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Lithogenic sediment on Arctic pack ice: Potential aeolian flux and contribution to deep sea sediments

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Abstract

Potential aeolian input of lithogenic sediment to sea ice and possible contribution from sea ice to sedimentation in Eurasian Arctic deep basins are discussed for modern and glacial environments. Low atmospheric fluxes estimated by previous investigations of snow samples from Amerasian Basin sea ice and the Greenland ice cap indicate that atmospheric deposition from long range sources probably provides only low quantities of lithogenic material to the Eurasian ice surface. Other likely sources for the predominantly fine-grained sediment in the Eurasian Arctic ice are entrained river, nearshore and shelf sediments.

Particles deposited both on the sea ice surface and within the upper ice column will affect ice characteristics. Especially in multiyear ice which experiences extensive surface melting during summer, particles within the melted snow and ice will be concentrated at the ice surface. If particle concentrations are high, the ice surface will become darkened or discolored, changing ice albedo and melting patterns. Sediment may aggregate to form more or less cohesive pellets during repeated freeze-thaw cycles. Implications for deposition from particle-laden sea ice to the sea floor are discussed.

High dust content in Greenland ice formed during the last glacial maximum indicates that at that time atmospheric flux of lithogenic material was much higher than today. Correspondingly large fluxes may be expected to the surface of sea ice during the last glacial maximum.

1. Introduction

Although the occurrence of particle-laden sea ice is often commented on by Arctic investigators (e.g. Nansen, 1897; Clark and Hanson, 1983), its importance remains unknown because its distribution has not been systematically surveyed. During the 1893-1896 FRAM expedition in the eastern Eurasian Basin, Nansen (1897, p.436-7) noted that the "upper surface of the floes is nearly everywhere of a dirty brown colour, or, at least, this sort of ice preponderates, while pure white floes, without any traces of a dirty brown on their surface, are rare..." (July 18, 1894 at approximately 81° 30'N, 125°E). Observations of the ice surface north of Svalbard indicated that as much as 10% of the ice surface may exhibit discolorations from sediments (Drewry, 1986; p. 229). In the Barents Sea, areal coverage of brownish ice was sometimes observed to be as high as 20-30% of a given ice area (Vinje, 1985). Larssen et al. (1987), in their investigation which preferentially sampled particle-laden ice in Fram Strait, found that an average of 20% of total ice volume contained sediment debris. Concentrations of particulate material ranged up to 3 g/l. Particles were predominately fine-grained: 30-60% of the bulk material in particle-laden ice was less than 2 um, with only minor grains coarser than 63 um.

Because much of the sediment in Arctic sea ice is observed to be fine-grained, an obvious source to be considered is aeolian dust (Nansen, 1897). However, fine-grained sediment may be incorporated in sea ice also by other mechanisms. Fine-grained sea floor sediments from shallow continental shelves can be incorporated in sea ice by formation of