Methane Emission from the Coastal Retreat in the Western Yamal

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The large amount of methane is withdrawn from turnover of the Earth and preserved in permafrost. Methane is emitted in the atmosphere during the permafrost degradation on the shelf, the continent and the melting of the subsurface ice. In recent decades great attention is given to analysis of the methane content inasmuch as, according to the relevance, methane is the second greenhouse gas after the carbon dioxide, its increase in the atmosphere has a significant impact on the climate as a whole. Since the second half of the XX century, the concentration of methane in the atmosphere has been increasing annually by 1%.

Data on methane concentration in air inclusions into ground ice and permafrost exposed in a cliff near the Marre Sale polar station, the western Yamal (69°43'N/66°49'E) has been obtained for the first time.

Complex of quaternary deposits containing various generations of syngenetic ice wedges and two types of massive ice composed the section of the cliff near the station. Long-term regular observations of the sea coast retreat since 1978 showed a speed of about 1.7 meters per year (Vasiliev et al., 2006). Total of 247 samples of gas from permafrost and ice were collected. CH_4 concentration was measured by headspace-equilibration, using KhPM-4 (Russia) gas chromatograph with flame ionization detector and hydrogen used as a carrier gas (Pushchino, Russia). The methane concentration in massive ice sheet was abnormally high. It reached 21.5 ml kg-1 in the ice, which exceeded by an order of magnitude the concentration found for other sediments composing the coastal section. Methane is practically absent in the Holocene sands and the ice of syngenetic ice-wedges. Given the coastal retreat rate, we assessed the annual flux of the methane buried in permafrost due to erosion of 100 m long coastal section near Marre-Sale. With the destruction of costal bluff near Marre-Sale that consists of sand and ice-wedge polygons, the atmosphere there receives 0.235 g of methane per 1 m2 in a single year, whereas melting of tabular massive ground ice liberated 19.7 g/a per 1 m2 from permafrost.

Such variations of methane concentrations across sediment types correlated with permafrost genesis. Formation of syngenetic permafrost was shown to be unfavorable for methane accumulation on the contrary to epigenetic permafrost (Vasiliev et al., 2015). The amount of methane released from permafrost due to erosion was estimated for 100 m of the coast and for the full length of 4.5 km long coastal section was estimated. It was found, that each year the destruction of 100 m of the sea coast in the research area causes 10300 g of methane to be released into the atmosphere and around 463500 g is released around a 4.5 km-long coastline.

Fluxes of methane buried in permafrost due to coastal erosion were dominated by methane from marine clays and loams, as shown on the Fig 1 (Key: 1 – alluvial sand (MIS 1 age); 2 – lacustrine silt and sand (MIS 2 age); 3 – lacustrine silt and sand (MIS 3-MIS 4 age); 4 – marine clay and loam (MIS 5 age); 5 – syngenetic ice wedges; 6 – tabular massive ground ice.).

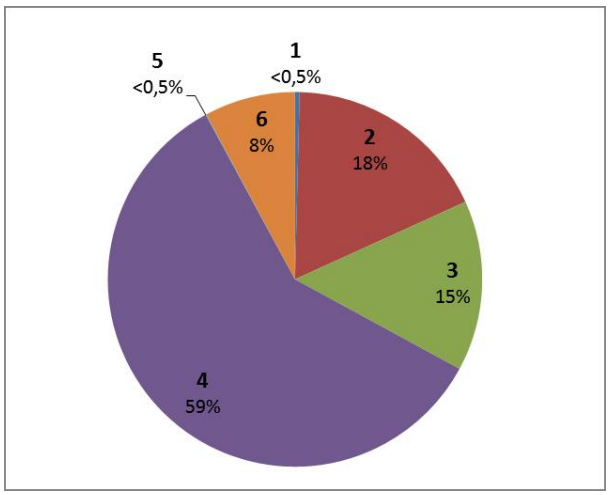

Figure 1: Annual contribution of methane fluxes from erosion of sediments and ice to the total emission of methane from the 100 m coastal section.

The comparison between the amount of methane released into the atmosphere from the surface of tundra wetland ecosystems of the north of Western Siberia and the amount of methane released into the atmosphere as a result of the destruction of the sea coast

near the polar station Marre-Sale showed, that the amount of methane coming from the 1 m2 section of the coast amounted to 5.01 g per year. Average methane emission from tundra wetland ecosystems was 1.17 g/a per 100 m2 (Kazantsev, 2013). The value of methane emissions in the destruction of frozen sea shore with underground ice is high enough and comparable to the emission of methane from wetland ecosystems.

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