

## Abstracts SWEDARCTIC 2010

### Taymyr Peninsula:

#### Circum-Arctic Tectonic Evolution and Orogeny

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This project is concerned with understanding the tectonic evolution of the circum-Arctic region, in general, and of the Amerasian Basin, in particular. The latter has important implications for the development of Earth's modern global climate system. Changes in the tectonic development of the Amerasian Basin should be reflected in the depositional record. These changes can be documented using provenance analysis of sediments deposited before, during, and after the opening of the basin. Provenance analysis will include high-spatial resolution, in-situ measurements of uranium, lead, oxygen and hafnium isotopes of detrital zircon populations. The recognition of specific age profiles and petrogenetic discriminants should permit correlation of terranes and sediment source(s), and constrain the relative timing and tectonic setting of the sedimentary depositional environment. In addition, results will be integrated with those from other regions via our Circum-Arctic Sediment Provenance database, allowing us to synthesize an integrated regional model for the opening of the Amerasian Basin.

#### Taymyr Revisited – A Quest for Former Eurasian Ice Sheets Margins and Mega-Fauna Extinction during the Last Glacial Cycles

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A new paradigm has evolved concerning the growth and decay of Eurasian Ice Sheet(s) during the QUEEN work in Arctic Russia (Svendsen et al. 2004): there is an apparent phase-antiphase behaviour with maximum ice sheet extent in the east during the early phase of a full glacial cycle, whereas maximum in the west comes late in a full glacial cycle. This has been shown for the last glacial, the Weichselian, but we know nothing of such patterns during earlier glaciations, e.g. during the penultimate glaciation, the Saalian. Another recent paradigm shift is our understanding on how large ice sheets grow on shallow shelf areas in the Arctic North (e.g. Möller et al. 2006) and how they grow to previously unbelievable sizes, as during the Saalian when ice was grounded at water depths in excess of 1000 m on the Lomonosov Ridge in the Arctic Basin (Jakobsson et al. 2001, 2008) and caused crust deflection so large that shore-lines on Severnaya Zemlya, just 200 km from the shelf break, were isostatically lifted to altitudes of about 140 m a.s.l. (Möller et al. 2006). However, knowledge from the marine-based sides of Kara and Barents Sea subsheets must be balanced with data from the terrestrial margins to be able to do proper ice sheet modelling of a Pan-Arctic ice sheet in the Saalian as re-proposed recently by Jakobsson et al. (2008). Then we must also know (which we do not today):

- spatial and temporal relations of former ice sheet marginal zones in terrestrial Arctic Siberia,
- which marginal zones represent terminal zones contrary to recessional zones for different ice expansion phases, and
- near-frontal ice sheet dynamics.

This project thus aims at resolving the spatial and temporal distribution of Kara Sea-based terrestrial ice sheet margins, research that is critical for making N-S and E-W correlations and modelling of Eurasian Ice Sheets over time. When examining the sedimentary archives, samples will also be taken for unravelling environmental change in Late Pleistocene to Holocene flora and fauna. We have recently shown that mitochondrial and chloroplast DNA from past plants and animals (including mammoth, bison, horse, and muskoxen) can be directly obtained from less than 2 grams of perennially-frozen sediments up to ca. 450 Kyr in age, even in the absence any macrofossils (Willerslev et al. 2003, 2007). Due to the huge number of such sequences in GenBank coupled with our involvement in a large-scale sequencing project of Arctic plant taxa, the majority of the sediment DNA (sedaDNA) sequences can be securely identified to species level (Taberlet et al. 2007). The sedaDNA appears to originate from locally deposited tissue such as fine rootlets, seeds, feces, shed skin and hair that has disintegrated over time (Lydolph et al. 2005) and has been found to be of local origin (Haile et al. 2007). Additionally, it has been shown that DNA leaching between layers are insignificant as long as the sediments has remained frozen (Hansen et al. 2006) making it possible to obtain ages for the DNA through direct dating of the sediments. The new approach makes it possible to monitor changes in species and population composition through time, even when no visible biological material is present (Willerslev & Cooper 2005). As an example, based on such technique we have found preliminary evidence for woolly mammoth survival on the Taymyr Peninsula up to 6,000 years later than is indicated from the presence of macrofossils, challenging established theories on causes for megafauna extinction (Haile et al., in review). Establishing "last" appearance dates for megafauna and potential vegetation change around times of extinction is intended to run parallel with the work on glacial geology, the latter being essential for the environmental interpretation of the sediments being host for the sedaDNA. We believe that this research will lead to giant steps forward in our understanding of the Late Quaternary megafauna "mass" extinction.

#### Consequences of Climate Change on the Demography and Evolution of Arctic Lemmings

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The Pleistocene fluctuations in climate are believed to have resulted in increased rates of faunal turnover, population divergence and adaptation. However, the importance of the glacial cycles for the speciation and extinction processes is still debated. Until recently, our understanding of the interaction between past climate change and species evolution was based on methods with significant, recognised limitations. Palaeontological methods are typically unable to identify skeletal remains below the species level, while phylogeography is constrained by the need to infer past events, making it difficult to identify complex series of extinctions, replacements and bottlenecks. This project aims to circumvent these limitations by analysing ancient DNA from Late Pleistocene lemming fossils. The resulting genetic data will be integrated with information on past distributions and climates, as well as back-casted species distribution models. This will allow me to examine i) the timing of extinctions and demographic change in relation to past climate fluctuations, ii) where and when populations diverged and species evolved, and iii) whether local populations became extinct, moved or adapted when faced with climate change. The results from this project will help increase our knowledge of how habitat change drives the speciation and extinction processes, and can increase the accuracy of models forecasting the impact of future climate change on biodiversity.

Greenland:

## RINK (Respons af Indlandsisen til Naturlige Klimaændringer)

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Giant ice-shelves drifting away, melting glaciers revealing unknown coastlines, the sea ice diminishing year after year – according to the mass media this is the Arctic that coming human generations will experience as rapid global climate changes progress. However, these predictions are mostly based on forward modeling of events that have taken place within the last 30 years where satellite surveillance and submarines monitor the annual trend in the Arctic Ocean. We ask: what was the situation in the past? Thirty years of knowledge is not very long and what are the natural variation of sensitive factors like the sea-ice extent and the frontal changes of the Greenland Ice Sheet along the coast?

The RINK (Respons af Indlandsisen til Naturlige Klimaændringer) project will investigate how the ice margin reacted to earlier periods of warming, the interrelationship between sea-ice and sea-level changes and not at least how it has effected human adaptation and migration. Even though the interior of the Greenland Ice Sheet contains the largest mass, it is local climatic and topographical conditions that control the discharge of ice – and therefore the intensity of response to climatic change. RINK pursue a better understanding of the ice marginal dynamic, i.e. in what way and how fast the ice sheet retreated and thinned over timescales of 100–200 years and even up to 1000–3000 years. Raised coastal landforms will indicate if open water or permanent sea-ice prevailed along the coasts, thus enabling a new understanding of the sustainability of palaeoeskimos that once lived in Greenland's most inhospitable regions. Finally, by applying 3D-visualisation we propose to illustrate the evolution of ice free land and the ice marginal zone through time, and to enhance public understanding of the complex geological processes behind changes of the Greenland Ice sheet during the last 10,000 years.

## Spitsbergen:

### LASHIPA – Large Scale Historical Exploitation of Polar Areas

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LASHIPA 9 is a part of the data collection for the historical-archaeological research project LASHIPA (Large Scale Historical Exploitation of Polar Areas). The objective of the expedition is to collect archaeological data from British mining- and prospecting camps from the early 19th century on Spitsbergen. LASHIPA is a research project within the framework of the International Polar Year 2007–2008. The project objectives are to explain the development of industry in the polar areas from the 16th century until today and the consequences of that development for the geopolitical situation and the natural environment there. In LASHIPA, university departments and research institutes in Sweden, the Netherlands, USA, Russia, Norway and Great Britain cooperate and seek explanations and understandings from an international comparative perspective. The project deals with research problems concerning a) the driving forces behind industrial development in the polar areas, b) the transfer of technology and community planning to polar environments, c) international competition over natural resources and d) international competition for national influence over polar no-mans lands. LASHIPA 9 will operate in Bellsund, Van Mijenfjorden, Van Keulenfjorden, Reserchefjorden, Hornsund and Hedgehogfjellet (Spitsbergen east coast). The field work consists of documentation of surface remains using: a) total station, b) GPS-PDA, c) digital camera, d) tape measurement and drawings and 4) description.