In : Lee, Jeffrey A. and Zobeck, Ted M., 2002, Proceedings of ICAR5/GCTE-SEN Joint Conference, International Center for Arid and Semiarid Lands Studies, Texas Tech University, Lubbock, Texas, USA Publication 02-2 p. 395

Subarctic aeolian reactivity in northern Finnish Lapland : a 10 ka year record

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Introduction

Two post-glacial dune fields have been studied in the subarctic Finnish Lapland. Study areas are situated just below and beyond the Scots pine (Pinus sylvestris) forest limit. These dune fields were originally formed shortly after deglaciation along the same esker chain, which runs from Muddusjärvi dune field to northeast towards Iijärvi dune area in northern Finnish Lapland. The dune fields are situated 70 km apart. Aeolian activity has been reported widely in subarctic and arctic environments: in Alaska (e.g. Koster & Dijkmans 1988), Canada (e.g. Filion 1984, 1987; Filion et al. 1991), Greenland (e.g. Dijkmans 1990), Iceland (e.g. Arnalds 1990), and Fennoscandia (e.g. Bergqvist 1981, Seppälä 1995, Käyhkö 1997, Kotilainen 1991). Aeolian landforms are known to be sensitive indicators of environmental changes, especially in cold environments. The aeolian formations are in most cases derived from glaciofluvial or fluvial sediments and the reactivation processes can be related to climate and/or human impact. In this presentation the main focus is the dating of the aeolian reactivation events of these dune fields during the Holocene.

Methods

The stratigraphy of the dunes at both fields was studied with fine resolution sedimentology. In total 55 ^{14}C datings from buried charcoal horizons at dune lee sides were obtained. Dune section was studied in 3 D and the charcoal horizons were carefully revealed by removing the upper sediment layers. Pieces of charcoal were then picked with tweezers from the table. All recent material (e.g. plant roots) was carefully removed from the pieces. Most of the samples were dated using conventional radiocarbon dating at the University of Helsinki Dating laboratory. Four samples were dated using AMS-technique.

Sedimentology and stratigraphy of the sandy units between charcoal horizons were studied and the most important units for dating purposes were determined. Those included sand layers under the lowest charcoal horizon and also between the charcoal horizons as well as layers covering a major erosional plane. The sand units were sampled for TL/OSL –dating using black plastic tube (diameter 10 cm), which was hammered into the dune section. Dating of the 15 TL/OSL -samples was carried out at the University of Helsinki Dating laboratory.

Results

Based on data of ^{14}C datings from buried charcoal horizons on dune lee sides and TL/OSL dates of the aeolian sediments between them, the main periods of aeolian reactivation phases were estimated. The earliest reactivation phase (Phase I) appears to have taken place at around 8400 - 7900 cal years BP. The next dune building phase occurs at around 7300-5800 cal years BP (Phase II). At 4500-3850 cal years BP is Phase III and 3200-2400 cal years BP Phase IV. The last reactivation phase V occurs only at the sparsely vegetated Iijärvi dune field at around 500- cal years BP and is a continuing process.

Conclusions

The dune fields had been colonized by vegetation after the most intensive aeolian period just after deglaciation, and this oldest charcoal horizon represents the average age of this burned down pioneer forest. The second charcoal horizon indicates the average age of the next stabilizing vegetation at the dune field. The period between these charcoal horizons marks the reactivation phase. Forest fires are natural phenomena and do occur frequently throughout the forest history. However, the length of the reactivation phase is a signal of climate and/or human impact on the area.

This earliest aeolian reactivity phase can been compared to rapid environmental changes observed in many proxies around North Atlantic region. The rapid cooling around 8.2 ka has been recorded e.g. in Greenland ice-core proxies (O'Brien et al., 1995), North Atlantic deep-sea sediments (Bond et al., 1997) and lake sediments e.g. in Sweden and Finland (e.g. Korhola et al., 2001). Reactivation of the dune fields might be related to reorganization of the atmospheric and surface ocean circulation over Greenland and North Atlantic. It is possible that this "8.2 ka cooling event" resulted in surface water cooling and decrease in the North Atlantic Current northward transport of surface water causing cooling of the high latitudes. This mechanism might decrease precipitation over the subarctic Fennoscandia and thus trigger the onset of the aeolian reactivation in the region. These results suggest coupled ocean–atmosphere forcing of the whole Holocene aeolian history in the subarctic Finnish Lapland.

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