4.6.4 Geomicrobiological studies

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4.6.4.1 Introduction and objectives

Permafrost deposits commonly contain different amounts of methane, being a potential source of this climate relevant trace gas in case of thawing (Moraes & Khalil 1993, Rivkina and Gilichinsky 1996). In addition, organic carbon presently stored in perennially frozen paleosoils and sediments may be decomposed to methane when temperature rises. An increased emission of methane followed by an increase of atmospheric methane concentrations may be the result. The objective of the geomicrobiological investigations was to improve our understanding of the permafrost-inhabiting microorganisms that produce and oxidize methane. Working tasks in the field were:

- sampling of perennially frozen paleosols and sediments with differing ecological factors (pH, grain size, content of organic carbon and nutrients, age of permafrost deposits) for measurement of activity at low temperatures, abundance and diversity of methane producing and oxidizing microorganisms
- determination of methane content in permafrost deposits.

4.6.4.2 Methods

Samples were taken from different geocryological units of the coastal permafrost exposure, comprising late Pleistocene sand-peat complex, late Pleistocene ice complex, Holocene cover and Holocene thermoerosion valley deposits. All of the sampling sites were likewise described and sampled for cryolithological and sedimentological studies (see chapter 4.6.2). In total 29 samples were taken for geomicrobiological investigations (see sample list in Appendix 4-4).

After removal of thawed material at the respective points of the cliff, samples from perennially frozen parts were taken with a hammer and a small axe. For microbiological, molecularbiological and biochemical analyses, subsamples were immediately stored on ice and transported frozen to Germany. Subsamples for geochemical and -physical analyses were transported at ambient temperatures. Furthermore, methane content was determined in the field: Immediately after sampling, 10 to 20 g of frozen material was placed into gastight 50-ml-glassbottles, which were previously filled with 35 ml of a saturated sodium chloride solution. The sodium chloride prevented microbial activity and minimized methane solubility in the sample suspensions. Methane stored in the permafrost material was forced into the headspace of the bottles by vigorous shaking after thawing. Two to four weeks after sampling, gas concentrations in the headspaces were analysed by gas chromatography in the field laboratory on the Island Samoylov, Lena Delta.

4.6.4.3 First results: Methane content of permafrost samples

Table 4.6.4-1. Methane content in permafrost samples from different geocryological units (for more details about subprofiles see chapter 4.6.2.).

Cryolithological unit	Methane concentration [µmol/kg ice]	Peat	Sample number	Number of subprofile
Late Pleistocene sand-peat complex	0	+	Mak 100	MAK 1
	0	-	Mak 101	
	340	+	Mak 102	MAK-2
	139	-	Mak 103	
	22	+	Mak 104	
	2	+	Mak 105	MAK-3
	0	+	Mak 106	
	2	-	Mak 107	
	0	+	Mak 108	
Late Pleistocene Ice Complex, transition to sand-peat complex	13	-	Mak 109	MAK-4
Late Pleistocene Ice Complex	0	-	Mak 110	MAK-5
	0	-	Mak 111	
	0	-	Mak 121	MAK-9
	0	-	Mak 122	MAK-8
	429	+	Mak 126	MAK-12
	98	-	Mak 127	
	361	+	Mak 128	
Late Pleistocene ice complex, transition to Holocene cover	63	-	Mak 112	MAK-10
	131	-	Mak 113	
	290	-	Mak 114	
	423	-	Mak 115	
	662	+	Mak 116	
	115	-	Mak 117	
Holocene cover	541	+	Mak 118	
	416	-	Mak 119	
	691	+	Mak 120	
Holocene thermoerosion valley deposits	15	+	Mak 123	MAK-11
	602	-	Mak 124	
	343	+	Mak 125	

All analysed Holocene permafrost samples contained methane (see Table 4.6.4-1), ranging from 15 to 691 µmol/kg ice. In Ice Complex samples, methane presence varied strongly between various subprofiles: 63 to 662 µmol methane per kg ice could be detected in samples from the subprofile Mak-10, which represents the transition to the Holocene cover. Mak-12 was another subprofile rich in methane (98 to 429 µmol/kg ice), representing an older part of the Ice Complex (0 to 2 m a.s.l) with marked peaty paleosoils. In contrast to that, no methane could be found in samples from subprofile Mak-5, Mak-8, Mak-9 and only a small quantity (13 µmol/kg ice) in a sample from profile Mak-4. These lacking or minor methane contents in Ice Complex material have been earlier reported by Rivkina & Gilichinsky (1996) for various boreholes taken in the Kolyma-Indigirka Lowland, Siberia.

Samples of the sand-peat-complex were taken from three subprofiles, one of them (Mak-2) with 22 to 340 µmol methane / kg ice and two of them with lacking or minor concentrations (Mak-1, Mak-3). At the latter sites, even peaty material was free of methane, indicating oxic conditions in the peats at the time of the latest freezing.