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Submarine Permafrost in the Laptev Sea

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There are currently many research studies on the Laptev Sea shelf permafrost distribution and permafrost thickness models. This article presents the results of field research of submarine permafrost in the Khatanga Bay area of the Laptev Sea shelf. The field work was performed in the area of the fast land ice in the Nordvik Bay by a team of experts from Moscow State University, Far Eastern Federal University, and the Arctic Research Centre, and incorporated geocryological drilling, geophysical surveying, and laboratory testing of thawed and frozen monolith rocks. The research was achieved through a combination of activities, such as the drilling of 13 core wells up to a depth of 50 m from the fast land ice of the Nordvik Bay, defining the thermal characteristics of over 300 monoliths from the Khatanga Bay shelf and the electromagnetic sounding of over 1000 holes from the ice of the Nordvik Bay. Our laboratory testing allowed identification of the permafrost roof in the Nordvik Bay and traced the permafrost foundering to a depth of 200 m, as well as an assessment of the distribution of permafrost to a depth of 500 m and modeling of the permafrost thickness dynamics for the next 50 years.

INTRODUCTION

This complex multidisciplinary research project was carried out from the land fast ice in the Nordvik Bay of the Laptev Sea (Fig. 1) in order to study the geocryological conditions of the Khatanga Bay. The primary aim was to obtain and summarize data on the geocryological conditions of the southwestern part of the Laptev Sea, which is required to assess the impact of adverse environmental parameters that occurred during the industrial development of the area. The permafrost-geological structure and cryogenic processes, along with the presence of surface gas, are definitive geotechnical features of the shallow-water areas of the Arctic shelf, accounting and assessment of which are critically important at the first stages of development.

Understanding the geocryological conditions and the rock characteristics of the region are vital for the design and operation of offshore facilities and the planning of other activities in the Laptev Sea.

The authors of this research paper anticipate that the results presented can support further geological exploration and provide useful baseline information for the conceptual design of offshore infrastructure and hydrocarbon transportation systems.

AREA OF RESEARCH

The area is located in the southwestern part of the Laptev Sea and covers most marine areas of the Khatanga, Nordvik, and Anabar bays, as well as the land adjacent to the south. This territory of the Khatanga Bay has had limited geological study, there are no offshore geotechnical wells, and the available bottom sampling data are insufficient to provide information on the engineering and physical properties of soil mass.

The Khatanga Bay extends into the North-Siberian lowland 278 km to the southwest. The bay is shallow (up to 10 m), and water depths in excess of 30 m only occur in some relief depressions. Modern terrigenous sediments are found as inundated and unconsolidated, sometimes high plasticity sediments and admixture of plant detritus brought by the Khatanga and Anabar rivers, with the occasional presence of shell detritus. Mudstone sediments are mainly either shades of brown (yellow, greyish, greenish-brown) or grey (yellowish, greenish, brownish-grey). Sandy sedi-

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