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Provenance analysis of central Arctic Ocean sediments: Implications for circum-Arctic ice sheet dynamics and ocean circulation during Late Pleistocene

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ABSTRACT

Mineralogical and geochemical data generated from the well referred shallow core 96/12-1pc on the Lomonosov Ridge, central Arctic Ocean was used to evaluate ice transport from the circum-Arctic sources and variability in sediment drainage and provenance changes. In this study heavy minerals in central Arctic sediments were used to determine those most prominent provenance areas and their changes related to the Late Pleistocene history of glaciations in the Arctic. Provenance changes were then used to infer variations in the paleoceanographic environment of the central Arctic Ocean, such as variations in the distribution of sea ice, icebergs controlled by the Arctic Ocean circulation. Four critical end-members including Victoria and Banks Islands, the Putorana Plateau, the Anabar Shield, and the Verkhoyansk Fold Belt were identified from the Amerasian and Eurasian source areas, and their proportional contributions were estimated in relation to Late Pleistocene ice sheet dynamics and ocean circulation.

The results show changes in transport pathways and source areas within two examined transitions MIS6-5 and MIS4-3. The main source for material during MIS6-5 transition was Amerasian margin due to the high dolomite content in the studied section of sediments inferring strong Beaufort Gyre (BG) and Transpolar Drift (TPD) transport for this material. IRD material during late the MIS6 to 5 deglacial event was from terrigenous input through from the MacKenzie route Banks/Victoria Islands then transported as far as the Lomonosov Ridge area. The transition, MIS4-3 in comparison with MIS6-5, shows a clear shift in source areas, reflected in a different mineralogical composition of sediments, supplied from the Eurasian margin, such as the Anabar Shield, the Putorana Plateau and the Verkhoyansk Fold Belt during active decay of the Barents-Kara Ice Sheet presumable associated with an ice-dammed lake outburst then triggered by a strong TPD over the central Arctic. These two studied deglaciations suggest that contributions of different circum-Arctic sediment sources are related to interaction between ice sheet decay, sea ice production and circulation.

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1. Introduction

Central Arctic Ocean sediments preserve important information on paleoenvironmental conditions in the circum-Arctic region. The physical and chemical properties of central Arctic Ocean sediments have been studied by means of glacial-interglacial variability in lithology (Belov and Lapina, 1961; Clark et al., 1980; Herman, 1974; Phillips and Grantz, 1997), chemistry (Eisenhauer et al., 1994; Spielhagen et al., 1997), and faunal assemblages (Herman, 1974; Jones et al., 1999). Additionally, lithology and geochronology were presented by Jakobsson et al. (2001), Spielhagen et al. (2004), Polyak et al. (2004) and Adler et al. (2009). These studies provided basic reconstructions of ice sheet events in the Arctic Ocean, such as the growth and decay of ice sheets, discussion on ice rafting, sea ice activities, and inputs of freshwater.

Present sedimentation on the central Arctic Ocean ridges is the product of glacial and sea ice activity (Jakobsson et al., 2001; Spielhagen et al., 2004), which means it may also preserve a record of the dynamic evolution of the ice sheets and perennial ice cover of the Arctic Ocean. That is why mineralogical investigation of terrigenous sediment components, including study of coarse

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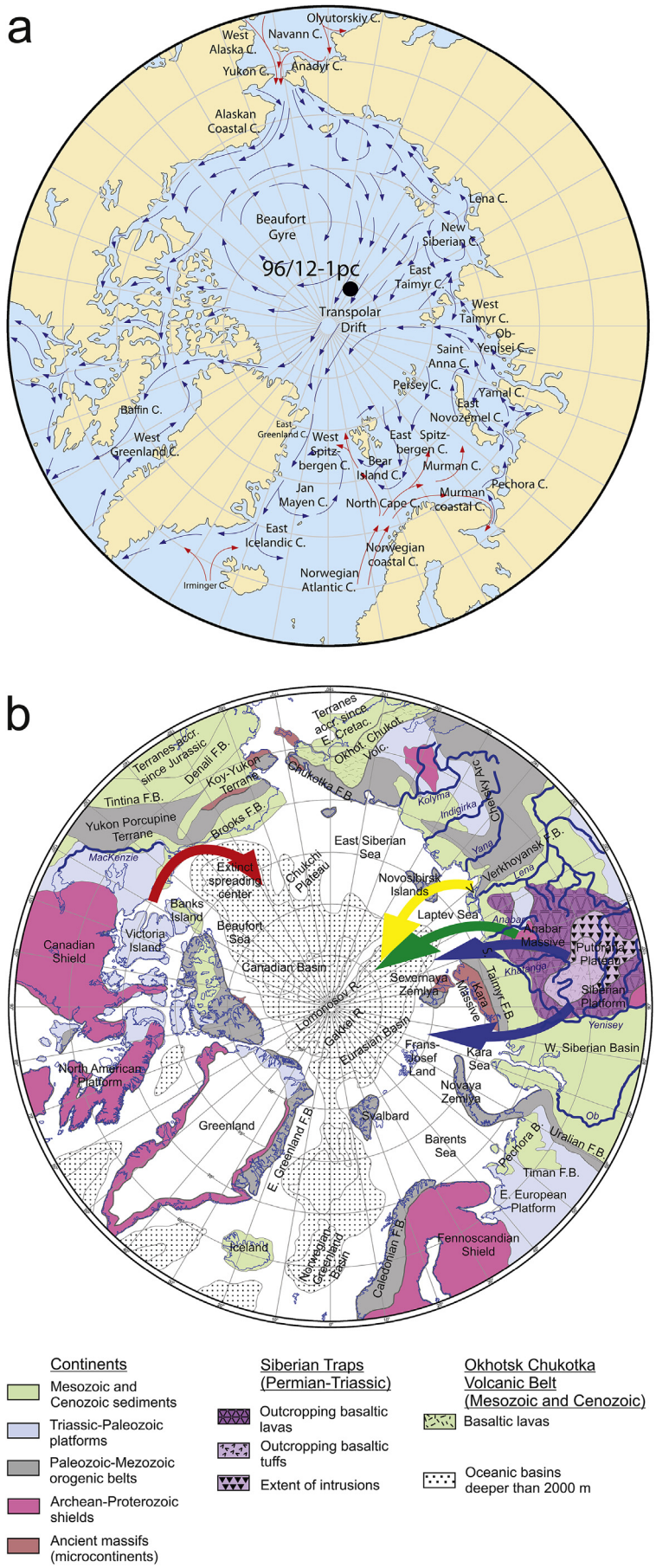

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