task invites techniques that work remotely. In the research below, we explored the seafloor of the Kandalaksha Gulf of the White Sea employing the most promising of such techniques, seismoacoustics.

The modern White Sea has a very complicated geological history. Tectonically, this basin is part of the East European Platform taking place on the south-east border of the Fennoscandian Shield. The Kandalaksha Gulf is the west branch of the southeastward White Sea palaeorift system, which cut into the eastern side of the Shield. In the period immediately after the Karelian tectonomagmatic cycle, the entire region was a single platform. In the Oligocene, it entered its neotectonic stage. (Baluev et al., 20004; Slabunov, 2009).

Geologically, there are two structural stores beneath the seafloor of the Kandalaksha Gulf. The lower one is crystalline bedrock of gneisses and granite-gneisses of the Archean White Sea series. The upper one is a cover of sediment on this bedrock. This cover, in turn, consists of three layers. These are as follows (bottom-up): the Riphean terrigenous deposits, which fill avlakogenes in the foundation; southeastward this layer is covered by the Vendian deposits; and then almost uninterrupted cloak of the Pleistocene and the Holocene sediments.

The modern White Sea is a young basin formed just 10 to 12 ka at the very end of the Pleistocene. During the Valdai glaciation it was filled with ice. During the Allerod, freshwater lakes appeared around its perimeter. Towards the end of the Allerod, the ice started to quickly disappear. Barents seawater flushed in, and the process of subglacial sediment accumulation started. The sediment from that time is uniform in composition but widely varies in thickness. The sedimentation progressed against the backdrop of very complicated, varied and often conflicting tectonic movements that are so typical of the White Sea region. Besides the post-glacial isostatic rise of Scandinavia amounted to some 100 meters in the White Sea area. The basin's deglaciation spanned the Pre-Boreal and the Boreal times and did not end until the early Atlantic. The resulting seabed sediment is very complex structurally, diverse lithologically and varied chronologically and genetically. With the ice gone, including the surface one, the current sea stage of sediment accumulation started, in which sea currents and the biota played increasingly important roles (Nevesskiy et al, 1977; Devdariani, 1985; Rybalko, 2009; Polaykova, 2010). This was how the unstable geography and the unstable tectonics of the White Sea in the Quaternary period resulted in a sediment layer that is so complicated structurally, so diverse lithologically and so uneven in thickness.

We see four major stages of the late-glacial and post-glacial sediment accumulation in the White Sea: 1) the glaciolimnetic stage (Allerod), in which the sediment came from several freshwater lakes filled with glacial water; 2) the glaciothalassic stage (late Dryas), in which the sediment (abundant and mostly uniform silt) came from a mass of seawater hidden beneath a thick ice sheet; 3) the transitional stage (the pre-Boreal and Boreal times); 4) the thalassic stage (middle and late Holocene), in which sea-type sediment accumulation reigned supreme.

Past and recent geological and geophysical exploration has discovered particularly thick sediment layers in seabed troughs in the southeast of the Kandalaksha Gulf. The thickness there is over 150 meters in places. Overall, the geography and thickness of the quaternary sediment closely reflects the pre-quaternary surface of the seabed. The lower part of the Quaternary sediments is represented by glacial sediment complex. At the base of the complex, characteristic glacial sediment is everywhere to be found. It usually consists of peripheral glacial marine which is the most extended sediment of the Kandalaksha Gulf. Topping the glacial sediment is a layer constructed during the transitional and the thalassic stages. The lower part of this topping layer is the transitional sediment which forms a distinct complex which is in places 20 meters thick ((Nevesskiy et al., 1977; Devdariani, 1985).

In the period since 2001, DEKO Geofizika Ltd and the Geology Department of Moscow State University have been conducting research to gain a better insight into the geology and tectonics of the Kandalaksha Gulf and assess the condition of the marine environment in this Subarctic shelf area. In the period since 2003, seismoacoustic surveys have also been carried out. In the Velikaya Salma Strait, there were detailed seismoacoustic surveys and continuous seismoacoustic profiling, which involved the use of a side scan sonar and video cameras. The sediment has been also sampled in a number of places (Sorokin et al., 2009).

The principal results are as follows: improved knowledge of the geology and tectonics of the area; improved knowledge of the sea bottom surface of the Kandalaksha Gulf (this sea bottom surface usually follows the one of the underlying bedrock surface); a map of the sea bottom surface of a significant part of the Gulf; improved knowledge of the structure and the surface of the underlying bedrock of the Velikaya Salma Strait segment; the types of seismographic records in the segment; the geological identification of these types; the locations of these record types; a compendium and systematization of all seismoacoustic data from the Kandalaksha Gulf. A close examination of recent and earlier seismographic records from the surveyed site enabled us to identify the following seismocomplexes within this site (bottom-up): 1) the acoustic bedrock; 2) the glacial sedimentary complex; 3) the post-glacial and the glaciothalassic sedimentary complex; 4) the most recent thalassic sedimentary complex.

Detailed seismoacoustic profiling allowed our team to gain a better insight into the geological structure of the White Sea basin. The complicated history, geology and tectonics of this basin make it an excellent proving ground in which to hone techniques for interpreting seismoacoustic data from glacial shelf areas. The types of seismographic records identified in the White Sea are probably yardsticks for exploring shelf seabed in other Arctic seas. Seismoacoustic methods are very useful for researching Cainozoic sediments in these seas (Epshtain, 2010). Such exploration produces a wealth of knowledge about the surface terrain of the bedrock and also about the vertical structure (usually highly complicated) of the Quaternary sediments in Arctic basins. It also largely eliminates the need for direct sampling of these sediments. The exploration techniques developed and tested out in the White Sea are almost certainly applicable to the wider Arctic Ocean.

References

Baluev A. S., Moralev V. M., Glukhovskiy M. E et al, 2000. Tectonic evolution and the magmatism of the White Sea rift system // Geotectonics, №5, p30-43.

Devdariani N. A., 1985. Geological structure of the White Sea basin. Author's abstract of the PhD thesis, Moscow, p. 16.

Epshtain O.G., Starovoitov A.V., Dlugach A.G., 2010. “Soft” moraines in the Arctic and Antarctic - new facial type of glacial deposits. Bull. of the Mosc.Soc.Nature Invest. V. 85, issue 2, p.23-44.

Nevesskiy E.N., Medvedev V.S., Kalinenko V.V., 1977. The White Sea: sedementation and its Holocene history. Moscow: “Science”, - 236 p.

Polyakova E.I., Novichkova Y., Shilova O., H. Bauch Y., 2010. Holocene variability of the White Sea (Western Arctic) level and hydrological conditions. APEX Fourth International Conference and Workshope. Hofn, Iceland. May 26-30, p. 70.

Slabunov A.I., 2008. Geology and geodynamics of Archean mobile belts based on the example to the White Sea province of the Fennoscandian Shield. - Petrozavodsk: Karelian scientific center RAN (Russian Academy of Science). - 296 p.

Sorokin V. M., Starovoitov A.V., Tokarev M.J. et al, 2009. Complex geologic-geophysic researches of the sediment cover in the Velikaya Salma Strait // Reconnaissance and conservation of mineral resources, №2, p. 47-52.

Rybalko A.E., . Zarrina E.P., 2009. Features of sedimentogenesis of the inland seas and large lakes of the Quaternary glacial areas, E.P. VI Russian Conference on Quaternary period. Novosibirsk, p.523-527.

TALK

Contrasting interglacials in the Arctic Ocean – an Eemian-Late Holocene comparison based on stable oxygen and carbon isotopes

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The last interglacial (Eemian), the first interval in marine isotope stage 5 (MIS 5) is often considered as a possible analog for future climate conditions forced by anthropogenic greenhouse gas emissions. The reason lies in decades of research on the Eemian which have shown that in many areas in the northern hemispheric mid-latitudes hypsithermal Eemian climate conditions were warmer than at any time in the Holocene. In the Atlantic sector, northward Atlantic Water transport is the major means of heat transfer to the northern high latitudes. As a possible explanation for Eemian-Holocene differences, one may thus propose a stronger and warmer Atlantic Water advection to the Arctic for the peak Eemian than for the Late Holocene. Since surface-near water mass properties are reflected in the oxygen and carbon isotope composition of planktic foraminifers, a comparison of such values from Eemian and Holocene sediments can give hints on possible differences in Arctic Ocean environments in these intervals.

While there is a dense coverage of isotope values from planktic foraminifers in sediment surface samples available for large parts of the Arctic Ocean and the northern Nordic Seas, the number of suitable Eemian isotopic records is still rather limited. The situation is complicated by meltwater influences on surface-near waters in the MIS 6/5 transition and by the generally rather low sedimentation rates in the Arctic which often restrict Eemian deposits to a few centimeters. Comparison of available records, mostly from the Fram Strait and Eastern Arctic Ocean, show ca. 0.5‰ higher oxygen isotope values in the Eemian than in the Late Holocene. Carbon isotope differences are variable but the number of sites with slightly lower values in the Eemian is dominating. The results may be interpreted in several and partly contrasting ways, involving differences in river run-off, salinity, temperature, ice-coverage, and main habitats of the planktic foraminifers.

POSTER

The Arctic in Rapid Transition (ART) Initiative: Integrating priorities for Arctic Marine Science over the next decade

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The Arctic is undergoing rapid environmental and economic transformations. Recent climate warming, which is simplifying access to oil and gas resources, enabling trans-Arctic shipping, and shifting the distribution of harvestable resources, has brought the Arctic Ocean to the top of national

and international political agendas. Scientific knowledge of the present status of the Arctic Ocean and the process-based understanding of the mechanics of change are urgently needed to make useful predictions of future conditions throughout the Arctic region. These are required to plan for the consequences of climate change. A step towards improving our capacity to predict future Arctic change was undertaken with the Second International Conference on Arctic Research Planning (ICARP II) meetings in 2005 and 2006, which brought together scientists, policymakers, research managers, Arctic residents, and other stakeholders interested in the future of the Arctic region. The Arctic in Rapid Transition (ART) Initiative developed out of the synthesis of the several resulting ICARP II science plans specific to the marine environment. This process started in October 2008 and has been driven by early career scientists. The ART Initiative is an integrative, international, multi-disciplinary, long-term pan-Arctic network to study changes and feedbacks with respect to physical characteristics and biogeochemical cycles in the Arctic Ocean in a state of rapid transition and its impact on the biological production. The first ART workshop was held in Fairbanks, Alaska, in November 2009 with 58 participants from 9 countries. Workshop discussions and reports were used to develop a science plan that integrates, updates, and develops priorities for Arctic Marine Science over the next decade. The science plan was accepted and approved by the International Arctic Science Committee (IASC) Marine Group, the former Arctic Ocean Science Board. The second ART workshop was held in Winnipeg, Canada, in October 2010 with 20 participants from 7 countries to develop the implementation plan. Our focus within the ART Initiative will be to bridge gaps in knowledge not only across disciplinary boundaries (e.g., biology, geochemistry, geology, meteorology, physical oceanography), but also across geographic (e.g., international boundaries, shelves, margins, and the central Arctic Ocean) and temporal boundaries (e.g., palaeo/geologic records, current process observations, and future modeling studies). This approach of the ART Initiative will provide a means to better understand and predict change, particularly the consequences for biological productivity, and ultimate responses in the Arctic Ocean system. More information about the ART Initiative can be found at http://aosb.arcticportal.org/art.html.

TALK

Hot times in the Beringian Arctic – Pliocene and Quaternary warm extremes in the 3.6 Ma record of Lake El'gygytgyn/ NE Russia

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High arctic Lake El'gygytgyn (67°30' N, 172°05' E) is a 3.6 Ma old meteorite crater lake located in Chukotka/ NE Russia. In spring 2009, the ICDP El'gygytgyn Drilling Project recovered the entire, 317-m long lacustrine sediment record of the lake. With its widely continuous sequence since the Pliocene, the lake sediment record is unprecedented, for the first time providing a high-resolution Pliocene-Pleistocene paleoclimate reconstruction from the terrestrial Arctic.

Initial pollen and geochemical data of the basal sediments suggest much warmer conditions in the Arctic during the mid Pliocene, with boreal forests occupying the lake surroundings. This confirms predictions of regional and global climate and vegetation models. A higher biogenic opal accumulation in the early stage of the lake, partly masked by a much higher sedimentation rate, suggests enhanced lake productivity, triggered by the higher temperature and/ or a higher nutrient supply. During the late Pliocene, a change in the vegetation pattern around the lake to more tundra-dominated habitats indicates a gradual change to cooler conditions in Central Chukotka. The gradual cooling, however, was interrupted by various short-term climatic deteriorations.

The Pliocene/Pleistocene boundary at Lake El'gygytgyn is characterized by a change to more frequent climate fluctuations rather than an abrupt cooling. Within the Quaternary, several distinct peak interglacials (e.g., MIS 47/49, MIS 11) poke out of the general glacial/interglacial pattern. Highest biogenic opal and organic contents during these interglacials point out extremes in the lake productivity, triggered by much warmer conditions in Western Beringia as confirmed by exceptional vegetation patterns in the pollen data. The knowledge and understanding of those peak interglacials is essential for the prediction of Arctic response to a future global warming.

TALK

Holocene variability of surface and subsurface Atlantic Water inflow on the West Spitsbergen continental margin

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The Atlantic Water inflow through EasternFramStrait - a major pathway of warm and saline water to the Arctic Ocean – plays an essential role for the Arctic Ocean heat budget (Schauer et al., 2004). Atlantic Water (AW) has been continuously present since ca 20,000 years in the EasternFramStrait (Rasmussen et al., 2007). However, the conditions of the AW inflow through the FramStrait have varied much throughout the Holocene. From two sediment cores from the West Spitsbergen continental margin we present multiproxy evidence of variations of the Atlantic Water inflow and the position of the sea ice margin during the past ca 10,000 cal kyr BP. Maximum occurrence of the subpolar planktic foraminifer species *T. quinqueloba* suggests warmest temperatures of the Atlantic Water-bearing West Spitsbergen Current during the early part of the Holocene (10 to 8 cal ka BP). However, low planktic $d^{13}C$ values indicate limited ventilation of the AW layer that most likely submerged beneath a relatively thick surface layer of sea ice and lower salinity. A second warming pulse between 5 and 6 ka was accompanied by higher planktic $d^{13}C$ values pointing to the AW layer appearing at the surface. In the second half of the Holocene, increased IRD contents indicate a neoglacial trend found in many records of the North Atlantic realm (e.g. Koç and Jansen, 2002). Despite of the decreasing solar insolation planktic foraminiferal assemblages suggest a return of slightly strengthened Atlantic Water advection around 3 to 2 ka and a strong warming event in the present, anthropogenically influenced period.

References

Koç, N. and Jansen, E., 2002. Holocene Climate Evolution of the North Atlantic Ocean and the NordicSeas - a Synthesis of New Results, in: Wefer, G., Berger, W., Behre, K.-E., Jansen, E. (Eds.), Climate Development and History of the North Atlantic Realm. Springer-Verlag, pp. 165-177.

Rasmussen, T.L., Thomsen, E.; Slubowska, M.A., Jessen, S., Solheim, A., and Koç, N., 2007. Paleoceanographic evolution of the SW Svalbard margin (76°) since 20,000 14C yr BP. Quaternary Research, 67, 100-114.

Schauer, U., Fahrbach, E., Østerhus, S., Rohardt, G., 2004. Arctic warming through the FramStrait: Oceanic heat transport from 3 years of measurements. Journal of Geophysical Research 109(C6), C06026.

C. HYDROLOGICAL EXTREMES:

POSTER

A causal link between drainage of ice-dammed lakes and glacier retreat

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Recent years investigations have suggested that the circulation of warm seawater along the coast of Greenland play an important role for the mass balance of the Greenland Ice Sheet. A key driving force for the circulation is the contribution of meltwater in the inner parts of fjord systems where surface freshwater run-off is found in the top of the water column in the fjord while sub-glacial meltwater is entrained deeper in the water column. The latter is highly important as this colder buoyant freshwater is pushed to the water surface followed by a compensating landward current bringing warm salty water to the glacier front.

In early September 2009, the lake Illuliartôq, dammed by the Narssap Sermia glacier in Godthåbsfjorden, drained during a weekend. Large amounts of cold fresh meltwater draining into the fjord at the base of the glacier where it contributed to the water circulation in the fjord. The large quantity of buoyant freshwater changed the osmotic pressure and pushed redfish to the water surface causing them to die from diving decease. Further investigation suggested that three ice-dammed lakes adjacent to the Narssap Sermia glacier had drained within the previous year.

Analysis of the water masses in Godthåbsfjorden shows that the sudden drainage of ice-dammed lakes not only affects the marine ecosystem but also has a tremendous effect on the circulation of water masses within the fjord. Preliminary results suggest that the drainage causes a landward flow of warm seawater which is 10-30 times the volume of an ice-dammed lake prior to drainage. The warm water influx in turn causes the glacier to retreat and gradually become thinner which feeds back to an increase in drainage events of ice-dammed lakes over time.

On a larger scale the feedback mechanism between the drainage of lakes, the circulation of water masses and the retreat of tidewater glaciers may suggest a speedup of the melting of the Greenland Ice Sheet.

TALK

Mineralogical content of a catastrophic flooding deposit of the Arctic Ocean: implications for provenance and sediment transport pathways during MIS 4

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Sedimentological and mineralogical evidence from the sediment cores from the Lomonosov Ridge suggest that a dynamic event took place sometime during MIS 4 or early MIS 3. The piston core retrieved during the icebreaker expeditions Arctic Ocean 96 show that up to 48 cm thick homogenous layer of grayish silty clay (gray layer marker bed) was deposited, which type of sediment is also detected during the expeditions Ymer 80 and LOMROG 07, thus owing correlation much over the Eurasian basin. A sharp boundary to underlying sediment indicate rapid onset of the deposition. The heavy mineral compositions of the gray layer own indications of specific provenance for the sediments. This abrupt change in sedimentation was probably related to a catastrophic release of water to the Eurasian basin from an ice dammed lake on the Siberian hinterland in connection with significant increase in iceberg surging from the Barents-Kara ice sheets.

This can be supported by the first results from the electron microprobe analysis of the heavy mineral composition of the gray layer. The most abundant heavy minerals in the gray layer are garnet (almandine-pyrope), epidote, ilmenite and hematite/goethite with some amphiboles and zircon. The prominent provenance for garnet (almandine-pyrope) and epidote is granulitic and lower grade metamorphic rocks of the Anabar Shield (Condie et al., 1991) and the Taymyr Fold Belt (Pease & Vernikovsky, 1998) indicating that the outbrush of waters was probably finding pathways towards east along the Anabar and Khatanga river valleys to the Laptev Sea and towards the final depositional site by sea ice and iceberg transportation. The occurrence of Ti-rich oxide minerals are possible reflecting the calcite veins within the Anabar Shield dolomites. Pyroxenes which are abundant in the lower part of the gray layer as well as ilmenite and hematite are referring to their origin from the Siberian flood basalt province of the Putorana Plateau with the prominent pathway being along the Khatanga or Yenissei river valleys. Chemical weathering of basalts in the Putorana Plateau has generated soils consisting of smectite with goethite saturated bore waters (Pokrovsky et al., 2005), which both minerals are also represented in the mineral composition of the gray layer. Smectite content is prominantly increasing just at the base of the gray layer. All these are consistent with the source areas of the Putorana Plateau and the Kara and Laptev sea shelves, geographically situated within the boundaries of a huge ice dammed lake (Krinner et al., 2004; Mangerud et al., 2004), which is then once the Barents–Kara ice sheet shrunk, believed to be rapidly released with generation of gray layer marker bed in the Eurasian basin.

References

Condie, K.C., Wilks, M., Rosen D.M., and Zlobin, V.L. 1991. Geochemistry of metasediments from the Precambrian Hapschan Series, eastern Anabar Shield, Siberia. Precambrian Research 50, 37-47.

Krinner, G., Mangerud, J., Jakobsson, M., Crucifix, M., Ritz, C., and J. I. Svendsen, J.I., 2004.Enhanced ice sheet growth in Eurasia owing to adjacent ice-dammed lakes. Nature 427, 429-432.

Mangerud, J., Jakobsson, M., Alexanderson, H., Astakhov, V., Clarke, G.K.C., Henriksen, M., Hjort, C., Krinner, G., Lunkka, J.-P., Möller, P., Murray, A., Nikolskaya, O., Saarnisto, M., and Svendsen, J.I., 2004. Ice-dammed lakes and rerouting of the drainage of northern Eurasia during the Last Glaciation. Quaternary Science Reviews 23, 1313-1332.

D. PERMAFROST EXTREMES:

TALK

Winter climate reconstruction from Radiocarbon-dated ice wedges – examples from Siberia and Alaska

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In permafrost regions, paleoclimate investigations are often restricted to lakes and permafrost profiles and, in many cases, based upon paleoecological (thus, summer) indicators (i.e. pollen). Here, we present data from ice wedges as new, mid-resolution climate archive. Ice wedges are the most abundant type of ground ice in Arctic permafrost deposits. Stable water isotopes in ice wedges are considered to be suitable winter temperature tracers because they can be directly linked to atmospheric precipitation and the filling of frost cracks with snow (melt) occurring in winter/spring. The organic matter included in ice wedges can be dated by Radiocarbon methods, hence allow age control of discrete parts of an ice wedge. However, a careful selection of the samples to be dated is a prerequisite for a successful application of the ^{14}C dating technique to ice wedges.

In the frame of fieldwork in Siberia and Alaska, ice wedges and enclosing sediments were studied and sampled in detail. The main objective was to link the isotope composition of ice wedges (and by that the winter temperature) to the time of their formation by AMS-dating of organic matter enclosed in ice wedges, and hence, to establish ice wedge-based winter isotope thermometers. Here, we will present data on the stable isotope composition ($\delta^{18}O$, δD, *d* excess) of ice wedges with sufficient suitable datable organic matter.

The North Siberian data show that the ground ice on the first terrace of the Lena Delta was mainly formed in the second half of the Holocene between about 6 kyrs cal BP and today, and, thus mostly contemporaneously to sediment accumulation. In general, ice wedge-growth was particularly active in the past 2 kyrs. The ice wedges display a marked variability in their isotopic composition reflecting changing Late Holocene winter conditions. Warmest winter conditions were observed in the most recent centuries and about 1000 years BP, whereas around 5 kyrs cal BP winter climate was significantly colder. The winter warming trend is in line with the winter insolation curve and also detected in ice wedges at the Oyagos Yar study site, Dmitrii Laptev Strait, NE Siberia (Opel et al., 2011).

In our Alaska study, we investigated a relict buried ice-wedge system within continuous permafrost near Barrow. The winter climate reconstruction from Barrow ice wedges comprises the first radiocarbon-dated centennial-scale stable water isotope record from permafrost in North Alaska (Meyer et al. 2010a; 2010b). The data demonstrate ground-ice formation between Allerød and Preboreal as well as the existence of a clear Younger Dryas cold event, formerly believed to be reduced or absent in the area. Moreover, the stable isotope records may contain information about the atmospheric paleo moisture sources.

In summary, detailed ^{14}C-based studies on the stable isotopic composition of ice wedges reveal the winter climate history of the time of their formation. We present two ground ice-based winter climate records from (a) Northern Siberia covering the last 6 kyrs as well as (b) North Alaska including the Pleistocene-Holocene boundary, both at about centennial-scale resolution. The linkage between ground and glacier ice records in the Russian Arctic is the topic of a second APEX abstract by Thomas Opel and co-authors.

References

Meyer, H., Schirrmeister, L., Yoshikawa, K., Opel, T., Wetterich, S., Hubberten, H.-W., Brown, J. (2010a). Permafrost evidence for severe winter cooling during the Younger Dryas in northern Alaska, Geophysical Research Letters, 37, L03501.

Meyer, H., Schirrmeister, L., Andreev, A., Wagner, D., Hubberten, H. -W., Yoshikawa, K., Bobrov, A., Wetterich, S., Opel, T., Kandiano, E., Brown., J. (2010b). Late Glacial and Holocene isotopic and environmental history of northern coastal Alaska - results from a buried ice-wedge system at Barrow, Quaternary Science Reviews, 29, 3720-3735

Opel T, Dereviagin A, Meyer H, Schirrmeister L, Wetterich S. 2011. Paleoclimatic information from stable water isotopes of Holocene ice wedges on the DmitriiLaptevStrait, Northeast Siberia, Russia. Permafrost and Periglacial Processes, 22, 84-100.

TALK

Late Quaternary landscape and climate variability in the East Siberian Arctic recorded in permafrost

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The study region belongs to western part of the Beringia, the region non-glaciated during the late Quaternary between the Eurasian and the North American ice sheets. During glacial-interglacial and stadial-interstadial climate cycles the responding periglacial landscape dynamics in West Beringia were related to sea level changes exposing large parts of the shallow East Siberian shelf during cold periods; to warm-stage induced thermokarst leading to surface subsidence (Grosse et al., 2005, 2006, 2007); and to strong transformations of the paleo-relief and the hydrological regime (Schirrmeister et al. 2003, 2008; Wetterich et al., 2008) caused by small-scale eustatic and/or neotectonic surface movements (Kienast et al., 2008; Schirrmeister et al., 2010, 2011).

Dealing with permafrost as paleoenvironmental archive several limitations have to be taken into account. Most prominent is the frequent lack of continuous permafrost sequences due to intense and varying landscape history of thermal induced sediment erosion and relocation. Consequently, local stratigraphies are sometimes difficult to correlate on a regional scale. Despite the wide use of different geochronological methods such as radiocarbon dating (e.g. Schirrmeister et al., 2008), optical and infrared stimulated luminescence (OSL, IRSL; Schirrmeister et al., 2011,), $^{230}Th/^{234}U$ disequilibria (Schirrmeister et al., 2002; Wetterich et al., 2008) or $^{36}Cl/Cl$ ratio in ground ice (Blinov et al., 2009, Glichinsky et al., 2007) there are still large uncertainties for comparing different geochronological results. Some of them are probably related to unknown influences of permafrost processes on chemical and physical parameters important to the age determination techniques.

The stratigraphically longest permafrost records covering Saalian to Holocene periods were obtained along the Dmitry Laptev Strait, which connects the Laptev and the East Siberian seas, (Andreev et al., 2004, 2009).The oldest permafrost records are from peat on Bol'shoy Lyakhovsky Island (New Siberian Archipelago) $^{230}Th/^{234}U$-dated to about 200 to 160 ka. (Schirrmeister et al. 2002).

Ice-rich deposits of the Yedoma Suite are the widest distributed late Pleistocene paleo archive of the East Siberian Arctic. These polygenetically formed Ice Complex sequences (Schirrmeister et al., in press) are characterized by huge syngenetic ice wedges (Meyer et al., 2002b) and exposed over long distances along river banks of the Lena, Yana, Indigirka, and Kolyma rivers and Laptev and East Siberian and Chukchi sea coasts. The polygon tundra of West Beringia is considered as faunal and floral refuges during glacial periods and representative for tundra steppe biomes inhabited by a megamammal fauna called the Mammoth Fauna. Fossil bioindicators of the Yedoma Suite reflect paleoenvironmental variations during the MIS 4 to MIS 2 stadial-interstadial changes (Bobrov et al, 2004, 2009; Kienast et al., 2005; Sher et al., 2005; Wetterich et al. 2008). In addition, the organic matter preserved in sediments of the Yedoma Suite is considered as potential carbon source under permafrost degradation due to ongoing global warming. The youngest records of the Lateglacial and Holocene climate variations are mostly stored in frozen lacustrine and boggy sequences of thermokarst depressions (e.g. Wetterich et al., 2009).

The coldest records indicated by stable water isotope signatures of syngenetic ice wedges were found in late Saalian (Meyer et al., 2002a) and Late Weichselian horizons. The warmest records are preserved in ice wedge casts of the last Interglacial exposed manifold along the DmitryLaptevStrait (Kienast et al., 2008, in press). A high content of fossil bioindicators such as pollen, plant macrofossils, chironomids, ostracods, cladoceras, diatoms, testaceae allow qualitative and quantitative reconstructions of paleogeography, and paleoclimate and paleoecological data respectively. Using pollen, plant macrofossils and chironomids, the mean temperature of the warmest month (T_{July}) was independently estimated with about 13 °C (10 °C warmer than today in the area) by different numerical methods (Kienast et al., in press).

Finally, there are some ideas to connect and to correlate the periglacial extremes of the terrestrial East Siberian Arctic with marine and glacial records and to think about a complex landscape dynamic controlled not only by climate factors but also by glacial, marine and neotectonic processes. A good place to study such relationships could be the Island New Siberia of the New Siberian archipelago, where terrestrial permafrost sequences, marine deposits and glacier ice remains occur in a strong local connection.

References

Andreev, A., Grosse, G., Schirrmeister, L., Kuznetsova, T.V., Kuzmina, S. A., Bobrov, A.A., Tarasov, P.E., Novenko, E.Yu., Meyer, H., Derevyagin, A.Yu., Kienast, F., Bryantseva, A., Kunitsky, V.V., 2009. Weichselian and Holocene palaeoenvironmental history of the Bol'shoy Lyakhovsky Island, New Siberian Archipelago, Arctic Siberia. Boreas 38(1), 72-110. doi:10.1111/j.1502-3885.2008.00039.x.

Andreev, A. A., Grosse, G., Schirrmeister, L., Kuzmina, S. A., Novenko, E. Yu., Bobrov, A. A., Tarasov, P. E., Kuznetsova, T. V., Krbetschek, M., Meyer, H., Kunitsky, V. V., 2004. Late Saalian and Eemian palaeoenvironmental history of the Bol'shoy Lyakhovsky Island (Laptev Sea region, Arctic Siberia). Boreas, 33(4), 319-348. doi:10.1080/03009480410001974.

Blinov, A., Alfimov, V., Beer, J., Gilichinsky, D., Schirrmeister, L., Kholodov, A., Nikolskiy, P., Opel, T., Tikhomirov, D., Wetterich, S.(2009).36Cl/Cl ratio in ground ice of East Siberia and its application for chronometry, Geochemistry, Geophysics, Geosystems (G3). 10(1), doi: 10.1029/2009GC002548.

Bobrov, A.A., Andreev, A.A., Schirrmeister, L., Siegert, Ch. (2004). Testate amoebae (Protozoa: Testacea) as bioindicators in the Late Quaternary deposits of the BykovskyPeninsula, Laptev Sea, Russia. Palaeogeography Palaeoclimatology Palaeoecology, 209, 165-181. doi:10.1016/J.PALAEO.2004.02.012

Bobrov, A.A., Müller, S., Chizhikova, N.A., Schirrmeister, L., Andreev, A.A.(2009).Testate Amoebae in Late Quaternary Sediments of the Cape Mamontov Klyk (Yakutia). Biology Bulletin, 36(4), 363-372.

Gilichinsky, D. A. , Nolte, E., Basilyan, A.E., Beer, J., Blinov, A., Lazarev, V., Kholodov, A., Meyer, H., Nikolsky, P.A., Schirrmeister, L., Tumskoy, V. (2007). Dating of syngenetic ice wedges in permafrost with 36Cl and 10Be, Quaternary science reviews. 26, 1547-1556. doi:10.1016/j.quascirev.2007.04.004

Grosse, G., Schirrmeister, L., Kunitsky, V. V., Hubberten, H. -W. (2005). The Use of CORONA Images in Remote Sensing of Periglacial Geomorphology: An Illustration from the NE Siberian Coast. Permafrost and Periglacial Processes, 16, 163-172. doi:10.1002/ppp.509.

Grosse, G., Schirrmeister, L., Malthus, T.J., 2006. Application of Landsat-7 satellite data and a DEM for the quantification of thermokarst-affected terrain types in the periglacial Lena-Anabar coastal lowland. Polar Research, 25(1), 51-67.

Grosse, G., Schirrmeister, L., Siegert, Ch., Kunitsky, V.V., Slagoda, E.A., Andreev, A.A., Dereviagyn, A.Y., 2007. Geological and geomorphological evolution of a sedimentary periglacial landscape in Northeast Siberia during the Late Quaternary. Geomorphology, 86(1/2), 25-51. doi:10.1016/j.geomorph.2006.08.005.

Kienast, F., Schirrmeister, L., Siegert, C., Tarasov, P. (2005). Palaeobotanical evidence for warm summers in the East Siberian Arctic during the last cold stage. Quaternary Research, 63(3), 283-300. doi:10.1016/j.yqres.2005.01.003

Kienast, F., Tarasov, P., Schirrmeister, L., Grosse, G., Andreev, A.A., 2008. Continental climate in the East Siberian Arctic during the last interglacial: implications from palaeobotanical records. Global and Planetary Change, 60(3/4), 535-562. doi:10.1016/j.gloplacha.2007.07.004.

Kienast, F., Wetterich, S., Kuzmina, S., Schirrmeister, L., Andreev, A., Tarasov, P., Nazarova, L., Kossler, A., Frolova, A., Kunitsky, V.V., in press. Paleontological records indicate the occurrence of open woodlands in a dry inland climate at the present-day Arctic coast in western Beringia during the last interglacial. Quaternary Science Reviews, doi:10.1016/j.quascirev.2010.11.024.

Meyer, H., Dereviagin, A. Yu., Siegert, C., Schirrmeister, L., Hubberten, H.-W., 2002a. Paleoclimate reconstruction on BigLyakhovskyIsland, North Siberia - Hydrogen and oxygen isotopes in ice wedges. Permafrost and Periglacial Processes, 13, 91-105. DOI: 10.1002/ppp.416.

Meyer, H., Derevyagin, A., Siegert, C., Hubberten, H.-W., 2002b. Paleoclimate studies on BykovskyPeninsula, Northern Siberia hydrogen and oxygen isotopes in ground ice. Polarforschung 70, 37-51.

Schirrmeister, L., Oezen, D., Geyh, M.A., 2002. 230Th/U dating of frozen peat, Bol'shoy Lyakhovsky Island (North Siberia), Quaternary Research. 57, 253-258. doi:10.1006/qres.2001.2306.

Schirrmeister, L., Kunitsky, V. V., Grosse, G., Schwamborn, G., Andreev, A. A., Meyer, H., Kuznetsova, T., Bobrov, A., Oezen, D., 2003. Late Quaternary history of the accumulation plain north of the Chekanovsky Ridge (Lena Delta, Russia) - a multidisciplinary approach. Polar Geography, 27(4), 277-319.

Schirrmeister, L., Grosse, G., Kunitsky, V., Magens, D., Meyer, H., Dereviagin, A., Kuznetsova, T., Andreev, A., Babiy, O., Kienast, F., Grigoriev, M., Overduin, P.P., Preusser, F. (2008). Periglacial landscape evolution and environmental changes of Arctic lowland areas for the last 60,000 years

(Western Laptev Sea coast, Cape Mamontov Klyk). Polar Research, 27(2), 249-272. doi:10.1111/j.1751-8369.2008.00067.x.

Schirrmeister, L., Grosse, G., Kunitsky, V.V., Fuchs, M.C., Krbetschek, M., Andreev, A.A., Herzschuh, U., Babyi, O., Siegert, C., Meyer, H., Derevyagin, A.Y., Wetterich S., 2010. The mystery of BungeLand (New Siberian Archipelago): Implications for its formation based on palaeo-environmental records, geomorphology, and remote sensing. Quaternary Science Reviews, 29, 3598–3614. DOI:10.1016/j.quascirev.2009.11.017.

Schirrmeister; L., Grosse, G. Schnelle; M., Fuchs; M., Krbetschek. M., Ulrich; M., Kunitsky, V., Grigoriev, M., Andreev, A.; Kienast, F., Meyer, H., Klimova, I., Babiy, O., Bobrov, A., Wetterich, S., Schwamborn, G. (2011). Frozen paleo-environmental records from the western Lena Delta: Periglacial landscape dynamics in northern East Siberia during the Late Quaternary. Palaeogeography, Palaeoclimatology, Palaeoecology 299, 175–196, doi:10.1016/j.quascirev.2009.11.017.

Schirrmeister, L., Kunitsky, V. V., Grosse, G., Wetterich, S., Meyer, H., Schwamborn, G., Babiy, O., Derevyagin, A. Y., Siegert, C., in press. Sedimentary characteristics and origin of the Late Pleistocene Ice Complex on North-East Siberian Arctic coastal lowlands and islands - a review. Quaternary International, doi:10.1016/j.quaint.2010.04.004.

Sher, A.V., Kuzmina, S.A., Kuznetsova, T.V., Sulerzhitsky, L.D., 2005. New insights into the Weichselian environment and climate of the East Siberian Arctic, derived from fossil insects, plants, and mammals. Quaternary Science Reviews, 24, 533-569.

Wetterich, S., Kuzmina, S., Andreev, A.A., Kienast, F., Meyer, H., Schirrmeister, L., Kuznetsova, T., Sierralta, M., 2008. Palaeoenvironmental dynamics inferred from late Quaternary permafrost deposits on KurungnakhIsland, Lena Delta, Northeast Siberia, Russia. Quaternary Science Reviews, 27(15-16), 1523-1540. doi:10.1016/j.quascirev.2008.04.007.

Wetterich, S., Schirrmeister, L., Andreev A.A., Pudenz, M., Plessen, B, Meyer, H., Kunitsky, V.V., 2009. Eemian and Late Glacial/Holocene palaeoenvironmental records from permafrost sequences at the DmitryLaptevStrait (NE Siberia, Russia). Palaeogeography, Palaeoclimatology, Palaeoecology 279: 73-95. doi:10.1016/j.palaeo.2009.05.002.

TALK

Palaeo-permafrost dynamics in El´gygytgyn Crater core data

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The El'gygytgyn Meteorite Crater in upland Chukotka holds the unique opportunity to trace frozen ground conditions back to the Pliocene. The basin was not glaciated in Quaternary time and terrestrial deposits accumulate episodically at piedmont settings and continuously in a central lake basin. Drilling into sedimentary permafrost nearby the shore of the Crater Lake recovered a 141 m long core of frozen deposits that belong to an alluvial fan entering the lake basin from the west. The permafrost core contains ground ice throughout and largely consists of sandy gravels with clasts embedded in a sandy matrix. Pollen assemblages, ground ice hydrochemistry (i.e. stable water isotopes, major cations and anions) are used as palaeoenvironmental indicators for reconstructing late Cenozoic climate, landscape and permafrost dynamics. Reconstruction of the local erosional and depositional history is supported by tracing palaeo-permafrost with meteoric ^{10}Be and in-situ ^{26}Al/^{10}Be. This research aids our understanding of permafrost history over long time scales in far NE Siberia, an area yet underexposed in palaeo-permafrost research.

The discontinuous pollen dataset suggests that - described from the top to the bottom - the Holocene is indicated by high amounts of alder and birch and is restricted to the upper 1.8 m of core. Here, organic matter can occur in amounts of >1 weight-%. Below, where organic matter decreases to negligible values, the Younger Dryas is represented by the interval 1.8-2.5 m showing a lack of birch and alder whereas the underlying Allerød down to 9.5 m core depth again contains those tree pollen. Sediments at ~20 m depth were probably formed during interglacial MIS 5.5 or 7 as inferred from the occurrence of alder and birch pollen, which can be correlated with other regional records. Whilst the pollen assemblages at ~36 m and ~51 m depth still indicate cold Pleistocene environmental conditions, those at about 62-65 m depth may belong to the MIS 11 based on high pollen counts of pine, larch, fir, spruce, and hemlock.

The inferred climate oscillations for the transition from the Allerød to the Younger Dryas and into the Holocene are also suggested by the water isotope record of the ground ice that mainly occurs as pore ice. δ^{18}O and δD minima and maxima in the upper core support the inferred vegetation history. This underpins that down to 9.5 m core depth deposition took place under subaerial conditions, where a precipitation signal has been preserved in the ground ice column. Below the Allerød core portion, the δ^{18}O values show less variation and tend toward more negative values. The δ^{18}O and δD values and a distinct distribution of major cations and anions along the core subdivide the pore ice record into several units. This pattern must be discussed in the framework of a basinward migration of the freezing front that marked the unfrozen zone (i.e. talik) below flooded lake margins in the past. A shallow lake environment prior to the Allerød is also indicated by the occurrence of distinctly rounded pebbles at 20 m core depth, suggesting shore-line processes and well sorted sandy layers, possibly deposited on the upper lake slope.

We conclude that the coring site was drowned at the relevant time intervals initiating thawing of the underlying permafrost before subsequent lake level fall allowed for re-freezing of the slopes. These thaw-freeze dynamics took place at least twice. The interpretation of lake level highstands is backed-up when considering exposed ancient lake terraces surrounding the lake at 10 m and 40 m above the modern shore line. Towards the Holocene a lake level fall gave way to the modern outline of the alluvial fan.

The inferred permafrost dynamics in the marginal Crater lake area has consequences when interpreting the 3.6 Myr lake sediment record.Destabilization of slopes due to thaw and freeze of permafrost may trigger debris flows into the basin and may have caused the frequent turbiditic layers in the sediment column.

POSTER

Pleistocene Ice Sheet in the East part of the Russian Arctic Shelf

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The ice sheet makes essential impact on relief formation of high-altitude Arctic regions. By this time much is known about quantity, development and destruction of Pleistocene ice sheets of the western and central parts of *the* Russian sector of Arctic regions. The East Siberian part is studied much worse, therefore in 2000-2010 authors conducted complex researches on Novosibirsk islands (The East Siberian Sea) and the north of Yakutia region. Numerous sequences of Quaternary deposits are studied. There were collected a lot of data that allowed reconstructing of an environment development of Novosibirsk islands and the northern part of the Yano-Indinirsky lowland during Pleistocene and Holocene.

It has been established that in Pleistocene the ice sheet occupied the part of Novosibirsk islands. Numerous locations of Upper Cenozoico deposits and the remained fragments of the glacier ice, the presence of moraines, the erratic mass and the aligned surfaces indicate that the ice centers were the De-Long islands where small ice sheets exists as yet. The glacier spread from the islands on hundreds kilometers, deformed and moved the bottom deposits, made exaration activity. The age of the glaciation has been established on the basis of the biostratigraphic data and results of radiocarbon and uranium-thorium dating of the folded deposits and the overlying deposits. Under our data the glaciation has occurred on border of Middle and Late Pleistocene.

The active deglaciation of buried strata deposits of the glacier ice and icy deposits with formation of the deep thermokarst lakes, the large thermocircuses proceed up to present time. The coastal line quickly changes and the area of islands decreases. For the historical period some islands have disappeared completely.

The ice sheet of Novosibirsk islands is unique geological event which has influenced on relief formation in Pleistocene and has defined its development in the present.

TALK

Parametric uncertainty and the evolution of the Greenland Ice Sheet

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Like all geophysical fluid dynamics models, ice sheet models depend on uncertain input parameters. These parameters include the prefactor on Glen's flow law, which controls how easily the ice flows in response to imposed stresses; the positive degree-day factors, which control how rapidly mass is removed from ice and snow surfaces at a given temperature; the basal sliding factor, which determines how rapidly the ice slides over thawed parts of the bed; and the geothermal heat flux, which affects how large the thawed part of the bed is. We evaluate the effects of uncertainty in these parameters on the evolution of the Greenland Ice Sheet over time. We relate the model output to problems in paleo-reconstruction of the Greenland Ice Sheet, such as the position of the ice margin during mid-Holocene time. Further, we investigate how this parametric uncertainty can be reduced through comparison of individual model runs to the observed, modern state of the ice sheet.

POSTER

A Late Weichselian and Holocene stratigraphy for Spitsbergen fjords

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High-resolution seismic data (Sparker, Boomer and 3.5 kHz penetration echo sounder) show characteristic reflection patterns in the fjords and bays of the Isfjorden area, the largest fjord system on Spitsbergen. They have, therefore, been used to establish a general stratigraphy for Late Weichselian and Holocene deposits in Spitsbergen fjords.

Seven seismostratigraphic units (S1 to S7) are distinguished. Subglacial deposits from the last glacial, but probably also deposits predating the last glacial, comprise unit S1. Unit S2 is composed of glacier-frontal deposits, reflecting halts and readvances during the deglaciation between c. 14,100 and 11,200 cal. years BP (calendar years before the present). Single and multiple sediment wedges comprising unit S3 reflect sediment reworking during the deglaciation. Unit S4 includes glacimarine sediments that reflect frequent changes in the physical environment (sub-unit S4a), as well as more stable physical environments with occasional ice rafting (sub-unit S4b) during the deglaciation. A period of enhanced ice rafting terminated the last glacial. Relatively homogenous sediments were deposited in a glacimarine environment with reduced ice rafting between c. 11,200 and c. 9000 cal. years BP (unit S5). More heterogeneous deposits comprising unit S6 are related to increased ice rafting during the last c. 9000 years. Unit S7 contains sediments and landforms that were deposited during and after glacier advances related to the Little Ice Age cooling and to surges.

Since the reflection patterns in the study area, as well as in other Spitsbergen fjords, are very similar, the proposed stratigraphy provides a useful tool to identify sedimentary environments, as well as to establish chronologies for single fjords from the last glacial until the present.

Reference

Forwick, M. and Vorren, T.O., 2011. Stratigraphy and deglaciation of the Isfjorden area, Spitsbergen. Norwegian Journal of Geology, 90(4). In press.

TALK

Dynamics of the Lomonosovfonna ice field, central Spitsbergen, since the last glacial maximum

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The Lomonosovfonna ice field belongs to the largest ice fields on 'Olav V Land' on Spitsbergen. It drains towards the north into Austfjorden/Wijdefjorden via the glacier Mittag-Lefflerbreen, towards the west into Billefjorden via Nordenskiöldbreen and towards the south into Tempelfjorden via Nordenskiöldbreen. Billefjorden and Tempelfjorden are tributaries of Isfjorden.

We analysed swath-bathymetry and high-resolution seismic data, as well as sediment cores (lithology, bulk-mineral assemblages) from the above mentioned fjords in order to reconstruct the dynamics of the Lomonosov ice field from the last glacial maximum until the present.

Glacial lineations indicate that icestreams in these fjords drained ice to the north and west of Svalbard during the last glacial. Sediment wedges and ridges indicate that the retreat of the ice streams occurred stepwise in all fjords and the final deglaciation terminated around 11,200 cal. years BP. Tidewater glaciers existed at the heads of Billefjorden and Tempelfjorden during the early Holocene. Their sizes were, however, probably relatively small.

Changes in bulk-mineral assemblages are suggested to reflect almost synchronous increases in the sizes of Tunabreen and Nordenskiöldbreen starting around 5600 and 5470 cal. years BP, respectively. This was probably due to a growth of Lomonosovfonna. Since then, the activities of these two glaciers seem to have varied more asynchronously. Apparent decreases in glacier activities occurred around 3700 cal. years BP (Tunabreen) and 3200 cal. years BP (Nordenskiöldbreen), i.e. during a period of the ongoing mid- and late-Holocene cooling. These behaviours might probably be related to 1) the enhanced formation of shorefast sea ice and/or more permanent sea-ice cover, trapping icebergs and forcing them to release their debris close to the calving fronts; or 2) the capture of larger amounts of ice and water in the glaciers.

Nordenskiöldbreen reached its Holocene – climatically induced – maximum ice extent around AD 1900. Tunabreen seems to have fluctuated repeatedly since c. 2000 cal. years BP. This might have been climatically induced (e.g. Roman Warm Period; Little Ice Age) or related to surges. Surges of Tunabreen have been observed in AD 1930, AD 1970 and between c. AD 2002 and 2005. No surges have, however, been observed for Nordenskiöldbreen.

This study is mainly a compilation of results published by Baeten et al. (2010), Forwick et al. (2010), Forwick & Vorren (in press) and unpublished data.

References

Baeten, N.J., Forwick, M., Vogt, C. and Vorren, T.O., 2010, Late Weichselian and Holocene sedimentary environments and glacial activity in Billefjorden, Svalbard. In: Howe, J.A., Austin, W.E.N, Forwick, M. & Paetzel, M. (eds.): *Fjord Systems and Archives*. Geological Society, London, Special Publication, v. 344, p. 207-223.

Forwick, M., Vorren, T.O., Hald, M., Korsun, S., Roh, Y., Vogt, C., and Yoo, K.-C., 2010, Spatial and temporal influence of glaciers and rivers on the sedimentary environment in Sassenfjorden and

Tempelfjorden, Spitsbergen. In: Howe, J.A., Austin, W.E.N, Forwick, M. & Paetzel, M. (eds.): *Fjord Systems and Archives*. Geological Society, London, Special Publication, v. 344, p. 163-193.

Forwick, M. and Vorren, T.O., 2011. Stratigraphy and deglaciation of the Isfjorden area, Spitsbergen. Norwegian Journal of Geology, 90(4). In press.

TALK

The Greenland ice sheet during LGM – a model based on field observations

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In the light of recent years' intense discussion on the role of Greenland Ice Sheet in global warming its reaction to past climatic change can contribute valuable information. We have updated the evidence for LGM (c. 23-20 kaBP) icesheet coverage. previous reviews An important part of the main The issue is complicated by the circumstance that during LGM (Last glacial maximum) the ice sheet margins around the whole perimeter stood on the shelf and "classical" evidence, such as large moraine belts, extensive sandurs and major drainage diversions do not apply. The first estimates were therefore based on observations on land, such as weathering limits on coastal mountains, major moraine belts, and altitudes of marine limits. Extrapolation from this gave estimates of LGM ice cover on the shelf ranging from inner to outer shelf, often under the assumption that it had to be either or, and not in between. Also, it was often assumed that if it could be demonstrated that the margin reached the shelf edge in one area, this should apply to the whole perimeter. Modelling, mainly on the basis of palaeoclimatic data, have presented a similar disparity between maximum and minimum estimates, assessing the Greenland ice sheet's contribution to Holocene sea level rise to between 0.3 and 2.6 m. Recent years have given spectacular new insight into shelf-ice distribution and behaviour - especially by detailed seismic surveys on the shelf and cosmogenic isotope surface exposure dating on coastal mountains. We combine this new evidence with the older observations. This model is conservative because it is, as far as possible, based on tangible evidence minimising the amount of speculation. The LGM ice sheet in this model covered c. 2.7 mio km^2, 65% more than the present. Two thirds of this excess relative to the present was on the shelf beyond the coast, and only one third on land and in fjord basins. The evidence also indicates that the glacial regimes varied between regions.

TALK

Tephrochronology a tool for dating the extremes

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The importance of tephrochronology as a tool for dating and correlation in Quaternary environments has become increasingly clear in recent years with increased research on climate and climate change. Precise and reliable dating of climatic archives is crucial to understand rapid climatic changes and leads and lags in the atmospheric, terrestrial, and oceanic systems. In the North Atlantic region tephra layers from Iceland have played an important role in dating and correlation of different geological archives.

On the North Icelandic shelf a high-resolution marine sediment core, MD99-2275, has been studied with the purpose of establishing a detailed tephrochronological and stratigraphical framework reported here for the past 7050 years. About 60 new tephra layers, originating from Icelandic volcanic systems, are revealed in the shelf sediments spanning this time period. The majority of the new tephra layers are basaltic in composition and originate from the most active volcanic systems in Iceland, the Grímsvötn, Veidivötn-Bárdarbunga, and Katla volcanic systems, with 20, 21, and 12 layers, respectively. Five of the new silicic and andesitic tephra layers are from the Hekla volcanic system, and two of those are the Hekla Ö, dated to 6060 cal. yrs BP(5275±55 ^{14}C BP), and the Hekla DH, dated to 6650 cal. yrs. BP, tephra markers not previously described outside of Iceland. For the last 15,000 years a total of 100 tephra layers have been identified so far in the core.

40 tephra layers in the shelf sediments have been correlated to their counterpart on land establishing a secure land-sea correlation between terrestrial tephra stratigraphy in Iceland and the marine tephra stratigraphy on the shelf. The detailed land-sea correlation facilitates ^{14}C dating on specific tephra layers using terrestrial material, thereby avoiding complications with reservoir effects. In addition, such an layer by layer correlation allows for syncronity of events or lead and lags between terrestrial and marine records to be estimated. The extension of the terrestrial tephra stratigraphy of Iceland onto the North Icelandic shelf demonstrates the potential of this new and detailed marine tephrochronological framework to be extended further into the Iceland Sea and the Arctic, significantly improving dating and land-sea correlation of Quaternary records in the Arctic region. The tephrochronological framework on the North Icelandic shelf will be an important addition to the existing knowledge on tephra layers in Quaternary environments in the North Atlantic and Arctic region.

TALK

Ice sheet configuration during MIS 2 on Nordaustlandet, Svalbard

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The fjords and uplands of Nordaustlandet were subject to several glaciations of the Svalbard-Barents Sea ice sheet. It is our main objective to reconstruct deglaciation ages by means of cosmogenic nuclide dating and the ice sheet configuration of the last glaciation during Marine Isotope Stage 2 (MIS 2). Only ^{10}Be ages were useful for our interpretations because of unresolved analytical problems with ^{26}Al in this area.

The obtained ^{10}Be exposure ages emphasize our present understanding of former ice sheet configurations during MIS 2 in the Arctic with cold-based non-erosive ice domes on higher plateaus and erosive faster flowing ice streams in fjords. Bedrock samples on higher plateaus indicate all a complex glacial and exposure history with apparent ages between 33 and 120^{10}Be ka. In addition several erratic boulders suggest a cover of non-erosive cold-based ice during several periods with apparent ages between 24 and 122 ^{10}Be ka.

Erosional ice streams were confined to the fjords and lowlands below 200-230 m altitude. They became deglaciated between 13 and 15.4 ^{10}Be ka.

TALK

Svalbard's Ice Streams: spatial ice sheet reconstructions vs. numerical modeling

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Ice streams represent the main drainage pathways along which ice from the interior of an ice sheet is transported to the coast where it is discharged into the ocean. As such, they play a critical role in interlinking glacial marine and terrestrial environments. Spatial ice sheet reconstructions provide evidence of the location, extent and ideally also the spatio-temporal variability of former ice streams. Numerical ice sheet models, however, often fail to reproduce ice streams correctly (Kirchner et al., in preparation).

Referring to the reconstruction of Svalbard's paleo-ice streams by Ottesen et al. (2007), we illustrate the limitations of 'traditional' ice sheet models based on the (zeroth order) Shallow Ice Approximation (SIA)

- provide an explanation for these limitations, and suggest how to overcome them
- present first general modeling results obtained with an amended, so-called second order Shallow Ice Approximation (SO-SIA) ice sheet model that will eventually be able to model coupled ice sheet/ice stream systems (Ahlkrona, 2011).

References

Ahlkrona, J., 2011. Implementing Higher Order Dynamics into the Ice Sheet Model SICOPOLIS. Master's thesis, Uppsala University UPTEC F11 015, 49 pp. ISSN: 1401-5757

Kirchner, N., Hutter, K., Jakobsson, M., Gyllencreutz, R., in prep. Ice shelves in spatial reconstructions and numerical modeling - belonging together but treated apart: why? To be submitted to Earth Sci. Rev.

Ottesen D., Dowdeswell J.A., Landvik J.Y., Mienert J., 2007. Dynamics of the Late Weichselian ice sheet on Svalbard inferred from high-resolution sea-floor morphology. Boreas 36, 286–306. doi:10.1080/03009480701210378.

POSTER

Novaya Zemlya - a nucleus for glaciation in the Barents-Kara Sea during MIS 3-2?

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To improve understanding of paleo-ice sheets in the Eurasian North, we utilize high-resolution simulations of the Barents-Kara ice sheet-ice shelf complex. Correct modeling of coupled ice sheet-ice shelf dynamics is essential for our understanding of past glacial environments and for predictions of future sea level changes. Yet, the numerical modeling of interlinked glacial terrestrial (ice sheets) and marine environments (ice shelves) poses severe challenges. More precise predictions of ranges of future sea level rise based on 'new generation' ice sheet models will generally only be available to inform the 6th IPCC report. A pioneering new generation ice sheet model that is capable of simulating ice sheet-ice shelf dynamics through glacial cycles is the model TARAH (Pollard & DeConto, 2009).

Here, we utilize this model to perform simulations focusing on Novaya Zemlya as a possible nucleus of glaciation in the Barents-Kara Sea region during the MIS3-2 transition. Specifically, we seek to investigate two of the least understood features of this glaciation: i/ the timing and pattern of the growing ice sheet-ice shelf complex towards full LGM coverage, and, ii/ the interaction between the Barents and Kara Ice Sheets. Preliminary results of our simulations are shown, and will eventually be evaluated against spatial reconstructions (indicating that Late Weichselian glaciation of Novaya Zemlya started after 30 ka, and likely lasted less than 10 000 years., cf. Mangerud et al. 2008) and the Eurasian DATED database (Gyllencreutz et al., in prep.)

The insights gained from the integrative paleo-modeling approach performed here contribute to advancing our knowledge of the behavior of ice sheets and their fringing ice shelves in both warming and cooling climates by exploiting a cross-disciplinary approach of reconstructing former ice covers in the Eurasian North.

References

Gyllencreutz, R., Mangerud, J., Svendsen, J.I., Lohne, Ø.S.., in prep. A chronology database and spatial reconstructions of the Late Weichselian Eurasian ice sheets.

Mangerud, J., Kaufman, D., Hansen, J., Svendsen, J.I., 2008. Ice-free conditions in Novaya Zemlya 35 000–30 000 cal years B.P., as indicated by radiocarbon ages and amino acid racemization evidence from marine molluscs. Polar Research 27, 187–208.

Pollard, D., DeConto, R. M. 2009. Modelling West Antarctic ice sheet growth and collapse through the past five million years. Nature, 458, 329–332.

POSTER

The evidences of the Pre-Holocene glacier advance in West Spitsbergen

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The majority of the present Spitsbergen glaciers which ended on the land have only one end-moraine ridge of the last glacier advance stage (treskelen stage or Little Ice Age). Very often the ancient moraine formations are absent in forefield of the LIA moraine. This fact is explained that the glacier advance in the treskelen stage was the maximum in the whole Holocene (Oledeneniye 1975; Glyaciologia,1985).

In recent years we have obtained new information about landforms and sediments of the marginal zones of Grønfjord and Aldegonda glaciers. This data allow us to say about the evidences of the Pre-Holocene glacier advance in West Spitsbergen.

There is the push-moraine ridge in marginal zone of Grønfjord glacier. The formation of it refer to Little Ice Age (Tarasov, Kokin, 2007; Kokin, 2010). The push-moraine consists of sediments which accumulated before last glacier advance when they were deformed and redeposited by glacier. One of the units is glaciomarine deposits. It consists of silt and sandy clay (with very rare angular gravel) without lamination and contains shells of mollusks (Kokin, 2010). Probably it was accumulated in the fjord during glacier advance when relative sea level was higher and glacier was ended in the sea. In this period the advance of the glacier was smaller and the sea was spread into the land further than in LIA. Due to this all evidences of this advance was destroyed by the glacier during treskelen stage (LIA) except the glaciomarine sediments as part of push-moraine.

As for age of the glaciomarine sediments we can judge about it relatively radiocarbon dates of mollucks from another part of the push-moraine. They are 2020±120 (GIN–13633), 2080±80 (GIN–13634) (in situ mollusks) and 9480±100 (GIN-13830), 9400±100 (GIN-13831) (redeposited *Mya truncata*) radiocarbon years BP (Kokin, 2010). Besides, there are 4 radiocarbon dates of shells and wood from sediments of push moraine: 6530±120 (GIN–255), 6550±120 (GIN–225a) (Lavrushin, 1969), 8000±70 (Tln–172), 3250±60 (Tln–185) (Punning, Troitsky, 1977). So these sediments were formed in interval from 9,5 till 2 ^{14}C kyr BP. According to R.W. Feyling-Hanssen (1965) period 10,4-9 kyr BP has temperate conditions with dominating of *Mya*. Because of it much probable time of the glacier advance during which was accumulated glaciomarine sediments was before 10-9 kyr BP.

There is a moraine ridge outside of the proglacial zone of Aldegonda glacier. This ridge is situated to the left from left lateral moraine ridge and oriented under the angle to the lateral moraine of the last glacier advance. This aligned moraine ridge ends at the edge of the marine terrace the height of which is about 50 meters. Probably it was formed in a previous glacier advance when relative sea level was higher and lacier ice have spilled away from present proglacial zone. The radiocarbon dates of marine mollusks in terraces at the height from 0 to 12 meters show that the marine terrace at 50 meters is older than 10 ^{14}C kyr BP. These dates are 7710±100 (GIN-14069), 8480±80 (GIN-14067), 8700±140 (GIN-14063), 9300±90 (GIN-14066), 9340±80 (GIN-14064), 9610±110 (GIN-14068), 10 090±90 (GIN-14065) ^{14}C yr BP. So the formation of aligned moraine ridge was also before than 10 kyr BP.

So we have the evidences of the Pre-Holocene advance of Grønfjord and Aldegonda glaciers which took place before 9-10 kyr BP.

References

Feyling-Hanssen, R.W., 1965. Shoreline displacement in Central Spitsbergen. Medd. Norsk Polarinst. № 93.

Glyaciologia Shpitzbergena (Glaciology of Spitsbergen; in Russian). 1985. Moscow: Nauka, 200 p.

Oledeneniye Shpitzbergena (Svalbarda) (Glaciation of Spitsbergen (Svalbard); in Russian). 1975. Moscow: Nauka, 276 p.

Kokin, O.,2010. The geological structure and the age of the Grønfjord glacier’s push-moraine ridge (West Spitsbergen). Fourth International Conference “Arctic Palaeoclimate and its Extremes” (APEX), Höfn Hornafjordur, Iceland. P. 45-47.

Lavrushin, Yu.A., 1969. Quaternary sediments of Spitsbergen (in Russian). Moscow: Nauka, 181 p.

Punning, Ya.-M.K. and Troitsky, L.S., 1977. About Holocene advances of glaciers at Spitsbergen (in Russian). Materialv Glyatsiologicheskikh Issledovaniy, vol. 29, p. 211-216.

Tarasov, G.A. and Kokin, O.V., 2007. New data on Grønfjord glacier’s push-moraine ridge age (in Russian). Complex investigations of Spitsbergen nature, iss.7. Apatity: KSC RAS, p. 85-93.

TALK

The last Svalbard/Barents Sea Ice Sheet – New understanding of ice sheet dynamics from western Svalbard

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For several decades the history of the last Svalbard/Barents Sea Ice Sheet has been the subject to large scientific controversies. These differences were settled in the late 1990's with a general acceptance of a Barents Sea ice sheet, which was confluent with the Fennoscandian Ice Sheet to the south and extending to the continental shelf break in the west and north. To the east it barely inundated parts of the Russian mainland, leaving most of the Kara Sea ice free. This was a simplistic two dimensional model of ice sheet extent, aiming at mapping the maximum ice sheet margins.

During the last decade, the paleo ice-sheet studies have been revitalized by the use of new methods like exposure age dating and high resolution sea floor mapping, as well as an improved glaciological understanding of ice sheet behavior. Thus, new research questions have been asked and "old" areas of ice-sheet research have been revisited. This has allowed for better three-dimensional reconstructions, and differentiation of the dynamics of different parts of the ice sheet. Additionally, the focus has increased on understanding the interplay between the ice sheets and the adjacent ocean.

New research from the west coast of Svalbard and the adjacent shelf shows that the last ice sheet was much more dynamic than previously assumed. Fjords and troughs represented conduits for high-flux ice streams feeding the ocean, whereas inter-fjord areas experienced a limited ice flux leaving a contrasting sedimentary record. During the deglaciation, ice sheet configuration changed through a series of dynamically different glacial phases. However, most areas are today dominated by the depositional signatures left during the final decay of the ice sheet. This complex behavior of past ice sheets in both space and time provides a challenge for our established understanding of ice sheet/ocean correlation and interaction.

TALK

Timing and driving mechanism of deglaciation of central west Greenland

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The acceleration, thinning and retreat of many tidewater glaciers draining the Greenland Ice Sheet since the late-1990s suggests these systems may respond to climate changes much quicker than previously thought. This has highlighted our relatively limited understanding of how ice sheets grounded below sea level may respond to future climate changes (e.g. atmospheric and/or ocean warming, sea-level rise). Improved understanding of these processes is of significant socio-economic importance given the possible impact of a collapse of the marine-based West Antarctic Ice Sheet. Here we investigate the chronology and possible mechanisms driving deglaciation of the marine-based ice sheet in central west Greenland.

At the Last Glacial Maximum (LGM) a series of ice streams are thought to have extended across the shelf to large trough mouth fans at the shelf break in central west Greenland. In this study we present benthic foraminiferal and sedimentological results from a series of piston cores collected from these cross shelf troughs in the Disko Bugt and Ummannak region. These cores help constrain the timing of retreat of fast flowing ice streams through these deep water troughs towards the present day coastline to the east. The benthic foraminiferal fauna also provide a record of changing oceanographic conditions during this period of retreat and through the Holocene to the present day.

Basal dates from a series of cores from the trough draining west from Disko Bugt show rapid deglaciation across the shelf from *c.* 12.4 ka cal BP. Ice had retreated to the eastern regions of Disko Bugt by *c.* 10.3 ka cal BP. Benthic foraminiferal data from these cores shows limited evidence of relatively warm basal water currents reaching the ice margin at the time of deglaciation (dominated by a fauna indicative of proximal glaciomarine conditions). Further north in the Ummannak region a core collected from the trough mid-way across the shelf provides evidence of deglaciation significantly later, *c.* 10.9 ka cal BP. As with the region to the south, the benthic foraminiferal fauna suggest deglaciation and ice retreat took place significantly before influx of relatively warm waters reached the ice margin.

The data presented here provides offshore evidence of deglaciation of central west Greenland showing the shelf west of Disko Bugt deglaciated over 1000 years earlier than the Ummannak region to the north. The timing of deglaciation in the Disko Bugt region coincides with the relatively cold atmospheric conditions of the Younger Dryas suggesting atmospheric warming is unlikely to explain deglaciation. Given the lack of evidence of ocean warming at this time it seems likely, therefore, that deglaciation was initiated by sea-level rise. The time lag in deglaciation of the Ummannak region to the north could be due to thicker ice in this area maintaining ice stream stability under conditions of rising sea-level for longer.

TALK

Younger Dryas – Preboreal glacier oscillations in Iceland, a very dynamic response to a climate change

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At the height of the Weichselian Glaciation (LGM) Iceland was covered with an ice-sheet containing about 300.000 km3 of ice, covering more than 200.000 km2 and extending out onto the shelf around the island. The ice-sheet at LGM was to a large extent (70%) marine based. The initial deglaciation was largely sea-level controlled. Part of the ice-sheet literally collapsed when global sea-level rose rapidly due to accelerated melting of the continental ice-sheets and increased volumes of warmer water masses reached higher latitudes in the North Atlantic Ocean. Over a period of about 700 years, ending at about 14.6 cal. kyr BP, the Icelandic ice-sheet lost about 60% of its volume and retreated inside the present coastline. It reached its minimum size at about 13.9 cal. kyr BP when the ice-sheet only contained about 20% of its LGM-volume. At the beginning of the Allerød chronozone, the Icelandic ice-sheet reacted to the general deterioration of climate in the North-Atlantic region by an advance that culminated in Younger Dryas time (at 12.0 cal. kyr BP) when the ice-margin around the island was situated close to the present coastline. At that time relative sea-level was rapidly rising due to significant glacial loading and rapid transgression of eustatic sea-level in the coastal areas and, consequently, the marginal part of the ice-sheet was destabilized and the glacier margin retreated. A subsequent re-advance of the ice-sheet culminating in Preboreal time (at 11.2 cal. kyr BP) was a glaciodynamic response as the ice-sheet reached a new balance after a sudden loss of volume in times when the climate was rapidly shifted towards full interglacial conditions. In North Iceland this adaptation to a new glaciodynamic balance caused an outlet glacier to collapse and retreat some 50 km while at the same time the margin of the ice-sheet in South Iceland only retreated about 7 km. After culmination of the 11.2 cal. kyr BP re-advance the Icelandic ice-sheet became land-based due to rapid glacial glacio-isostatic uplift with a stepwise recession (alternating advances and retreats) until 8.7 cal. kyr BP when glaciers in Iceland were of similar extent as of today.

TALK

Sedimentary environments in Kveithola, Barents Sea, during Latest Weichselian deglaciation and Holocene

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The east-west trending trough Kveithola is located at the western Barents Sea margin and has proven to be an effective sediment trap offering the unique possibility to study sedimentary shelf environments during Latest Weichselian deglaciation and Holocene.

The existence of a 15 m thick sediment blanket masking existing glacial landforms of the Kveithola trough has been demonstrated by analyses of acoustic data. Moreover, the innermost part of the trough is characterized by additional <20 m thick asymmetric drift sediments lapping onto the sediment blanket. Seven sediment gravity cores from Kveithola trough have been studied with the aim to understand the origin of the sediment blanket and drift sediments. Sediment facies and additional parameters like clast content, shear strength, clay minerals and radiocarbon dating of molluscs suggest that the sediment blanket consists of glacimarine sediments derived from the east and deposited during deglacial times (from approximately 17 - 12 cal ka) while the shallower Spitsbergenbanken remained ice-covered. The drift sediments are tentatively interpreted to be derived through feeder channels north of the inner trough and may reflect later stages of deglaciation on Svalbard or episodes of turbidity currents triggered by brine rejection.

Knowledge on the deglaciation history of the area is primarily based on terrestrial studies on Bjørnøya which was ice-free by 10 ^{14}C ka BP (Hyvärinen 1968, Salvigsen and Slettemark 1995). With 26 radiocarbon dates in four gravity cores, this study adds unprecedented age control to deglaciation and Holocene events from 14.5 cal ka onwards.

References

Hyvärinen, H., 1968. Late-Quaternary Sediment Cores from Lakes on Bjørnøya. Geografiska Annaler. Series A, Physical Geography, 50(4), 235-245.

Salvigsen, O. and Slettemark, Ø., 1995. Past glaciations and sea levels on Bjørnøya, Svalbard. Polar Research, 14(2), 245-251.

TALK

Holocene palaeoenvironmental variability inferred by lake records of extreme continental climates in the Siberian Arctic

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The Siberian Arctic reveals the most extreme continental climate of the northern hemisphere. Holocene palaeoclimate and environmental variability is archived in lake sediments. As biological communities in Arctic lakes are particularly vulnerable to climate changes, because of the strong coupling between temperature and lake-ice cover, fossil diatoms are potentially the most important bioindicators of palaeoenvironmental change in arctic lakes. The aim of our project is (i) to identify Holocene climate-driven changes in lake ecology and (ii) to reconstruct and to understand Holocene thermokarst processes in the Siberian Arctic.

During joint Russian-German summer expeditions in 2009 and 2010, several thermokarst lakes have been investigated and sampled. Here, we present a multi-proxy based palaeolimnological investigation of sediment cores from one forest tundra lake (Lake Sysy 69°N, 123°E) and one tundra lake (Lake El'gene 71°N, 125°E) south of the Lena River Delta. One ~1.2 m sediment core from the forest-tundra lake (Sysy Ozero) has been dated to max. ~13.2 ka cal BP. The diatom assemblage is dominated by small benthic fragilarioid taxa, reflecting extreme environmental conditions through postglacial time. Shifts in the distribution of diatom taxa towards more diverse species associations suggest changes in climate and ecological status of the lake in the mid and late Holocene. Some of the changes might be explained by long-term natural lake ontogeny. The tundra lake, El'gene Kyuele, is 2.9 x 0.5 km in size, with maximum water depth of 10.5 m. Sediments have been dated to max. ~10.9 ka cal BP. The small catchment area reveals intensive thermokarst processes of the surrounding Yedoma-like sediments. Interestingly the analysed core material of El'gene Kyuele does not contain diatoms. Sedimentological and geochemical data of a ~1.4 m sediment core from field campaign 2009 reveal a strong correlation between Sr/Rb ratio and grain size. Alternating sedimentary periods suggest a cyclicity of sedimentary events possibly reflecting intensity variations of thermal erosion. Allochthonous sedimentation during to enhanced catchment erosion is indicated by coarser grain-sizes and lower concentration of total organic carbon (TOC). Fine-grained periods with higher TOC values reflect autochthonous sedimentation.

POSTER

The Kap Ekholm section – the molluscs' tale

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The Kap Ekholm section shows three marine pre-Holocene periods bounded by glacial sediments (Mangerud & Svendsen 1992=MS). In 1993 the mollusc faunas were investigated by on-site analyses and collection of bulk samples. The results are discussed here in connection with the revised stratigraphy of Jensen *et al*. (in prep.)=MJ. The lowest marine beds (Unit B according to MS/ units 2-3 according to MJ.) are characterised by low-diverse assemblages dominated by *Macoma calcarea* but also with old thick-shelled and deeply burrowed *Mya truncata*. Animals, which were crushed by cobbles dropped on them, and frequent escape tracks from burrowers testify to an unstable environment with frequent slumping. The only indication of a fairly warm climate was the occurrence of *Mytilus edulis*, which however was both sparse and represented only by small thin-shelled individuals - probably washed down from the littoral zone. *Mytilus* probably were brought in as larvae from more pleasant areas, indicating that such areas did exist elsewhere on Svalbard at the time. In the upper part it is replaced by *Astarte borealis*, indicating a deterioration of the environment. Although local events may have overruled the regional signal, this scenario has always been difficult to fit into the concept of a warm Eemian interglacial, as discussed by MS. The fauna-signal agrees much better with the new interpretation of this unit as a glaciomarine diamicton dating to an earlier ice-free period. In the overlying Phantomodden interstadial fauna (Units D/8-9) there are only species, which are also present in unit B, but fewer. The simplest interpretation here is that unit D is a continuation of the deterioration seen in unit B – and that the Phantomodden interstadial therefore is not a distinct interstadial, and the separating "till" reflects a local high sedimentation event. This is underlined by the difference to the much richer and more diverse assemblages from the overlying Kap Ekholm interstadial (unit F/11), which without any doubt represent an entirely different type of marine environment.

The fauna results therefore agree with the new sedimentological interpretation. However, there is one disagreement: The new sediment-interpretation of Units B, C, and D evokes a glacier-proximal environment. Although the mollusc faunas also indicate unstable conditions with intermittent periods of slumping they do not indicate proximity (< c. 2 km) to a glacier front. This kind of environment is usually characterised by burrowing sediment eaters which can cope with constantly high sedimentation-rates and large inflow of fresh water, notably *Portlandia arctica*. These species are absent or rare, while such a suspension feeder as *Mya trunacata* has managed to live to old age. This would suggest that the slumping events were on a decadal rather than annual scale, and therefore not very close to a glacier.

References

Mangerud, J. and Svendsen, J.I. (1992). The last interglacial-glacial period on Spitsbergen, Svalbard. Quaternary Science Reviews, 11, 633-664

Jensen, M.A., Håkansson, L., Hormes, A. & Preusser, F. In prep: A revised stratigraphy from the Kapp Ekholm section, Billefjorden, Svalbard: implications for late Quaternary glaciation history

TALK

Vegetation and climate during the Early Holocene warm phase at the Seward Peninsula, Alaska, Central Beringia

Frank Kienast[1], Lutz Schirrmeister[2], Guido Grosse[3] , Sebastian Wetterich[2]

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Plant macrofossils preserved in palaeo-lake sediments dated to 8.370 ± 50 years BP and outcropped in an eroding pingo at the coast of the Seward Peninsula, Alaska reveal the existence of subarctic tundra similar in character to the recent plant cover however enriched by numerous extralimital plant species. The found extralimitals are distributed today more inland but not necessarily more south. Examples for such rather continental plants are aquatic and marshland taxa such as *Cicuta mackenzieana, Potamogeton alpinus ssp. tenuifolius, P. gramineus, P. praelongus, Callitriche hermaphroditica, Utricularia intermedia* and *Ceratophyllum demersum* as well as *Chamaedaphne calyculata* and *Picea glauca* among woody plants. The find of macro-remains of black spruce proves the local presence of trees and thus a tree-line shift of about 70 km towards the modern coastline (Little, 1971-1978). The floristic composition indicates a higher mean temperature of the warmest month correlated with the global Early Holocene warming but possibly intensified by persisting continentality owing to the, at this time, more distant coastline as result of the delayed glacio-eustatic global sea level rise.

References

Little, E.L., Jr., 1971-1978. Atlas of United States trees, volumes 1-5: U.S. Department of Agriculture Miscellaneous Publication, available online at http://esp.cr.usgs.gov/data/atlas/little/

POSTER (Withdrawn)

Sedimentary records of LakeOnega level changes in the postglacial times

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LakeOnega, the second largest lake in European Russia, located within the fringe of the last glaciation, must have experienced a considerable glacioisostatic rebound after the retreat of the Scandinavian Ice Sheet. However, the estimation of the amplitude of the rebound and lake-level fluctuations appears complicated as the effect of the isostasy was largely obscured by the local tectonics. As a result, synchronous palaeo-shorelines are presently located at different elevations in the northern (emerging) and southern (submerging) parts of the basin, which is further complicated by more locally restricted tectonic processes.

In this study, we examined sediment sequences from the north-central part of the lake basin; lithological, diatom and pollen analyses, and radiocarbon dating were performed to reconstruct postglacial lake-level changes. The results were then compared to those previously obtained from different parts of the lake shore to contribute to our understanding of the basin's emergence history.

TALK

Manganese cycles and bioturbation as a stratigraphic tool in Arctic Ocean sediments

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Although the Arctic Ocean is an important player in the global climate system, surprisingly little is known about paleoenvironmental changes on geological time-scales. This is only partly due to the inaccessible nature of the ice-infested Arctic Ocean where research can only be performed from heavy icebreakers or from ice-stations drifting with the pack ice. Another, perhaps more severe, limitation comes from the notoriously poor age control of Arctic sediments resulting in age models that may differ by an order of magnitude or more. In an attempt to establish a better control of the stratigraphy, it has been suggested that manganese-rich layers also characterized by enhanced bioturbation and the presence of calcareous micro and nannofossils can be correlated to the low latitude oxygen isotope curve. A fundamental assumption behind this correlation is that interglacial conditions would lead to more open water, a higher primary productivity resulting in increased flux biological activity in the sediment due to the enhanced food flux. The higher sea-level and flooded shelf regions would also lead to increased deep-water formation, well oxygenated deep waters, and the precipitation of manganese.

To further test this hypothesis, a set of 12 piston and gravity cores covering an area from the Makarov Basin to the Fram Strait were studied for Mn-content using an Itrax XRF-scanner. Trace fossils and bioturbation was studied using conventional X-ray radiographs. The results show that on the Lomonosov Ridge in the central Arctic Ocean a strong correlation exists between Mn-content and the intensity of bioturbation. However, the X-ray radiographs also reveal the presence of diagenetically formed Mn-horizons in intervals void of biogenic structures. At sites outside of the central Arctic the relationship between bioturbation and Mn-enrichment becomes less clear. In part this can be attributed to physical disturbances by grounded ice bergs, but also to the fact that some of these sites are situated in an area that is believed to have had a perennial ice-cover even during peak interglacials, thus experiencing only minimal difference in e.g. food flux between glacial and interglacial conditions.

POSTER

Diatom-inferred history of one of the northernmost Greenland lakes

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Arctic ecosystems have proven most sensitive to climate and environmental changes that are particularily well recorded in lake sedimentary archives. Such records are still scarce from the most remote high latitude regions although having progressively increased in number recently. The diatoms from Arctic lakes are known among the most effective tools in reconstructing past climatic and environmental variability. In formerly (and presently) glaciated regions they also help reconstructing relative sea-level changes resulted from glacioisostatic rebound.

In this study, the diatom stratigraphy, as well as physical and geochemical proxies was used to reconstruct the Holocene history of one of the small lakes located in Peary Land, northernmost Greenland, to decipher the environmental changes of the past. The diatom record of BlissLake(83°35'14"N 28°21'12"W, 17 m a.s.l.) reveals three main stages of the lake's development which is corroborated with other data. In the earliest stage dated back to the Early Holocene, the diatom record suggests a proglacial environment with meltwaters freshening a marine bay. After the glacier retreat around 9,400 cal yr BP, increased abundances of meso- and especially polyhalobous diatoms suggest that marine conditions became established in the basin of Bliss Lake. A rapid increase in the freshwater diatoms abundance and a respective drop in marine taxa starting from 7,560 cal yr BP mark the lake's isolation from the sea as a result of the glacio-isostatic uplift.

TALK

Breaking news on Ice Age Humans in Northern Russia

Jan Mangerud[1], John Inge Svendsen[1], Herbjørn Presthus Heggen[1], Ludovic Slimak[2], Hugues Plisson[3], Alexis Brugère[4], Pavel Yurievich Pavlov[5]

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We have studied 6 Palaeolithic sites along the western flank of the northern Ural Mountains (Svendsen *et al.*, 2010). The oldest is dated to around 36-35 ^{14}C ka BP and were found in alluvial strata at Mamontovaya Kurya at the Polar Circle. At the Byzovaya site, located at 65ºN and radiocarbon dated to about 29-30 ^{14}C ka BP, more than 300 artefacts and several thousand animal remains, mostly of mammoth, were incorporated in coarse-grained debris-flow deposits, sealed by aeolian sand. Apparently the initial human colonisations along the Ural Mountains took place 40-35 cal ka BP, much earlier than assumed some few years ago.

A pressing question is if these Early Polar Explorers were Modern Humans, Neanderthals or both. An answer is in press in "Science" and will be given in the talk.

References

Svendsen, J. I., Heggen, H., Hufthammer, A. K., Mangerud, J., Pavlov, P. & Roebroeks, W. 2010: Geo-archaeological investigations of Palaeolithic sites along the Ural Mountains - On the northern presence of humans during the last Ice Age. *Quaternary Science Reviews29*, 3138-3156.

TALK

Specificity of vegetative dynamic of northern islands during Holocene

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Terrestrial vegetation of islands of Arctic Ocean is very good characteristic for extreme palaeoclimatic, tectonic conditions and sea level changes. We have pollen data from lakes of the Solovki Archipelago in the White Sea and New Siberian Archipelago between the Laptev Sea and the East Siberian Sea. We have pollen data from sediments from small lakes of the Big Solovetsky Island. At the New Siberian Islands we analyze pollen data from lakes sediments (and other archives). On these islands we have compared vegetation development in the Holocene with vegetation development on adjoining continents at the same time. We found out that distinctions connected with feature of an environment development at limited territory of islands are revealed.

Our researches showed, that on change of vegetation in the northern islands is influenced only the global changes: global changes of the climate, a sea level maxima and large tectonic movements. Accordingly, we can reconstruct environment changes at global level by restoring of vegetation dynamics in the northern islands.

The study is supported by the Russian Foundation for Basic Research (N10-05-00651-a).

POSTER

Mg/Ca paleotemperature reconstructions of Atlantic Water advected to the European subarctic and arctic margins the past 14.000 cal yr B.P.

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Foraminiferal Mg/Ca-ratios have proven to be valuable proxies for reconstructing past water temperatures and salinities especially in subtropical to tropical regions. However, recent studies have expanded the temperature range of the proxy to include subarctic and arctic environments. In this study we aim to reconstruct the temperatures of the inflowing Atlantic Water mass on the European arctic and subarctic margins from late glacial to the present using Mg/Ca-ratios measured on planktic and benthic foraminiferal tests. The Atlantic Water is carried towards the Arctic by the North Atlantic Current and its meriodinal extension the West Spitsbergen Current. Both currents are important components of the meridional overturning circulation system of the North Atlantic. Furthermore, these currents contribute to the relatively milder climate along their paths.

The subarctic paleorecord is based on two adjacent cores from ca. 500 m water depth in the Andfjorden, North Norway covering an Allerød - present sequence constrained by 15 AMS datings. SiZer analysis indicates variable chilled bottom water temperatures during Allerød and Younger Dryas, before a significant multistep temperature increase mark the onset of the Holocene. Stable relatively high temperatures prevail throughout the Holocene with a significant but modest decline at around 3.500 cal yr B.P.

The arctic paleorecord is based a core from ca. 1500 m water depth on the West Spitsbergen slope. The corecovers an Allerød - present sequence constrained by 13 AMS datings. SiZer analysis indicates no significant sea surface temperatures (SSTs) during the Late Glacial/Holocene boundary presumably linked to prevailing severe sea ice conditions and melt water influence in the area. Significant SST decline is observed from the early Holocene to ca. 6.000 cal yr B.P. SST remain remains low and stable until ca. 3000 cal yr B.P. after which a significant temperature increase initiates and continues toward the present.

POSTER

Warm or Cold? Ecological signals of a Plio - Pleistocene pollen and dinoflagellate cyst record from the Tjörnes section (northern Iceland)

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The Pliocene and Pleistocene sediments preserved in the cliffs on the TjörnesPeninsula (northern Iceland) give a unique insight in the changing biotic life during a major cooling period. The marginal marine deposits at Tjörnes preserved as well terrestrial signals (pollen, spores, plant macroremains) as marine signals (ostracods, molluscs, foraminifers, dinoflagellate cysts). Analysis of organic-walled palynomorphs such as pollen/spores and dinoflagellate cysts bypasses problems such as decalcification and saturation by silica. A simultaneous research on both proxies was thus possible throughout the whole Tjörnes beds and four selected interglacial periods of the Pleistocene Breidavík Group (Hörgi Formation, Fossgil Member, Svarthamar Member and Torfhóll Member). The Pliocene Tjörnes beds archived a rather warm environment, while the onset of the glaciations at the beginning of the Quaternary is recorded in the superjacent Breidavík Group.

Based on the presence of thermophilic and non-thermophilic dinoflagellate cysts, a reconstruction was made of the surface water temperature variation. The dominance of warm water species such as *Barssidinium pliocenicum*, *Echinidinium euaxum*, *Operculodinium centrocarpum s.s.* and *Tuberculodinium vancampoae* is indicative for a rather warm environment during deposition of the entire Tjörnes beds ánd the Hörgi Formation. *Filisphaera filifera* and *Habibacysta tectata*, both cold water species, are nevertheless present in the Tjörnes beds in lower abundances. The latter species is recorded in the oldest Tapes and Mactra Zones but is absent in the superjacent Serripes Zone, while *Filisphaera* species are recorded only in the Serripes Zone. The decrease in water depth in this zone (evolution to an estuarine environment) might also play a role. From the Svarthamar Member on, a gradual cooling is observed. Abundances of thermophilic species such as *Lingulodinium machaerophorum* and *Operculodinium centrocarpum s.s.* decrease and abundances of cold water species such as cysts of *Penthapharsidinium dalei*, *Bitectatodinium tepikiense*, *Islandinium minutum*, *Spiniferites elongatus* increase. A dinoflagellate cyst assemblage comparable to the present-day situation is found from the upper part of the Svarthamar Member onwards.

The pollen also indicate a clearly warmer climate compared to the present day situation during the deposition of the Tjörnes beds, Hörgi Formation and the Svarthamar Member. Within these deposits, warmth demanding taxa as *Ilex*, *Quercus*, *Tilia*, *Sambucus*, *Viscum album*, *Castanea*, *Juglans* and *Acer* are recorded. An impoverished assemblage is observed in the Thorfhóll Member with *Pinus*, *Alnus* and *Betula* as the most important tree taxa, together with *Cyperaceae* and *Poaceae* as the dominant herbs, and spore plants.

TALK

Northern migration through the Bering Strait during Zanclean times: evidence from dinoflagellate cyst biostratigraphy in Tjörnes (northern Iceland)

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The Plio-Pleistocene sections of the Tjörnes peninsula in northern Iceland present a unique sequence in which near-shore and terrestrial deposits alternate with lava flows. This centrally located outcrop plays an important role in the correlation of climate signals from eastern and western Atlantic sections.A robust age model for the entire Tjörnes sequence was not available up to now.

A palynological analysis with marine palynomorphs (mainly dinoflagellate cysts) of 68 samples from the Tjörnes beds and 20 samples from the superjacent Breidavík Group was carried out in order to refine the age model of the Tjörnes sequence independent of the available K/Ar ages (Verhoeven et al., in press). The dinoflagellate cyst biostratigraphy of the Tjörnes beds holds a Pliocene palynoflora what indicates most probably a post-Miocene age for the base of the Tjörnes beds. Both *Operculodinium tegillatum* and *Batiacasphaera minuta*, which have a well defined highest occurrence near the top of the Zanclean at c. 3.8 Ma, are present in the sequence until halfway the Serripes Zone. *Reticulatosphaera actinocoronata*, with a highest occurrence around 4.4 Ma, is recorded *in situ* at the base of the Serripes Zone. An age model has been constructed based on a revised correlation of the available palaeomagnetic polarity data according to the presence of biostratigraphical dinoflagellate cyst data within the section. The deposits with a normal polarity observed above the Skeifá lavas in the Serripes Zone are correlated with the Cochita Subchron (4.187 – 4.300 Ma), while the sediments with a normal polarity below the Skeifá lavas are correlated with the Nunivak Subchron (4.493 – 4.631 Ma). Based on this correlation, the top of the Serripes Zone is dated c. 4.0 Ma and the base c. 4.5 Ma. The Gilbert/Gauss transition is located between the Tjörnes beds and the Höskuldsvík lavas and the Gauss/Matuyama transition between the Furuvík and Hörgi Formation. The exact position of both reversals are not preserved as two appreciable hiatuses of 0.40/0.50 Ma and 0.7 Ma occur at these locations.

According to the new age model, the invasion of Pacific molluscs at the base of the Serripes Zone took place before 3.8 Ma. In combination with the palaeopolarity data, this invasion can be placed immediately below the top of the Nunivak Subchron (4.493 Ma) at c. 4.5 Ma. This ecological event fits well with other changes observed in the Northern Hemisphere ocean circulation between 4.7 and 4.2 Ma and was caused by the shoaling of the Central American seaway (Haug and Tiedeman, 1998; Haug et al., 2001; Steph et al., 2006). During this period sea level remained c. 20 m higher than today (Miller et al., 2005), facilitating a doubling of the Arctic though-flow in the Bering Strait (Sarnthein et al., 2009) from the direction of the Pacific over the Arctic into the Atlantic.

References

Haug, G.H., Tiedeman, R., 1998. Effect of the formation of the Isthmus of Panama on Atlantic Ocean thermohaline circulation. Nature 393, 673–676.

Haug, G.H., Tiedeman, R., Zahn, R., Ravelo, A.C., 2001. Role of Panama uplift on oceanic freshwater balance. Geology 29 (3), 207–210.

Miller, K. G., Kominz, M.A., Browning, J.V., Wright, J.D., Mountain, G.S., Katz, M.E., Sugarman, P.J., Cramer, B.S., Christie-Blick, N., Pekar, S.F., 2005. The phanerozoic record of global sea-level change. Science 310 (5752), 1293–1298.

Sarnthein, M., Bartoli, G., Prange, M., Schmittner, A., Schneider, B., Weinelt, M., Andersen, N., Garbe-Schönberg, D., 2009. Mid-Pliocene shifts in ocean overturning circulation and the onset of Quaternary-style climates. Climate of the Past 5, 269–283.

Steph, S., Tiedeman, R., Prange, M., Groeneveld, J., Nürnberg, D., Reuning, L., Schulz, M., Haug, G., 2006. Changes in Caribbean surface hydrography during the Pliocene shoaling of the Central American Seaway. Paleoceanography 21 (4) , PA4221, doi: 10.1029/2004PA001092

Verhoeven, K., Louwye, S., Eiríksson, J. & De Schepper S. (in press). A new age model for the Early Pliocene Tjörnes beds (Iceland) and its palaeoceanographic implications. Palaeogeography, Palaeoclimatology, Palaeoecology.

POSTER

The APEX-related RINK project in Greenland in 2010 and 2011 – a report

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In the summer of 2010 one group (5 persons/1 month) worked in the interior of the extensively ramified Nuuk Fjord system. Five lakes were cored. Some of these were "threshold lakes", which were cored for their signal of nearby glacier retreat and advance. The three others were cored for their Holocene organic sediments as part of our research into sedDNA and, combined with geochemical parameters, its use as climatic and environmental proxy. Among these lakes was Johs Iversen Sø, one of the most extensively investigated lakes in Greenland. The field work also comprised a revision of the deglaciation history of this area, using exposure samples from large valley systems in this area of alpine and heavily dissected topography, and OSL dating of large deglacial sediment accumulations.

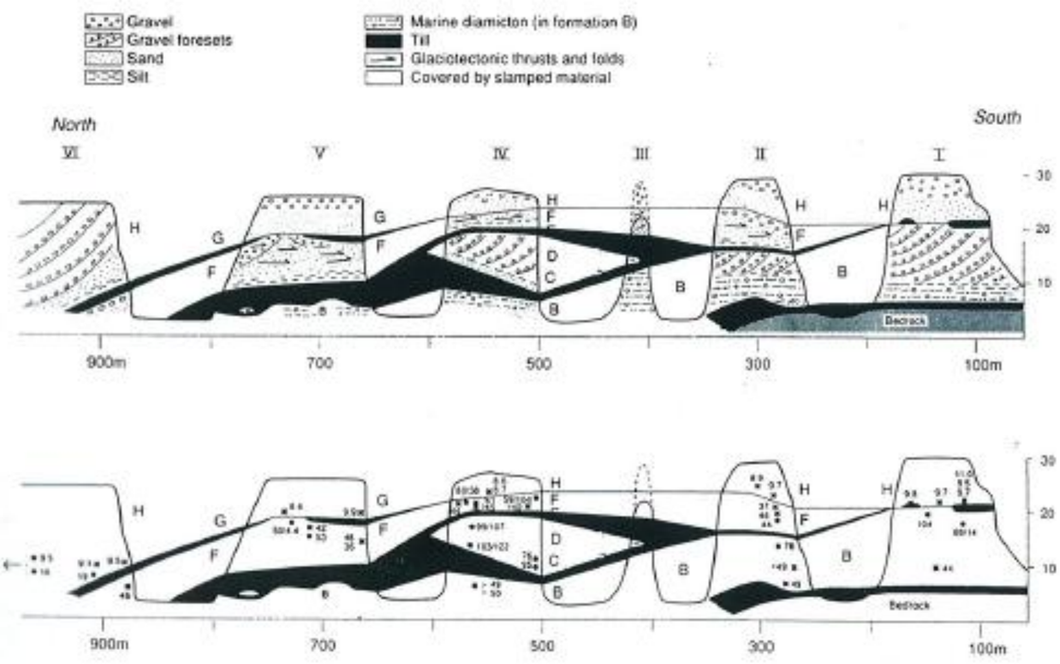
Another group (2 persons/3 weeks) worked along the same lines in Sermilik Fjord in south-east Greenland, – coring 2 lakes and collecting exposure samples. However, here a main activity was to make photogrammetry of glacier fronts, which were investigated during the past Geophysical years in 1933 and 1956. Finally, a suite of exposure samples was collected in the Upernavik area (1 person/1 week) in connection with ongoing geophysical work.

For 2011 a roster of scattered RINK-activities is planned: a continuation of field work in the Sermilik area, south-east Greenland (3 persons/2 weeks), lake coring at Jakobshavn in connection with ongoing geophysical investigations (1 person/1week), lake coring and remote sensing of types of periglacial terrain surfaces on Disko island (2 persons/2 weeks) in connection with ongoing studies of permafrost and a student course, and, finally, glacier-photogrammetry in the Upernavik area in connection with ongoing geophysical studies (1 person/1 week).

Kapp Ekholm: stratigraphy and glacial history

Ólafur Ingólfsson, University of Iceland and UNIS

The Kapp Ekholm sections are situated in the bay between Kapp Ekholm and Phantomodden in Billefjorden, an inner branch of Isfjorden. The site is located 14 km from the fjord head, which is occupied by the large outlet glacier Nordenskiøldbreen, and one km south of the present delta from Mathiesondalen. The Kapp Ekholm coastal sections are about 30 m high and 1 km long. They are the only known site in the inner fjords of central part of Spitsbergen where several till beds occur, interstratified with marine sediments.

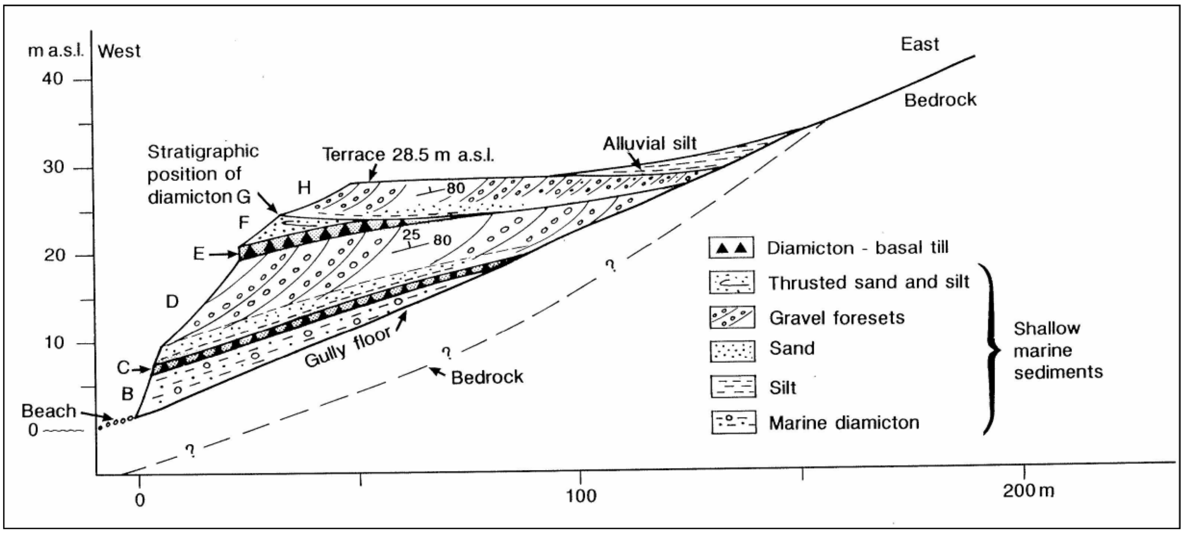


Lithostratigraphic division of the Kapp Ekholm sections and correlations between outcrops. From Mangerud & Svendsen (1992).

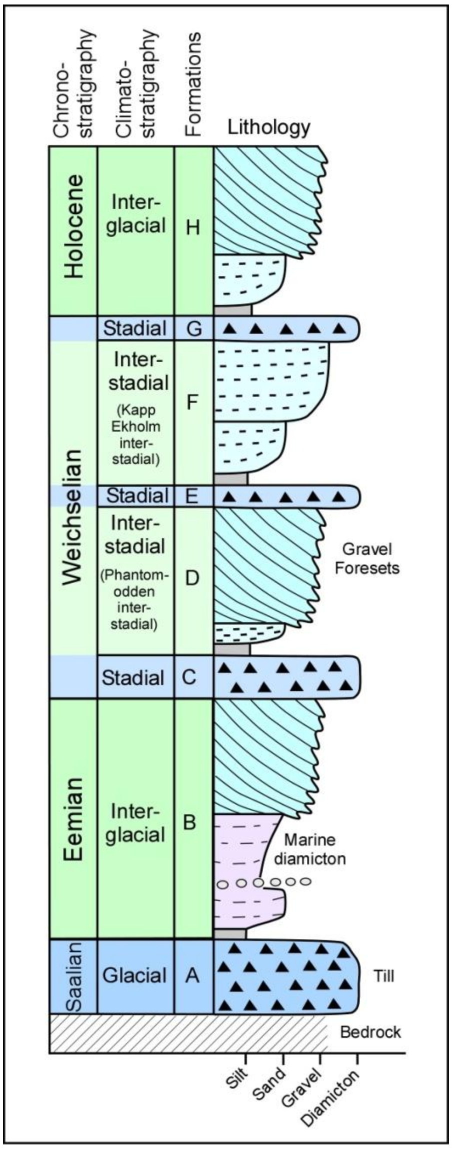
Stratigraphy - According to Mangerud & Svendsen (1992) the Kapp Ekholm succession is composed of four sedimentary cycles, each consisting of a diamicton overlain by a coarsening-upward sequence of glacial and marine sediments. By analogy with the Holocene cycle, each coarsening-upward sequence is considered to reflect regression caused by glacio-isostatic uplift after the preceding glaciation. In each cycle, the lower diamicton is interpreted as a basal till, demonstrating that a glacier overran the site.

The tills are directly overlain by massive glaciomarine silt, generally less than 0.5 m thick and without any evidence of hiatus between the two formations. Paired molluscs, sometimes in living position demonstrate a marine origin. The overlying sandy unit is considerably thicker, and is also more divergent between the different formations. It is usually massive due to bioturbation, but crude bedding does occur.

The lowermost formation A till, overlying striated bedrock and outcropping at section I. Photo: Ó. Ingólfsson, 2004.



A cross section of the stratigraphy at a gully south of section IV. From Mangerud & Svendsen (1992).



Composite stratigraphy of the Kapp Ekholm sections. Modified after Mangerud et al. (1998).

UNIS students mapping formation B, section I. Photo: Ó. Ingólfsson, 2004.

Subfossil molluscs in formation H sediments, section VI in the Kapp Ekholm sections. Photo: A. Wolfe, 2004.

Marine fossils, including molluscs in living position, are more common than in the underlying silt. The extensive bioturbation indicates that the sand was deposited below the wave base. The top of each cycle consists of a thick member of clast supported, rounded gravel forming steeply dipping (15-25^{O}) foresets. The gravel units interfinger with the underlying sand, showing progradation of foreshore sediments into deeper water with sandy bottom sediments. The foresets strike at almost 90^{o} to the present shoreline, and the dip is up-fjord, demonstrating that the gravel was deposited by longshore drift.

Studying formation C diamicton in the Kapp Ekholm sections. Photo: J. Landvik, 2004.

Paleoenvironments and age - Fossil shells of *Mytilus edulis* (common blue mussel) have been found in the formation B. This species requires warmer water than at present in the area, but lived around Svalbard during the Holocene climatic optimum. The inference is that formation B is of interglacial status, either the last (the Eemian, corresponding to Isotope Stage 5e in the deep-sea record) or an older interglacial. Mangerud & Svendsen (1992) and Mangerud *et al*. (1998) concluded that formation B was of Eemian age. They published a number of luminescence dates that cluster around the age of the Eemian. Forman (1999) dated the formation B sediments using the IRSL method and concluded they were closer to 200 ka old.

It is interesting to note that even though *Mytilus edulis* indicates that sea surface temperatures were warmer than at present during the deposition of formation B, it is so far the only 'extralimital' species recorded. In sediments from the Holocene climatic optimum on Svalbard a much more diverse fauna have been found, including the warmth-demanding species of *Zirphea crispate* (oval piddock), *Modiolus modiolus* (horse mussel) and *Arctica is1andica* (Iceland cyprine). It therefore appears that while the interglacial B was generally warmer than present, it was cooler than during the Holocene climatic optimum on western Spitsbergen.

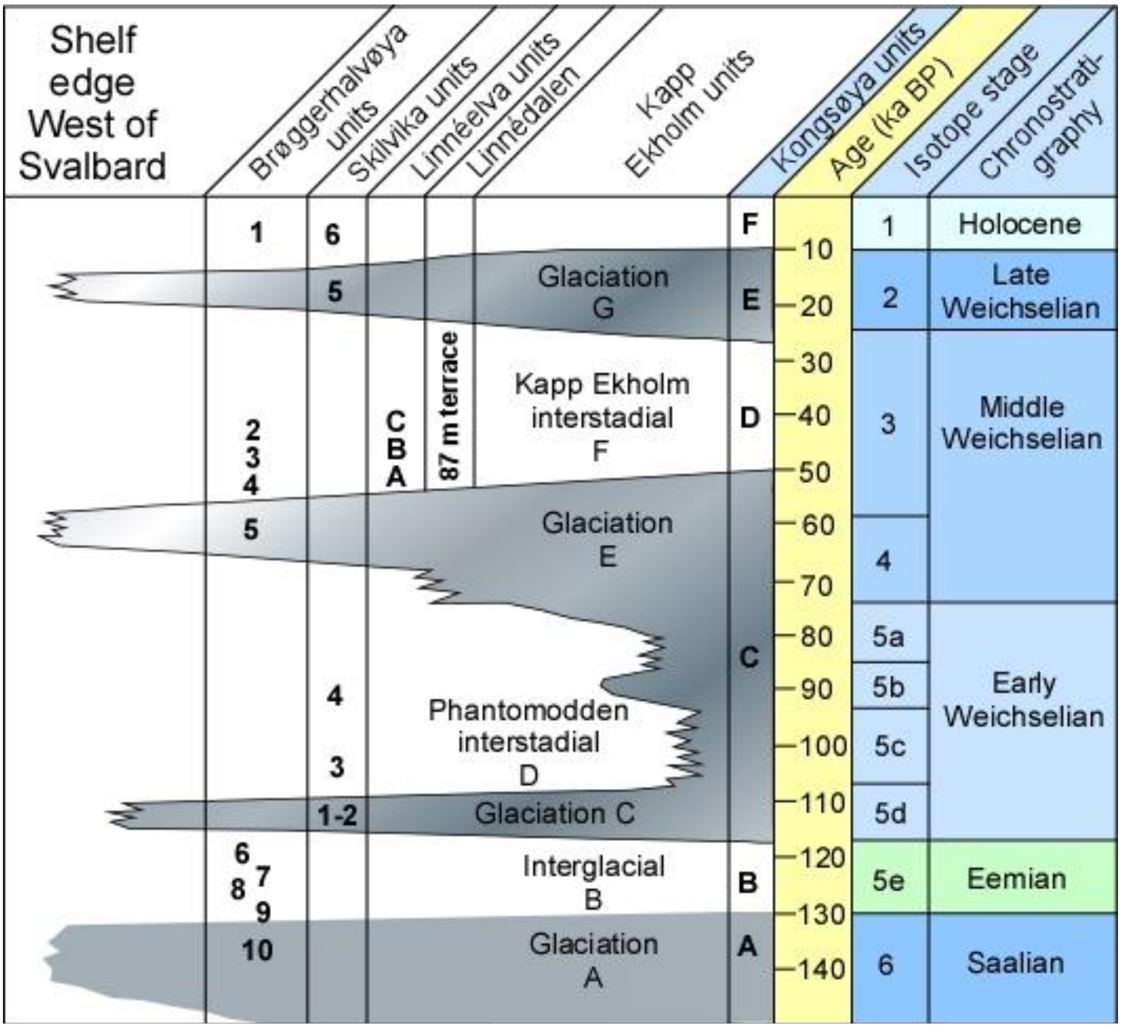
The succeeding ice free period, represented by formation D in the sections, is the Phantomodden interstadial. The amino acid D/L ratios from this formation overlap within one standard deviation with the ratios for interglacial. Mangerud & Svendsen (1992) take this to mean that the intervening glaciation (represented by formation C-till) was short-lived. They find an Early Weichselian age supported by the TL and OSL dates. This interstadial deposit is characterized by a low-diversity fauna indicating restricted circulation in the fjord. Forman (1999) did not date the formation D/Phantomodden sediments.

Students mapping the lower boundary of formation F, section IV in the Kapp Ekholm coastal cliffs. Photo: Ó. Ingólfsson, 2004.

The youngest pre-Holocene ice-free period recognized in the sections is represented by formation F, and called the Kapp Ekholm interstadial by Mangerud & Svendsen (1992). Amino acid D/L ratios, supported by luminescence dates, show that this interstadial is considerably younger than the Phantomodden interstadial and interglacial B. Eight radiocarbon dates yielded finite ages of 40-50 ka BP, close to the limit of the method. Most of the luminescence dates yielded ages between 40 and 70 ka. Mangerud *et al.* concluded that the age of the marine phase of the Kapp Ekholm interstadial is 40-60 ka. Forman’s (1999) IRSL dates from formation F suggest somewhat older age for the interstadial, 70±10 ka BP.

The Kapp Ekholm interstadial sediments contain a relatively rich mollusc fauna, including the subarctic species *Chlamys islandica* (Iceland scallop) and *Trophon truncatus* (bobtail trophon) suggest advection of Atlantic water to Spitsbergen. Large bones of a Greenland whale *(Balaena mysticus)* and seaweed also indicate seasonally open water in Billefjorden during the deposition of formation F.

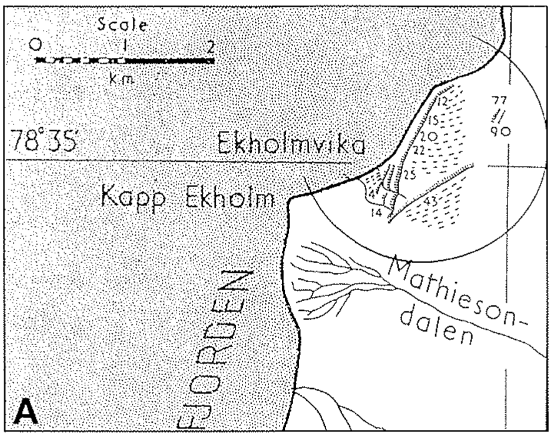
Glacial history - Mangerud & Svendsen (1992) and Mangerud *et al*. (1998) presented a synthesis for the Late Quaternary glacial history of Svalbard that relies heavily on the Kapp Ekholm event stratigraphy. Despite doubts expressed by Forman (1999) as to their chronology of the Kapp Ekholm glacial and marine events, their glaciation curve remains the most broadly cited overview.



Glaciation curve for Svalbard. Modified after Mangerud et al. (1998).

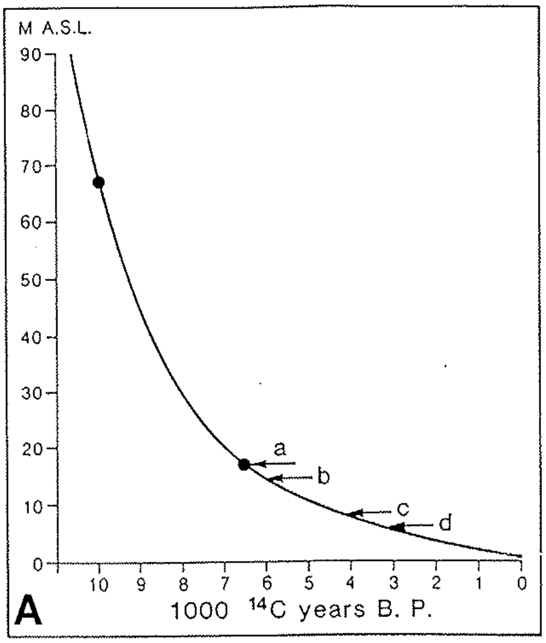
The four marine formations (B, D, F and H) demonstrate that during interglacial B, the Phantomodden interstadial, the Kapp Ekholm interstadial and the Holocene, glaciers in Billefjorden extended not much beyond the terminal zone of the present tidewater glacier. For these ice free periods Mangerud & Svendsen (1992) concluded that glacier extent on western Svalbard was not much larger than at present, perhaps similar or smaller.

The diamictons, interpreted by Mangerud & Svendsen (1992) as basal tills, suggest that the Kapp Ekholm site was overrun by a glacier between the marine episodes. The coarsening-upward sequence on top of each till indicates glacio-isostatic rebound so large that it has to reflect a regional ice sheet glaciation and not only an advance of the local fjord glacier.



Map of raised beaches in Ekholmvika. From Feyling-Hanssen (1955).

The surface behind the Kapp Ekholm sections is a levelled Holocene marine terrace. View towards Kapp Ekholm. Photo: A. Wolfe, 2004.



Relative sea level curve for the inner Isfjorden area. It is constrained by ^{14}C dates and pumice levels. From Salvigsen (1984).

The highest sea-level, which would provide a first approximation of the ice load, cannot be accurately determined for the different marine episodes. The Holocene marine limit above Kapp Ekholm is obscured by scree and solifluction lobes and can only be bracketed between 65-90 m a.s.1.

Kapp Ekholm: problems and potentials – There are a number of aspects to the Kapp Ekholm stratigraphy that could be studied in more details:

- The diamictons in the sequence (formations A, C, E and G) have yet to be thoroughly studied. Sedimentological and structural data supporting that they are true lodgement tills have yet to be presented.
- The correlation of units between sections along the cliff exposure is problematic. This is particularly true for correlations between sections III, IV and V.
- Mangerud & Svendsen (1992) recognized glaciotectonic disturbances in the sections, and mapped thrust planes and folds in formation F, below the formation G till. There is a lack of structural data describing those glaciotectonic deformations.
- There is a discrepancy between the chronologies of Mangerud *et al*. (1998) and Forman (1999). Future developments in dating methods might be able to resolve if interglacial B is of last interglacial (Eemian) age or older, and constrain better the age of the Phantomodden interstadial deposits.

Important references

Feyling-Hanssen, R.W. 1955: Stratigraphy of the marine Late-Pleistocene of Billefjorden, Vestspitsbergen. *Norsk Polarinstitutt Skrifter 107*, 1-186.

Forman, S.L. 1999: Infrared and Red Stimulated Luminescence Dating of Late Quaternary nearshore sediments from Spitsbergen, Svalbard. *Arctic, Antarctic and Alpine Research 31*, 34-49.

Mangerud, J. & Salvigsen, O. 1984: The Kapp Ekholm section, Billefjorden, Spitsbergen: a discussion. *Boreas 13*, 155-158.

Mangerud, J. & Svendsen, J.I. 1992: The last interglacial-glacial period on Spitsbergen, Svalbard. *Quaternary Science Reviews 11*, 633-664.

Mangerud J., Dokken T.M., Hebbeln D., Heggen B., Ingólfsson Ó., Landvik J.Y., Mejdahl V., Svendsen J.I. & Vorren T.O. 1998: Fluctuations of the Svalbard-Barents Sea Ice Sheet the last 150,000 years. *Quaternary Science Reviews 17*, 11-42.

Salvigsen, O. 1984: Occurrence of pumice on raised beaches and Holocene shoreline displacement in the inner Isfjorden area, Svalbard. *Polar Research 2.*, 107-113.