

URAL COAST OF BAYDARATSKAYA BAY, KARA SEA: MASSIVE ICE BEDS AS A FACTOR OF COASTAL DYNAMICS

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The dynamics of typical thermo-abrasion coasts is generally determined by both thermal and wave energy factors. Correspondingly, in the case of open straight coasts with equal wave energy conditions, the differentiation of coastal bluff segments by the rate of their destruction would be a function of cryolithological structure, in particular of the presence of massive ice beds.

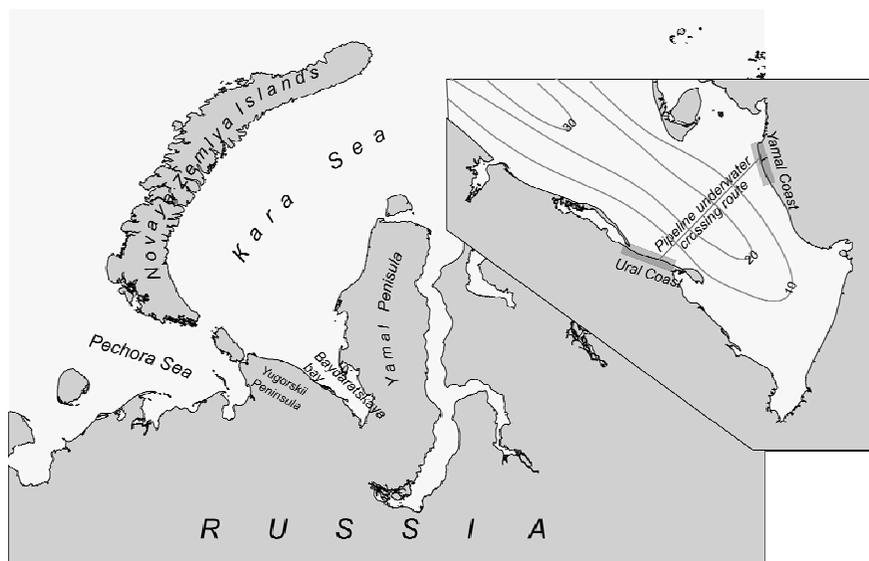


Figure 1. The research area.

Thick massive ice beds are exposed on the Ural Coast of Baydaratskaya Bay, Kara Sea (Fig. 1) to the west of a projected gas pipeline crossing (Fig. 2). They were first found here in 1991. We had an opportunity to investigate them in 2005 and 2006. The massive ice beds are exposed in several places. There the surface with altitudes from 10 to 15 m (in the east part of the research area) and from 20 to 25 m (in the west) comes to the coastline. The extent of massive ice bed exposures reaches up to 80 m along the coast.

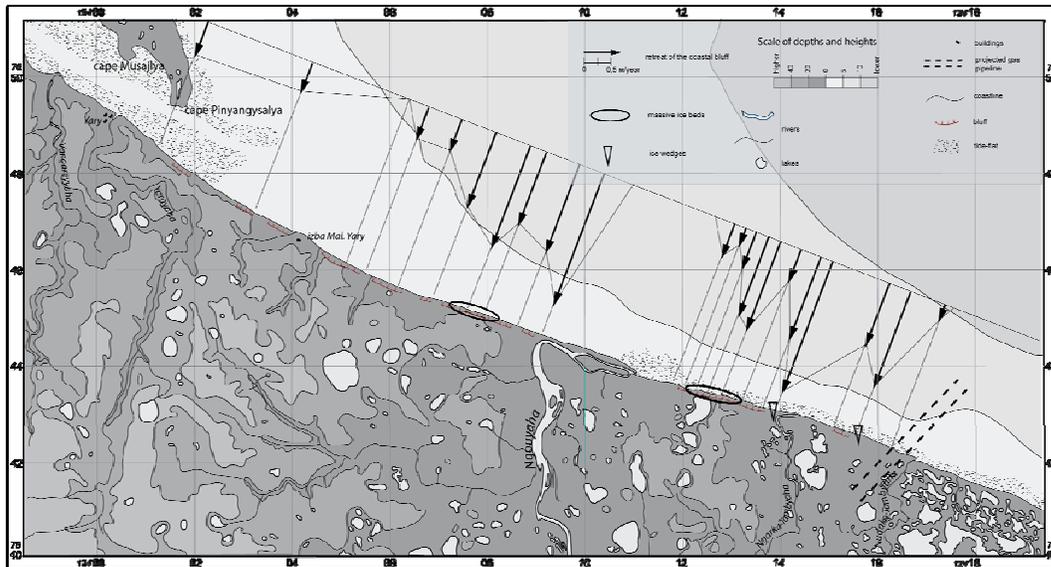


Figure 2. Massive ice bed location and retreat rate of the coastal bluff.

The thickness of the ice beds varies from 1 to 4-7 m (Fig. 3, a). Sediments which contain them are represented mostly by grey sands with minor lenses of gravel, sometimes pebble or loamy sands. Massive ice beds occur mostly as big lenses in different parts of the coastal bluff – in the upper, middle or lower. After storms, ice beds can even form a bench. The ice is laminated, layers are mostly sub-horizontal. Ice includes many sandy and loamy particles, sometimes even gravel and pebble, as dissipated, as in layers. In one place layers with different content of inclusions formed recumbent folds in the massive ice bed. The distribution of inclusions, the same overlying and underlying sediments and other factors point to the united origin of massive ice in the surfaces with different altitudes (10-15 and 20-25 m). However, this origin is not exactly determined. There are a few possible explanations. Among them a version of buried permanent snowbank, small glacier or even a submarine origin. To determine what version is correct samples of ice were taken for isotopic and chemical analysis, ground samples – to determine the type of salinity. Ice structure were described in the field. Most of analyses are being processing now, so we are waiting for the results to talk about massive ice beds origin more confidently.

Massive ice can occupy up to 1/3 of the coastal bluff (Fig. 3, a). Especially under such ice thickness due to massive ice beds thawing and destruction of overlaying sediments form large thermocirques. This process of thermo-abrasion and thermo-denudation destruction affects substantial areas, occupies up to tens metres towards the land. Here, landforms that are almost round in plan with vertical back walls made by massive ice beds and frozen sediments are formed. They thaw intensively in warm periods. Thawed sediments from thermocirques form strong flows to the beach. Then they are removing by waves and alongshore currents. During the short northern summer, the back frozen side of the thermocirque can retreat over several meters. The process goes on until the massive ice is completely thawed. After that the back side becomes stable. In this time the stage of predominantly abrasion of the

balks between adjacent thermocirques is continued. The cycle of thermo-abrasion activation repeats after a new massive ice bed is exposed.

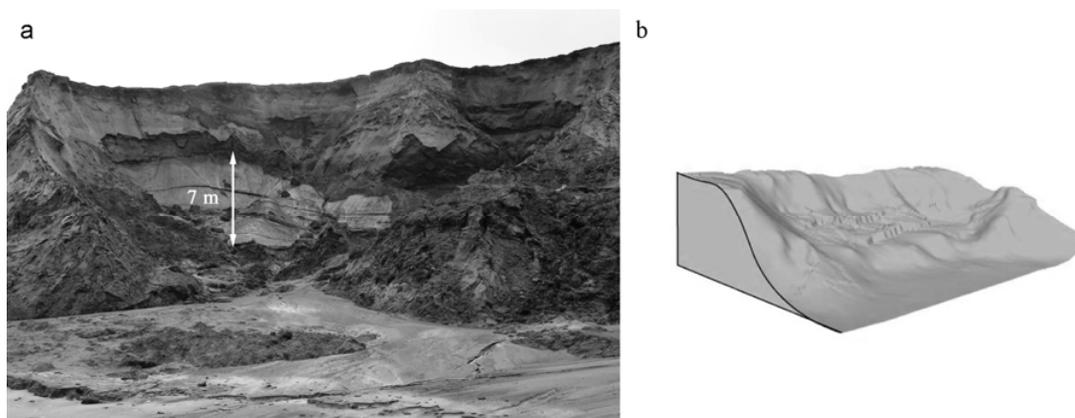


Figure 3. The thermocirque in 25-m surface: (a) – eastern part of the thermocirque (photo by A. Iosimov); (b) three-dimensional model.

This year taheometric shooting of thermocirques was carried out. The three-dimensional model of them has been made (Fig. 3, b). In the next year it is planned to make a repeated shooting, and also phototheodolite shooting to get a stereo mate. Than it would be possible to determine the volume of removed matter and correspondingly a rate of coastal destruction.

Data about massive ice bed location had been compared with annual rate of coastal destruction. Information about destruction rates is the result of monitoring observations on coastal dynamics, held since 1988. It had been found out that on the segments without massive ice the rate of coastal bluff retreat was on the average about 0,5m/year. But on the segments with massive ice beds the rate of retreat was three times or more higher than on the same heights of coastal bluff – even up to 3,5 m/year and more (Fig. 2).

Thus, this investigation confirmed that the rate of coastal bluff retreat is directly dependent on the presence of massive ice beds in the coastal bluff.

If we would take a segment with coastal bluff composed by sediments which include massive ice, than ice beds would expose only on at about 15% of its coastline. But massive ice beds were exposed in different parts of this coastal segment in different years. Taking this fact into account, we can conclude that in general all the length of this destructing surface is dynamically unstable. Our research permitted us to make recommendations about the location of the pipeline and the depth of its deepening taking into account the cryolithological composition of the coast.