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Methane and Carbon Dioxide in Permafrost of Lena River Valley, Eastern Siberia (Extended Abstract)

A. BROUCHKOV and M. FUKUDA

Research Center for North Eurasia and North Pacific Regions
Hokkaido University, Japan

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Methane contribution to greenhouse effect is significant; however, its distribution in permafrost is poorly known. Permafrost is impervious, thus gases could be trapped in soil pores for a long time. Methane content could be significant in permafrost (Figure 1).

Frozen alluvial deposits and ice complex were studied for methane and carbon dioxide content from the depths of up to 5 m and more in Eastern Siberia, near Yakutsk.

Methane concentration of pore air is high, up to 60,000 ppmv, though ice wedges do not contain as much methane as frozen soils. Average methane content in permafrost could be estimated as 0.05-10 ml/kg. The anti-proportional relationship between values of concentration of methane and carbon dioxide (Figure 2) performed in permafrost indicates possible occurrence of methane oxidizing process in deposits. On the whole, methane and carbon dioxide content in frozen soils rise in accordance to water content increase. Ice wedges are presented by two categories: with high methane content (generally, small wedges often with high mineral content) and almost without methane

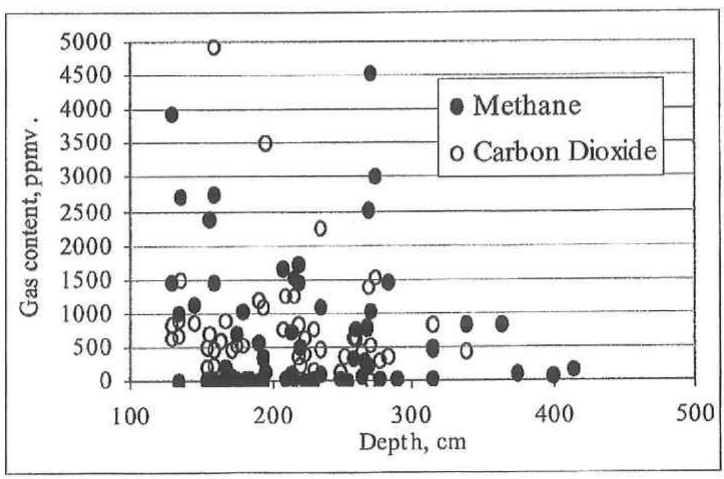

Figure 1. Methane and carbon dioxide content in frozen soils

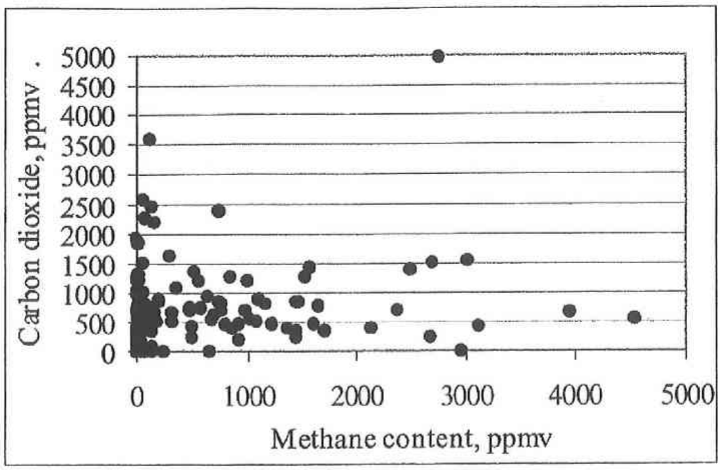

Figure 2. Relationship between methane and carbon dioxide content in permafrost (both frozen soils and ice wedges)

(ice wedges of big thickness).

Type of landscape determinates methane distribution in upper permafrost (Figure 3). It was found that the lower part of the forest contains less concentration of methane than higher position (Figure 4) ; thus, the older the permafrost the more methane it contains. Along transect measurements suggests that depressed ground surface in forest may represents thawing and refreezing of uppermost permafrost in the past Established relationship between volumetric air content and both values of methane and carbon dioxide concentration in permafrost also suggests thawing-freezing history. Total volumetric gas content, water content, density and their relationship were estimated in permafrost. Methane and carbon dioxide content rise in general with water content increase. According recent studies of gas content in active layer, freezing of water-saturated soil in alas or other landscape depression and its transfer to permafrost state probably could cause high methane concentration in upper permafrost.

Based on published data and the research an estimation of additional emission of methane from permafrost areas was made (Table 1). It shows that a considerable additional emission of methane could be expected in case of permafrost melting of 0.5 m depth, but probably not as a release of trapped gas, and an additional producing in the active layer.

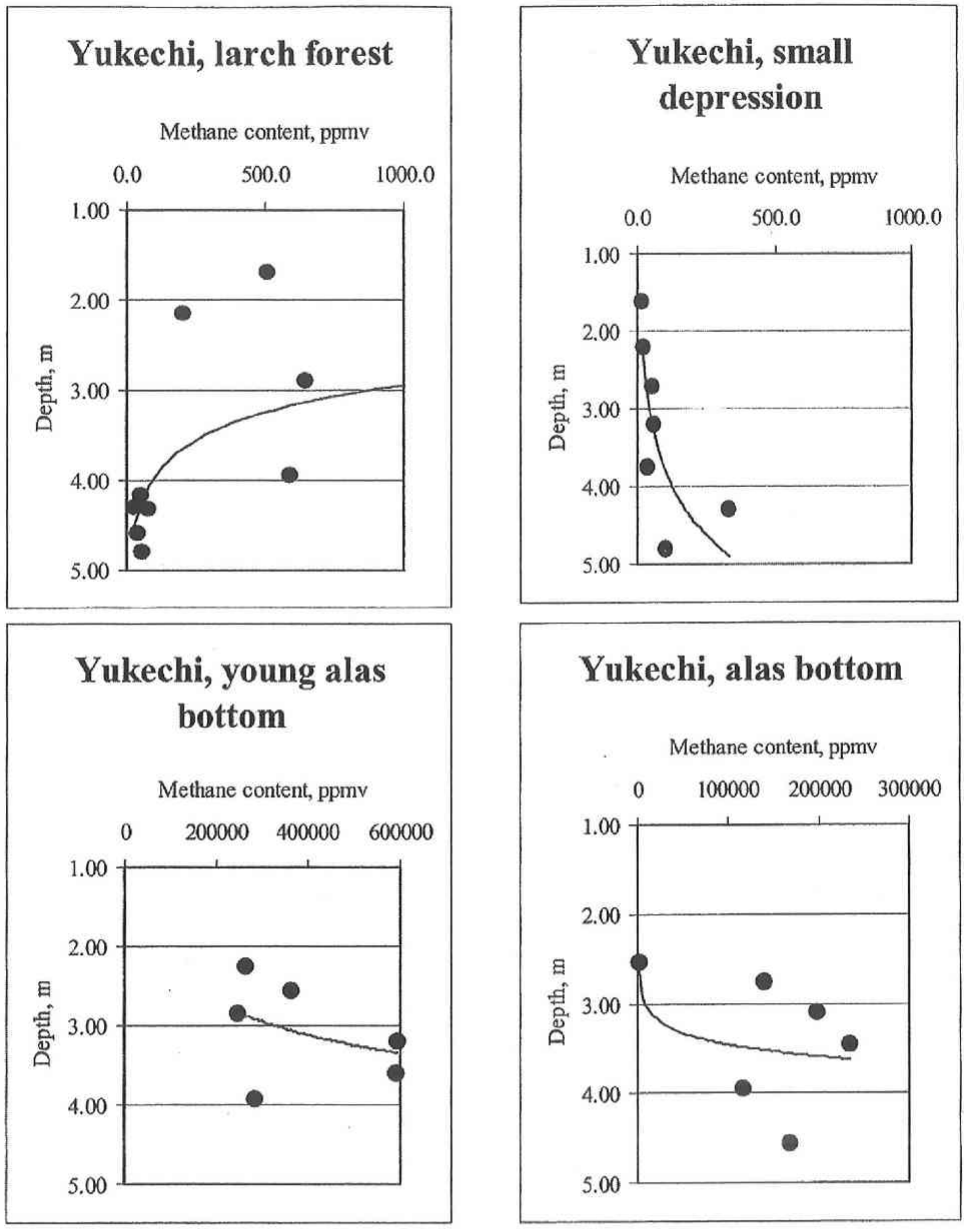

Figure 3. Distribution of methane content in permafrost of different landscapes, Yukechi site, right bank of the Lena river

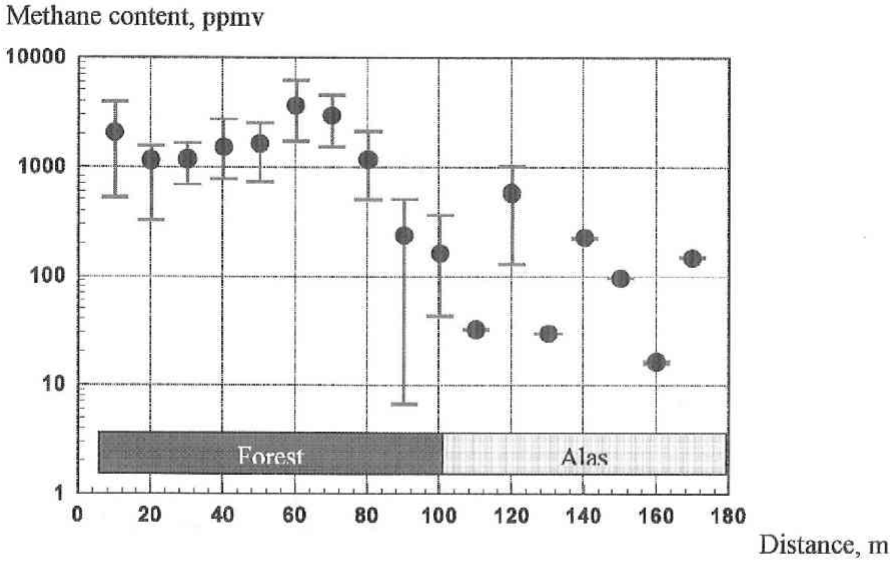

Figure 4. Methane content (ppmv), first section, from forest (left) to alas (right), Neleger site, left bank of the Lena river

Table 1. Estimation of CH_4 content in permafrost and effect of thawing

Latitude (degree N)	Area of wet-land (10^9 m^2)	Annual methane emission (Tg a year)	Methane producing in active layer, mg/dm^3 a day	Addition as a result of 0.5 m increase of active layer (Tg a year)		Addition as a result of thawing of all perma-frost (Tg)	Produ-cing in perma-frost, Tg a year	Collec-tion in perma-frost for 5,000 years, Tg
				Produ-ced	Release from perma-frost			
75-72.5	30.2	0.1	0.5	0.6	Fukuda, 1999; this study	1.0- 9.0	0.4	2,000
72.5-70	80.2	0.2	1.0	3.6		1.5-15.0	7.7	3,500
70-67.5	91.9	0.7	1.5	6.2		0.9-8.5	0.4	2,000
Total, Tg	202.3	1.0	10.4		0.001-1.5	3.4 - 960.0	1.5	7,500