COASTAL DYNAMICS AT THE WESTERN PART OF KOLGUEV ISLAND, BARENTS SEA

D.D. Perednya[1], M.O. Leibman[2], A.I. Kizyakov[2], B.G. Vanshtein[3] and G.A. Cherkashov[3]

[1]Moscow State University, Faculty of Geography, [2]Earth Cryosphere Institute SB RAS, [3]VNIIOceangeology

The coasts built of frozen deposits enclosing massive ground ice, are most dynamically developing in connection with tendencies of warming. In the European Arctic massive ground ice is found on Kolguev island. The western and northern coasts are actively affected by wave erosion and thermodenudation (complex of destructive processes on slopes).

The field study was undertaken 5 km south of the Sauchikha-river mouth at 69°12° N and 48°18°. Velikotsky (1998) has shown that thermodenudation plays a major role in coastal retreat in this region, and presented rough estimates of the retreat rate at the coasts complicated by thermocirques, as well as at the smooth-faced coasts, averaging at 1-2 m/yr and 0.1-0.2 m/yr, respectively.

Our field studies included: (1) measurements of retreat rates for various genetic types of the coasts; (2) establishing the dependence of coastal dynamics on geological structure and ice content of the coastal bluffs.

The studied coast has two genetically diverse levels (Velikotsky 1998): the lower level (wave-eroded bluffs with niches) and the upper level (gravitation or thermodenudation slopes). The lower level rises from the beach and is up to 10-15 m high. The upper level is above the lower one and is 20 to 40 m high. The break of the slope is related to a competent sandy layer in the middle of the geological profile, overlain and underlain by clayey deposits. A combination of smooth-faced wave-eroded bluffs and slopes or concave thermodenudation and nivation hollows are characteristic for the study area.

Erosion (bluffs) and combined accretion-erosion (river and creek mouths) coasts are found in the area. Three types of coasts are subdivided within the erosion group based on descriptions and airborne data: 1 high terraces with thermocirques and thawing massive ground ice, 2 high terraces with smooth-faced bluffs and gravitational slopes, and 3 low terraces (thermokarst depressions) with smooth-faced bluffs and gravitational slopes.

The river mouths of accretion-erosion coasts have no well defined estuaries and are separated from the sea by high beach-ridges (about 3 m).

The high terraces with thermocirques initially formed due to massive ice thaw, are now developing mainly due to thermoerosion of the thermocirque bottom and nivation of its scarp. Bluffs at the lower level are actively wave-eroded.

The high terraces with smooth-faced bluffs are built of relatively ice-poor sand and clay interbeddings. Wave-erosion activity forms niches and grottoes at the lower level, causing the failure of hung blocks.

The low terraces (thermokarst depressions) are characterized by a polygonal pattern which is possibly related to polygonal ice wedges at the surface. The terrace edges are dissected by narrow deep gullies, inheriting the polygonal pattern, and are complicated by nivation niches.

A narrow beach, wave-erosion niches, and steep to overhanging bluffs are typical for all forms of erosion coasts at western Kolguev island. Niches are open or protected by a debris cone at the sites with relatively ice-poor deposits. At the sites with thermocirques and, probably, at all sites with low cliff where the debris cone is not formed because of low debris yield, niches are filled by perennial snow patches which also fill the coastal gullies, providing the formation of the nivation hollows directly beneath the terrace edge.

Two of three thermocirques ("southern" and "central") described and mapped during the field study of 2002 are found on the aerial images of 1948 and 1969, while the third ("northern") one did not appear even on the map by Velikotsky (1998) based on survey of 1987.

During the last years thermodenudation is rather inactive and nivation, solifluction at the thermocirque scarps, and lateral thermoerosion in the bottoms of the thermocirques are developing.

Transects to measure scarp retreat at the most active and young "northern" thermocirque, formed after 1968 (according to aerial photography), were established (Fig.1). This scarp developed 150 m landward in less than 30 years, thus the retreat rate is not less than 5 m/yr. The stakes were set in staggered rows, allowing to map the terrace edge dynamics at an annual basis and to calculate the volume of erosion per meter of the coastline.

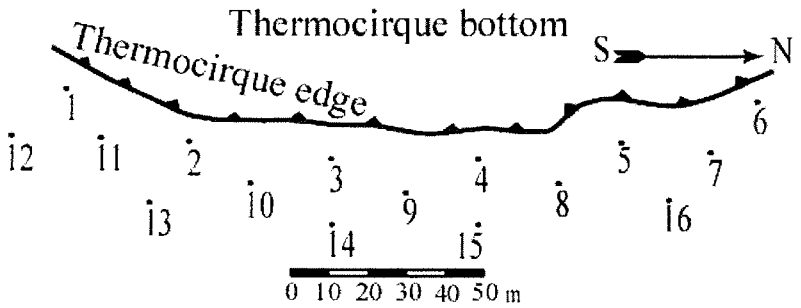

Figure 1. Monitoring network established at the edge of the "Northern" thermocirque.

As the smooth-faced bluffs represent the main portion of Kolguev coast, it is important to estimate their long-term dynamics. Our estimates are based on the comparison of aerial images of 1948 and 1968. In 20 years the backshore retreat approximates 60 m, while the terrace edge retreated 85 m (Fig. 2). Thus, the rate of retreat for this period averages 3 and 4 m/yr respectively.

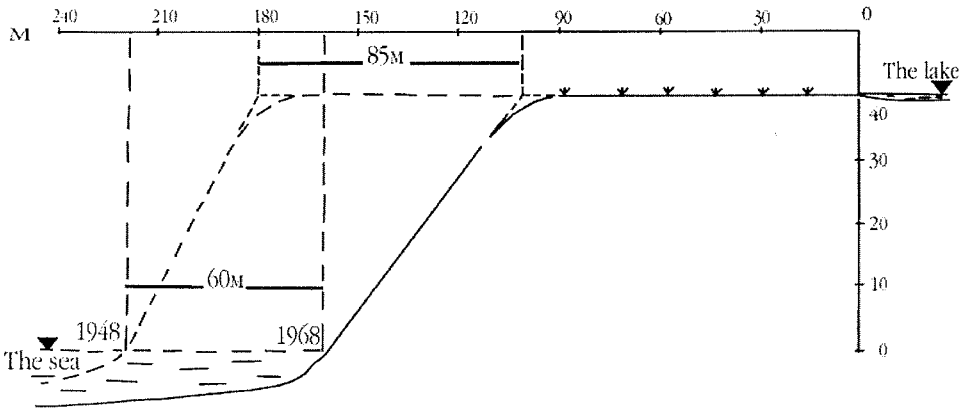

Figure 2. The scheme of coastal retreat at the low terrace (thermokarst depression).

Today the majority of the coastal bluffs are relatively stable. Actively retreating are the low terraces due to lateral thermoerosion and nivation, and the young "Northern" thermocirque due to slope processes and lateral thermoerosion. Thawing of perennial snow patches and new activation of coastal retreat processes is possible if air temperature increases or/and the circulation changes resulting in the melting of snow patches or the decrease of snow accumulation on the slopes of the western aspect in this region. The cyclicity in coastal retreat is controlled by the amount of ice thawing in combination with climate fluctuations.

The study is supported by INTAS, grant 01-2329.

Reference

Velikotsky, M.A. 1998. Modern shore dynamics of Kolguev island. In V.I.Solomatin, V.A.Sovershaev and I.I.Mazur (eds) Dynamics of the Arctic coasts of Russia: 93-101. Moscow: Faculty of Geography MSU.