# THE DEGRADATION OF COASTAL PERMAFROST AND THE DEVELOPMENT OF SUB-SEA PERMAFROST IN THE NEAR-SHORE ZONE OF THE LAPTEV SEA

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The dynamics of onshore permafrost and the evolution of offshore permafrost in the near-shore zone are closely interrelated. However, only a few drilling transects within the shoreface of the Asian Arctic Seas have been studied. Under the shallow shelf of the Laptev Sea facing thermal abrasion coasts the sub-sea permafrost table is usually found at a depth of 5-60 metres. Sometimes new formations of sub-sea permafrost were observed on shallows within accumulative bottom deposits. Our previous studies of coastal permafrost degradation at Ice Complex coasts showed that the sub-sea permafrost table slowly submerges from the shoreline to greater water depth.

In the Laptev coastal zone sub-sea permafrost was found within many sites: Eastern Taimyr Peninsula, Khatanga Bay, Nordvik Cape, Kozhevnikov Bay, Mammoth Tusk Cape, around the Lena and Yana Deltas, Bykovsky Peninsula, Muostakh Island, Buor-Khaya Bay, Siellyakhsky Bay, Vankina Guba Bay, Svyatoy Nos Cape and around the Big and Small Lyakhovski Islands (Figure 1).

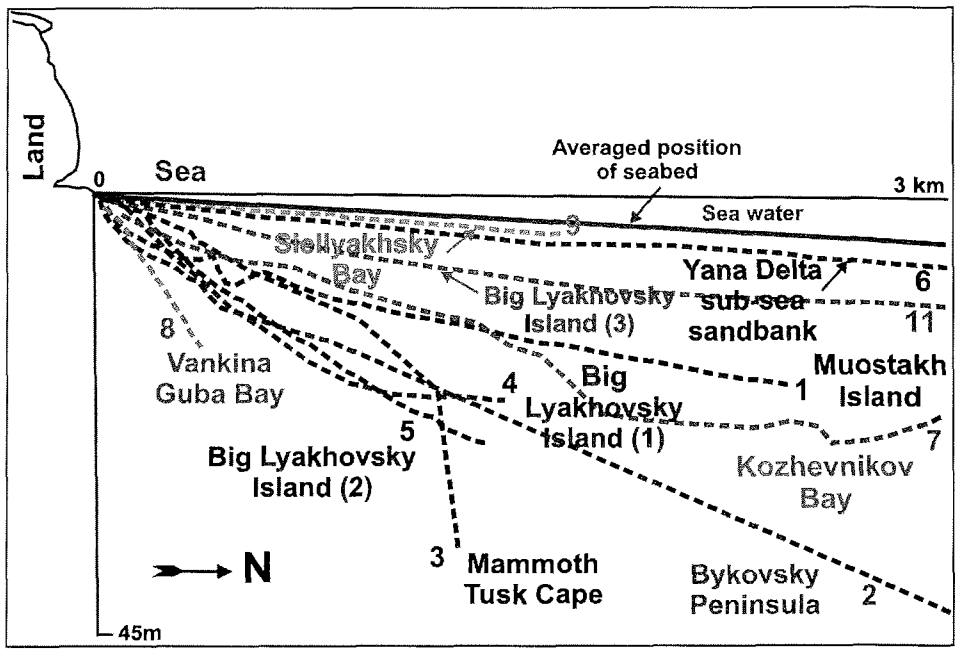


**Figure 1. Sub-sea permafrost table position at key sites in the near-shore zone of the Laptev Sea.**

During our studies the focus was on ice-rich sub-sea permafrost, which was investigated in detail, because more than 30% of the studied eroded coasts consist of the Ice Complex. According to published and our own data, the foot of the Ice Complex is very often lying below sea level (up to minus 10-20 m). When onshore ice-rich permafrost is transformed into the sub-sea state through coastal retreat its table changes very rapidly, at least initially. Based on coastal retreat rates, the time of submergence of a specific location can be dated back. If, for example, the depth of the permafrost table at a 2 km distance from the shoreline is determined at 15 m below sea level and the long-term coastal erosion rates are about 4

m/year, it is possible to conclude that 500 years ago this specific location was situated at the coast and that the mean trend of degradation of the sub-sea permafrost table is approximately 4 cm/year. However, it has to be noted that during the first stage of submergence the degradation of the permafrost table can be 10-times faster.

Preliminary studies show that depending on the average coastal retreat rate and other environmental conditions, including sediment features, water temperature and salinity regime etc., the dominant rates of degradation of the sub-sea permafrost table during the first stage of submergence vary from 1 to 10-15 cm/year, at a permafrost table inclination of 0.002-0.35 (from the shore to the sea). Preliminary analysis of the sub-sea permafrost table position at the key sites of the Laptev Sea near-shore zone allows us to reveal the regularities and peculiarities in permafrost evolution. The greatest inclination of the permafrost table (0.035) was found in the Vankina Guba Bay – profile 8. It is probably related to slow coastal erosion in this area and environmental specificity. Minimum permafrost table inclinations (0,002-0.003) were observed at the sites where accumulative sedimentation prevails (Yana Delta sub-sea sandbank – profile 6, Siellyakhsky Bay – profile 9). In this case new sub-sea permafrost formation is generated within the very shallow shoreface. Normally, the near-shore sites located at more or less open sea conditions are characterized by steep permafrost table inclination (north-west of Big Lykhovsky Island – profiles 5, 7; Mammoth Tusk Cape – profile 3; Bykovsky Peninsula – profile 2. Moderate permafrost table inclinations were found at Muostakh Island and Bykovsky Peninsula (Central Laptev Sea coast) - 0.007 and 0.013 respectively (average coastal erosion retreat rates are 13 and 3 m/year). In the Mammoth Tusk Cape area (Western Laptev Sea coast) the inclination of the permafrost table is very steep (0.015) within a distance of up to 1.3 km from the shore and extremely steep (more than 0.3) between the 1.3 and 1.4 km distance. This anomaly could be due to ancient thermokarst processes which occurred under subaerial conditions. An estimation shows that the average rate of permafrost table degradation at the studied transect is about 8 cm/year or slightly more.