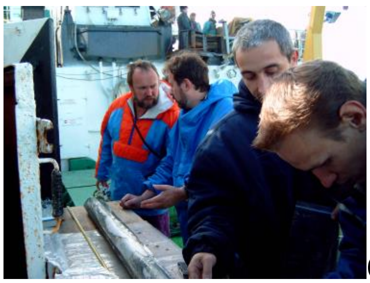
Distribution of Methane in the Water Column and Bottom Sediments of the Bering Strait and Chukchi Sea.

Alexander Savvichev[1], Igor Rusanov [1]& Kathleen Crane[2]

[1] Institute of Microbiology, Russian Academy of Sciences

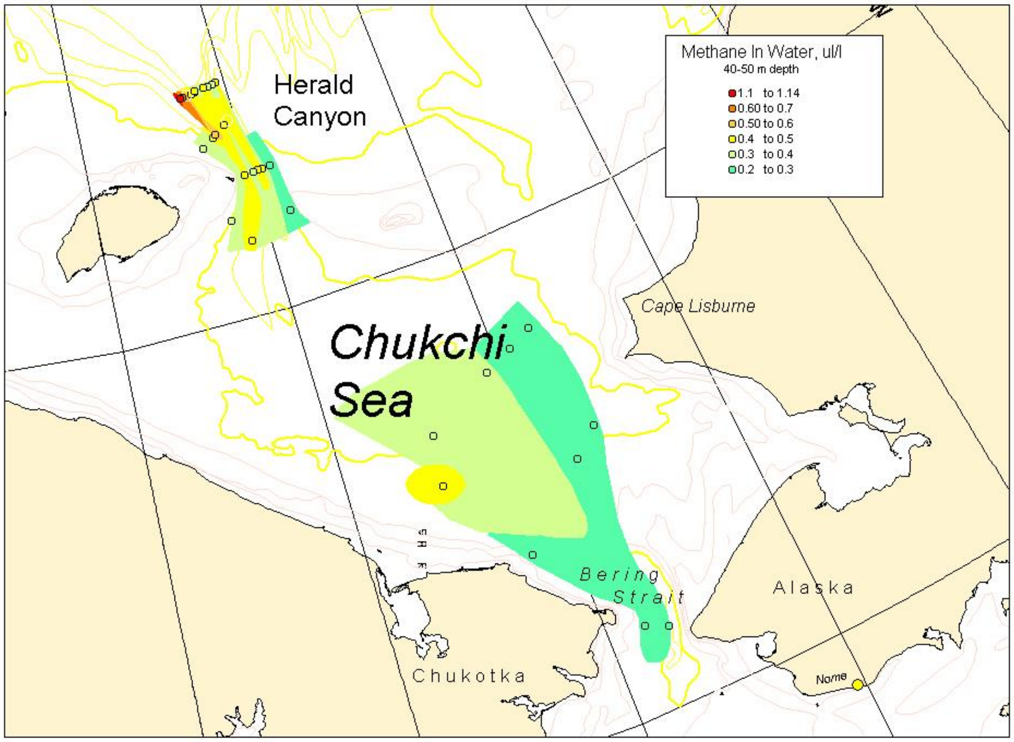
[2] Arctic Research Office, National Oceanic and Atmospheric Administration



One anticipated consequence of a warming climate in the Arctic Region is the enhanced release of gaseous methane from the subjacent permafrost. High methane concentration in the water column and/or sediments may also be indicative of both the nearby presence of gas deposits or microbial activity in the environment. Because methane is an important indicator of climate change, the RUSALCA expedition measured methane levels in both the water column and sediments.

To carry out the methane analysis, water samples were extracted from the Woods Hole rosette system's bottles and 2-cm^3 sub-sections of wet sediments taken from bottom grabs and cores, were placed into a glass vial, 30 cm^3 in volume. The sediment was flooded with 1 M KOH solution, leaving 3 cm^3 of the bottle volume free and covered by Balch rubber stopper (a headspace technique adapted by Egorov and Ivanov, 1998). After the water and gas phases mixed establishing phase equilibrium, a syringe for chromatographic analysis collected 0.25 ml of the headspace gas. For this purpose, a Chrom-5 with a flame ionization detector was used.

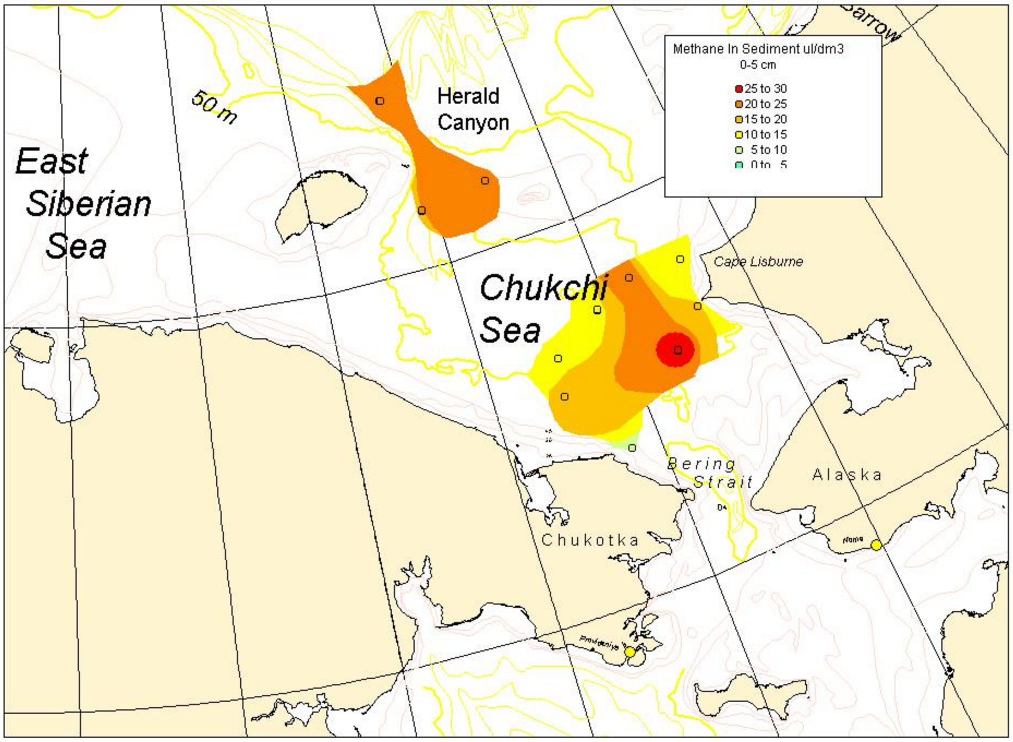
In the water column of the Bering Strait and southern Chukchi Sea, the contents of methane varied from 0.14 to 0.43 µl/l (Table. 1). The methane content in the surface layer of the water column was minimal and corresponded to CH_4 partial pressure in the atmosphere above. The greatest amount of methane was detected in bottom water of St. 24 and 25 (on the transect from the Chukotka Peninsula and Cape Lisburne in Alaska) Figure 1.



A. Savvichev, I. Rusanov and K. Crane, 2004

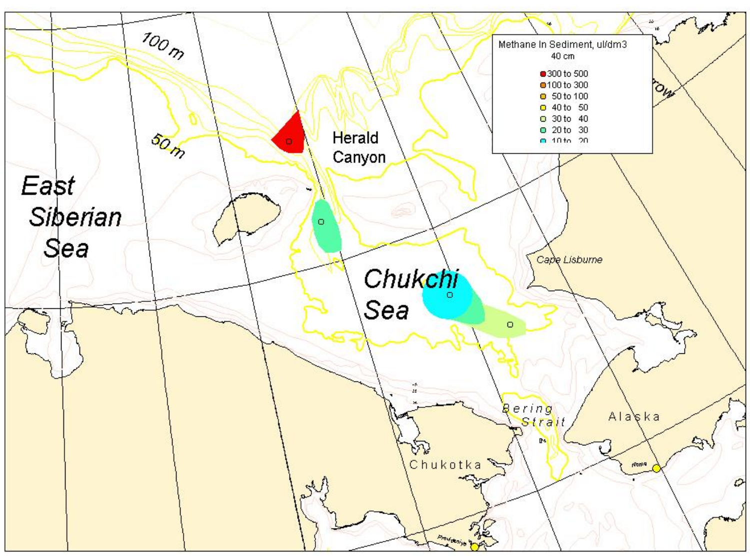
Methane was also measured in the northwestern Chukchi Sea along the Herald Canyon. Methane concentrations in this region exceeded concentrations in the water column of the Bering Strait, rising to 0.92 – 1.14 µl CH_4/l at the northern station 89-R at a depth of 40 m. Samples were not taken outside the Herald Canyon, so it is not known if this is a localized event confined to the fault-bounded "canyon" or is part of a much larger regional release of methane.

Bottom sediment samples from grabs and cores were analyzed north of the Bering Strait. The data show that the values of methane in Western Chukchi Seafloor vary from 5.5-to 420-µl CH_4/dm^3, varying by location and depth. Sediments from the southern stations of the Chukchi Sea were characterized by rather low methane content (up to 40 µl CH_4/dm^3)(Figure 2)



A. Savvichev, I. Rusanov and K. Crane, 2004

The highest concentrations of sedimentary methane were detected from the northern Herald Canyon (at a core depth of



A. Savvichev, I. Rusanov and K. Crane, 2004

40-100 cm) (Figure 3). This is the same location where high levels of water column methane were detected.

The methane concentrations in both the sediments and water column of the Chukchi Sea exceed the values of observed water column and sediment methane concentration in the Barents and Kara Seas and fall within the range of methane concentrations measured in the Black and White Seas (Table 3).

The microbial activity data from the Bering Strait and the Chukchi Sea will be processed in the laboratory. When these data are available, we will be able to more clearly determine the provenance of the elevated methane in the Chukchi Sea.

Table 1.List of water samples where methane was measured (1- station number, 2 - depth m, 3 - concentration of methane [CH_4], µl/l

N	Depth, m	[CH_4]
1	**2**	**3**
07-R	1	0,17
	20	0,20
	50	0,22
08-R	1	0,20
	20	0,19
	40	0,20
11-R	1	0,29
	5	0,29
	9	0,29
	20	0,29
	30	0,29
	40	0,29
14-R	1	0,14
	8	0,27
	30	0,27
	48	0,29
15-R	1	0,26
	10	0,22
	15	0,20
	20	0,24
	35	0,26
	45	0,26
20-R	1	0,22
	10	0,24
	22	0,29

	35	0,29
	50	0,29
21-R	1	0,17
	10	0,19
	15	0,19
	20	0,22
	35	0,24
	50	0,24
22-R	1	0,17
	5	0,17
	15	0,19
	25	0,24
	30	0,27
	40	0,31
	50	0,29
24-R	1	0,20
	6	0,17
	10	0,17
	15	0,20
	20	0,30
	25	0,34
	30	0,37
	40	0,37
	50	0,35
25-R	1	0,20
	10	0,29
	15	0,29
	20	0,31
	35	0,41
	50	0,43
106-R	1	0,26
	6	0,29
	10	0,36
	20	0,37
	24	0,36
	25	0,34
	35	0,48
	45	0,48
	50	0,46
	60	0,46
	66	0,43
44-R	1	0,26
	25	0,41
	50	0,34
56-R	1	0,19
	30	0,29
	50	0,26
58-R	1	0,21
	30	0,31
	50	0,29
60-R	1	0,19
	20	0,34
	30	0,41
	64	0,41
	90	0,37
61-R	1	0,20

	30	0,43
	80	0,37
62-R	1	0,21
	40	0,37
	62	0,37
64-R	1	0,24
	30	0,34
	50	0,46
67-R	1	0,22
	20	0,50
	36	0,39
70-R	1	0,20
	30	0,51
	54	0,41
71-R	1	0,32
	33	0,43
	57	0,56
74-R	1	0,24
	23	0,46
	69	0,43
75-R	1	0,29
	24	0,41
	73	0,37
80-R	1	0,26
	24	0,43
	49	0,43
81-R	1	0,26
	17	0,41
	32	0,34
	58	0,36
82-R	1	0,33
	21	0,34
	78	0,41
83-R	1	0,26
	22	0,37
	80	0,56
85-R	1	0,41
	23	0,31
	98	0,41
86-R	1	0,41
	19	0,39
	82	0,46
87-R	1	0,39
	16	0,37
	72	0,54
88-R	1	0,36
	25	0,46
	72	0,77
89-R	1	0,41
	6	0,39
	10	0,37
	14	0,32
	22	0,34
	25	0,37
	30	0,48
	40	0,92
	50	1,14
	60	1,02
	70	1,00
85B-R	1	0,41
	30	0,46

101	0,43

Table 2. Methane concentration in sediments. Station number, depth in core (C), Grab (G), cm. µl/dm^3

11-G	0 – 3	5,5
15-G	0 – 3	16,6
15-C	3 – 5	26,9
	9 – 10	14,7
	19 – 20	15,4
	29 – 30	14,3
	39 – 40	36,8
	54 – 55	14,3
	64 – 65	39,8
17-G	0 – 5	16,1
18-G	0 – 5	14,9
20-G	0 – 5	23,5
22-G	0 – 5	12,9
22-C	4 – 5	14,2
	9 – 10	13,8
	19 – 20	11,0
	29 – 30	10,5
	39 – 40	12,4
	44 – 45	11,5
	59 – 60	10,3
	79 – 80	14,3
	99 – 100	39,6
	119 – 120	15,2
	134 – 135	36,1
24-G	0 – 7	13,8
25-G	0 – 3	19,8
106-G	0 – 3	23,5
106-C	3 – 5	23,0
	9 – 10	13,8
	19 – 20	18,9
	29 – 30	19,3
	39 – 40	25,8
	49 – 50	27,1
	59 – 60	32,7
	79 – 80	50,6
	99 – 100	87,4
	119 – 120	78,2
	144 – 145	85,0

	159 – 160	112,7
	169 – 170	144,9
	189 – 190	149,5
85B-G	0 – 5	14,9
85B-C	5 – 6	21,6
	9 – 10	345,0
	14 – 15	391,0
	19 – 20	368
	29 – 30	368
	39 – 40	403
	49 – 50	368
	59 – 60	341
	69 – 70	334
	79 – 80	338
	89 – 90	336
	99 – 100	363
	104-105	419

Table 3

Reservoir	Methane content		Reference
	Water column, µl/l	Sediments µl/dm3	
Barents Sea	0.07 – 1.8	1.0 – 19.3	Savvichev, Rusanov, Pimenov, 2000
Kara Sea	0.06 – 0.72	0.46 – 240	Lein, Rusanov, Savvichev, 1996
Black Sea	0.49 – 8.5	2.4 – 29.9 x 10^3	Ivanov, Pimenov, Rusanov, 2002
White Sea (Kandalaksha Bay)	0.11 – 1.2	3.5 – 16.8 x 10^3	Savvichev, Rusanov, Yusupov, 2004
Chukchi Sea	0.14 - 1.0	5.0 - 419	Savvichev, Rusanov 2004 RUSALCA