Electronic Supplementary Information for

Development of a Coupled Geophysical-Geothermal Scheme for Quantification of Hydrates in Gas Hydrate-Bearing Permafrost Sediments

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The following data are available at Mendeley Data, https://doi.org/10.17632/2zf6dsxkfw.1:

1. Detailed experimental conditions and measured elastic wave velocities and ETC values at different effective overburden pressures (Section 4.1).

2. Detailed predicted and experimental saturations of the co-existing phases together with the PT conditions used for testing the performance of the coupled geophysical-geothermal scheme (Section 4.3).

Supporting Information

Table S1. ETC and ETC ratio at unfrozen and frozen conditions, predicted to investigate sensitivity of the modified ETC model to the saturation and pore-scale habit of hydrates.

Table S2. ETC and elastic wave velocities determined by the rock-physics model (EMT-C) at frozen conditions, predicted to investigate sensitivity of the modified ETC model to the unfrozen water saturation at different hydrates distribution patterns.

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Table S1. ETC and ETC ratio at unfrozen and frozen conditions, predicted to investigate sensitivity of the modified ETC model to the saturation and pore-scale habit of hydrates.

ETC and ETC Ratio at Unfrozen Conditions

No.	σ (-)	S_h (-)	S_w (-)	S_g (-)	ETC (W/m.K)	ETC Ratio (-)
				A=N/2		
	-	0.00	0.60	0.40	2.319	1.000
1	1	0.04	0.56	0.40	2.246	0.968
2	5	0.20	0.40	0.40	2.020	0.871
3	10	0.39	0.21	0.40	1.918	0.827
4	15	0.52	0.08	0.40	1.904	0.821
5	20	0.60	0.00	0.40	1.903	0.821
				A=N/4		
	-	0.00	0.60	0.40	2.319	1.000
6	1	0.02	0.58	0.40	2.298	0.991
7	5	0.10	0.50	0.40	2.225	0.959
8	10	0.21	0.39	0.40	2.151	0.927
9	15	0.33	0.27	0.40	2.100	0.905
10	20	0.51	0.09	0.40	2.074	0.894
11	25	0.55	0.05	0.40	2.068	0.892
				A=N/6		
	-	0.00	0.60	0.40	2.319	1.000
12	1	0.01	0.59	0.40	2.311	0.996
13	5	0.05	0.55	0.40	2.280	0.983
14	10	0.10	0.50	0.40	2.247	0.969
15	15	0.16	0.44	0.40	2.221	0.957
16	20	0.27	0.33	0.40	2.202	0.949
17	25	0.39	0.21	0.40	2.190	0.944
18	30	0.41	0.19	0.40	2.184	0.942
19	35	0.42	0.18	0.40	2.181	0.941
				A=N/8		
	-	0.00	0.60	0.40	2.319	1.000
20	1	0.01	0.60	0.40	2.316	0.999
21	5	0.02	0.58	0.40	2.302	0.992
22	10	0.05	0.55	0.40	2.287	0.986
23	15	0.08	0.52	0.40	2.273	0.980
24	20	0.13	0.47	0.40	2.262	0.975
25	25	0.22	0.38	0.40	2.253	0.971
26	30	0.28	0.32	0.40	2.247	0.969
27	35	0.30	0.30	0.40	2.244	0.968
28	40	0.31	0.29	0.40	2.242	0.967

ETC and ETC Ratio at Frozen Conditions

No	σ (-)	S_h (-)	S_i (-)	S_{uw} (-)	S_g (-)	ETC (W/m.K)	ETC Ratio (-)
				A=N/2			
	-	0.00	0.57	0.10	0.33	3.571	1.000
1	1	0.05	0.52	0.10	0.33	3.179	0.890
2	5	0.21	0.36	0.10	0.33	2.355	0.659
3	10	0.38	0.19	0.10	0.33	2.059	0.577
4	15	0.52	0.05	0.10	0.33	2.022	0.566
5	20	0.57	0.00	0.10	0.33	2.019	0.565
				A=N/4			
	-	0.00	0.57	0.10	0.33	3.571	1.000
6	1	0.03	0.54	0.10	0.33	3.370	0.944
7	5	0.12	0.45	0.10	0.33	2.887	0.808
8	10	0.24	0.33	0.10	0.33	2.579	0.722
9	15	0.39	0.18	0.10	0.33	2.401	0.672
10	20	0.52	0.05	0.10	0.33	2.334	0.654
11	25	0.54	0.03	0.10	0.33	2.324	0.651
				A=N/6			
	-	0.00	0.57	0.10	0.33	3.571	1.000
12	1	0.01	0.56	0.10	0.33	3.473	0.973
13	5	0.06	0.51	0.10	0.33	3.241	0.908
14	10	0.12	0.45	0.10	0.33	3.096	0.867
15	15	0.20	0.37	0.10	0.33	2.992	0.838
16	20	0.33	0.24	0.10	0.33	2.911	0.815
17	25	0.42	0.15	0.10	0.33	2.858	0.800
18	30	0.44	0.14	0.10	0.33	2.834	0.794
19	35	0.44	0.13	0.10	0.33	2.820	0.790
				A=N/8			
	-	0.00	0.57	0.10	0.33	3.571	1.000
20	1	0.01	0.56	0.10	0.33	3.526	0.987
21	5	0.04	0.53	0.10	0.33	3.401	0.952
22	10	0.07	0.50	0.10	0.33	3.320	0.930
23	15	0.12	0.45	0.10	0.33	3.265	0.914
24	20	0.19	0.38	0.10	0.33	3.212	0.899
25	25	0.29	0.28	0.10	0.33	3.164	0.886
26	30	0.32	0.25	0.10	0.33	3.138	0.879
27	35	0.33	0.24	0.10	0.33	3.123	0.875
28	40	0.34	0.23	0.10	0.33	3.113	0.872

Table S2. ETC and elastic wave velocities determined by the rock-physics model (EMT-C) at frozen conditions, predicted to investigate sensitivity of the modified ETC model to the unfrozen water saturation at different hydrates distribution patterns.

ETC

No.	S_{uw} (-)	S_h (-)	ETC (W/m.K)	No.	S_{uw} (-)	S_h (-)	ETC (W/m.K)	No.	S_{uw} (-)	S_h (-)	ETC (W/m.K)
					A=N/8						
1	0.00	0.00	3.929	1	0.03	0.00	3.839	1	0.09	0.00	3.670
2	0.00	0.12	3.567	2	0.03	0.12	3.479	2	0.09	0.12	3.312
3	0.00	0.25	3.495	3	0.03	0.25	3.407	3	0.09	0.25	3.240
4	0.00	0.36	3.426	4	0.03	0.36	3.342	4	0.09	0.36	3.180
					A=N/6						
1	0.00	0.00	3.929	1	0.03	0.00	3.839	1	0.09	0.00	3.670
2	0.00	0.12	3.402	2	0.03	0.12	3.317	2	0.09	0.12	3.153
3	0.00	0.25	3.269	3	0.03	0.25	3.183	3	0.09	0.25	3.016
4	0.00	0.36	3.209	4	0.03	0.36	3.123	4	0.09	0.36	2.955
					A=N/4						
1	0.00	0.00	3.929	1	0.03	0.00	3.839	1	0.09	0.00	3.670
2	0.00	0.12	3.154	2	0.03	0.12	3.078	2	0.09	0.12	2.936
3	0.00	0.25	2.789	3	0.03	0.25	2.716	3	0.09	0.25	2.581
4	0.00	0.36	2.672	4	0.03	0.36	2.599	4	0.09	0.36	2.462

Elastic wave velocities

No.	S_h (-)	v_P (km/s)	v_S (km/s)
	S_{uw}=0.00		
1	0.00	3.94	2.23
2	0.12	3.94	2.23
3	0.25	3.94	2.23
4	0.36	3.94	2.23
	S_{uw}=0.03		
1	0.00	3.92	2.21
2	0.12	3.92	2.21
3	0.25	3.92	2.21
4	0.36	3.92	2.21
	S_{uw}=0.09		
1	0.00	3.87	2.19
2	0.12	3.87	2.19
3	0.25	3.87	2.19
4	0.36	3.87	2.19

Table S3. ETC and ETC ratio at unfrozen conditions and frozen conditions, predicted to investigate sensitivity of the modified ETC model to the hydrate-forced heave.

ETC and ETC Ratio at Unfrozen Conditions

No.	p (LL)	S_h (-)	S_w (-)	S_g (-)	ETC (W/m.K)	ETC Ratio (-)
			h = 2 LL			
1	48	0.60	0.00	0.40	1.185	0.623
2	32	0.60	0.00	0.40	1.554	0.817
3	16	0.60	0.00	0.40	1.830	0.962
-	0	0.60	0.00	0.40	1.903	1.000
			h = 4 LL			
4	48	0.60	0.00	0.40	1.001	0.526
5	32	0.60	0.00	0.40	1.444	0.759
6	16	0.60	0.00	0.40	1.811	0.952
-	0	0.60	0.00	0.40	1.903	1.000
			h = 6 LL			
7	48	0.60	0.00	0.40	0.911	0.479
8	32	0.60	0.00	0.40	1.384	0.727
9	16	0.60	0.00	0.40	1.796	0.944
-	0	0.60	0.00	0.40	1.903	1.000

ETC and ETC Ratio at Frozen Conditions

No.	p (LL)	S_h (-)	S_i (-)	S_{uw} (-)	S_g (-)	ETC (W/m.K)	ETC Ratio (-)
				h = 2 LL			
1	48	0.10	0.42	0.08	0.40	1.419	0.400
2	32	0.10	0.42	0.08	0.40	2.172	0.612
3	16	0.10	0.42	0.08	0.40	3.245	0.915
-	0	0.10	0.42	0.08	0.40	3.546	1.000
				h = 4 LL			
4	48	0.10	0.42	0.08	0.40	1.128	0.318
5	32	0.10	0.42	0.08	0.40	1.978	0.558
6	16	0.10	0.42	0.08	0.40	3.214	0.906
-	0	0.10	0.42	0.08	0.40	3.546	1.000
				h = 6 LL			
7	48	0.10	0.42	0.08	0.40	1.004	0.283
8	32	0.10	0.42	0.08	0.40	1.888	0.532
9	16	0.10	0.42	0.08	0.40	3.189	0.899
-	0	0.10	0.42	0.08	0.40	3.546	1.000