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Physical and Mechanical Characteristics of Sea Ice in the Kara and Laptev Seas

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In the spring period of 2013–2017, the Russian Arctic and Antarctic Research Institute, in cooperation with the Rosneft Oil Company and the Arctic Research Centre, organized four complex expeditions in the Kara and Laptev Seas to study the physical and mechanical properties of sea ice (Fig. 1). Obtained data shows that for level ice with an increase in thickness, its mean temperature, salinity, and density decrease, but mean values of local strength and strength of ice samples at uniaxial compression increase. Failure zones of different intensity developed after the indenter penetration are studied. A range of comparison coefficients for local strength and uniaxial compression strength is updated.

INTRODUCTION

Complex expeditions in the Kara and Laptev Seas were conducted in a period of maximum ice thickness onboard the nuclear icebreaker "Yamal," with an onboard MI-8 helicopter. The main task was to evaluate the sea ice's main physical (temperature, salinity, density, texture) and mechanical properties. Ice structures of different age gradations were studied with both borehole indenters and sample coring. A comparison of strength at the uniaxial compression of cylindrical ice samples drilled parallel to the ice cover surface, with the ice strength in conditions of uniform compression (local strength), was performed.

EXPERIMENT METHODOLOGY

Measurements of ice temperature, salinity, and density, together with texture description, were performed at ice stations on two or more points. Sample coring was made with the core barrel "Kovacs Enterprise" with an internal diameter of 141 mm. Cores for texture analysis were oriented to cardinal directions with a magnetic compass. Taking into account the proximity of coring points, the texture pattern and physical properties of ice were considered as relative to the same ice.

At all stations, ice and snow thickness as well as ice freeboard, air temperature, and temperature at snow/ice boundary were measured. Textural analysis was made based on a study of ice plates 20–30 mm thick. Digital pictures of all plates were taken with a camera, which allowed us to receive high quality photos with a resolution sufficient for further processing.

The size and form of inclusions were analyzed in field conditions, and their origin (primary, secondary, air, salt, organic or mineral) and distribution were described together with ice layer separation. Performed records and received photos were analyzed in the onshore laboratory. Based on the character of inclusions and their special arrangement, a description of ice texture, height and sequence of layer distribution, form and sizes of inclusions, and their changes in the process of thermalmetamorphism was made. Layers of granular and columnar crystalline structure were defined based on the textural pattern. For this purpose, the interconnection of texture (inclusions in the ice) and structure (crystal pattern) described in Cherepanov (1976) was used. This classifi-

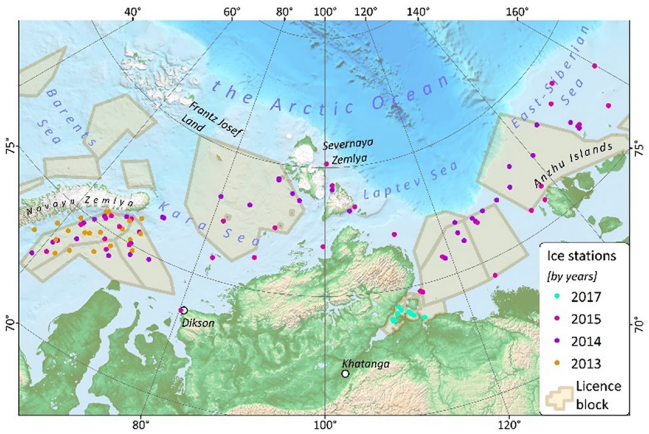

Fig. 1 Area of ice research works

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KEY WORDS: Borehole jack, comparison coefficient, local strength, physical properties, structure, uniaxial compression.