Supplement of: Age-dependence of fracture toughness and microstructure in saline ice

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Phase I: Medium-scale laboratory SCB experiments (2024)

Table S1. Phase I medium-scale laboratory SCB fracture test results for saline ice aged 14 days. The physical dimensions and fracture parameters recorded are: R (sample radius), B (sample thickness), a_0 (initial crack length), P_p (peak fracture load), and K_{IC} (fracture toughness). These parameter definitions apply to all subsequent tables in this supplementary document.

Core	**Depth** (mm)	**Salinity** (ppt)	R (mm)	B (mm)	a_0 (mm)	P_p (N)	K_{IC} (kPa$\sqrt{}$m)
Core 1	0	6.3	146	100	73	269.9	26.2
	0	6.3	146	100	78	331.1	36.0
Core 2	0	6.3	146	100	75	228.4	23.2
Core 3	0	6.3	145	100	75	262.8	27.3
Core 4	0	6.3	145	98	73	324.1	32.8
	0	6.3	145	100	75	276.1	28.7

Table S2. Phase I medium-scale laboratory SCB fracture test results for saline ice aged 28 days.

Core	**Depth (mm)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	5.5	145	100	80	336.4	39.2
Core 2	0	5.5	146	100	77	414.5	44.0
	0	5.5	146	100	77	424.1	45.1
Core 3	0	5.5	145	100	77	494.2	53.8
Core 4	0	5.5	133	102	76	399.4	56.3
	0	5.5	133	105	72	429.3	53.2
Core 5	0	5.5	140	99	76	371.4	45.1
	0	5.5	133	98	80	336.2	54.5
Core 6	0	5.5	140	102	84	248.7	35.4

Table S3. Phase I medium-scale laboratory SCB fracture test results for saline ice aged 43 days.

Core	**Depth (mm)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	5.9	140	99	78	557.0	70.8
	0	5.9	138	101	86	448.4	71.2
Core 2	0	5.9	145	102	76	529.8	55.2
	0	5.9	136	101	76	597.1	78.6

Table S4. Phase I medium-scale laboratory SCB fracture test results for saline ice aged 62 days.

Core	**Depth (mm)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	4.7	139	92	76	386.0	51.7
	0	4.7	141	101	75	386.5	43.8
Core 2	0	4.7	141	93	79	373.2	50.4
Core 3	0	4.7	139	100	78	473.2	61.1
	0	4.7	141	100	76	404.2	47.3

Phase II: Small-scale field SCB experiments (2025)

Table S5. Summary of the Phase II small-scale field SCB fracture tests conducted in Svalbard (March 2025). The table details the environmental parameters (temperature, density, and salinity measured at the given core depth) alongside the extracted fracture properties across two ice cores.

Core	**Depth (mm)**	**Temp. (°C)**	**Density (kg/m^3)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	-5.5	890.0	6.7	71	95	48	175	46.4
	100	-5.0	902.7	7.2	71	100	45	266	58.4
	200	-4.4	912.2	5.3	70	89	46	181	49.3
	300	-3.9	915.7	3.9	70	94	45	254	62.5
	400	-3.0	919.1	4.3	71	101	45	200	43.5
Core 2	0	-4.6	890.0	6.7	75	106	40	390	52.6
	100	-4.6	902.7	7.2	64	92	35	322	68.4
	100	-4.2	902.7	7.2	70	91	35	458	72.5
	200	-4.8	912.2	5.3	69	94	37	470	83.2
	200	-4.4	912.2	5.3	67	94	34	374	63.3
	300	-4.8	915.7	3.9	71	89	41	390	79.7
	300	-4.3	915.7	3.9	64	90	35	409	88.8
	400	-4.0	919.1	4.3	69	94	37	383	67.8
	400	-3.8	919.1	4.3	67	94	36	288	53.8
	500	-2.8	917.1	6.5	66	90	35	87	17.0
	500	-2.8	917.1	6.5	69	89	34	182	29.5

Phase III: Small-scale laboratory SCB experiments (2025)

Table S6. Phase III small-scale laboratory SCB fracture test results for saline ice aged 28 days.

Core	**Depth (mm)**	**Temp. (°C)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	-3.2	5.2	69	88	34	213	34.9
	100	-3.0	5.1	67	88	33	310	53.4
Core 2	0	-4.0	5.2	69	89	32	325	47.9
	100	-3.5	5.1	68	87	34	187	32.5
Core 3	0	-3.0	5.2	70	90	35	202	32.3
	0	-3.5	5.2	67	90	35	248	46.0

Table S7. Phase III small-scale laboratory SCB fracture test results for saline ice aged 55 days.

Core	**Depth (mm)**	**Temp. (°C)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	-2.1	4.7	69	53	36	152	45.5
	0	-2.5	4.7	66	53	35	189	62.7
	60	-2.5	4.6	70	51	34	184	49.6
	120	-2.3	4.6	69	53	35	207	59.0
	120	-2.4	4.6	68	54	37	230	74.6
	180	-2.2	4.4	68	54	34	91	25.5
	240	-2.1	4.7	69	55	38	72	22.9
Core 2	0	-2.5	4.7	70	60	39	165	47.8
	0	-2.5	4.7	66	59	37	187	61.6
	60	-2.5	4.6	70	57	35	192	48.5
	60	-2.5	4.6	65	56	34	104	32.7
	120	-2.2	4.6	71	55	37	113	31.0
	120	-2.3	4.6	67	55	34	125	36.1
	180	-2.3	4.4	70	55	33	137	32.7
	240	-2.1	4.7	68	60	36	50	13.9
	240	-2.1	4.7	67	60	37	19	5.8

Table S8. Phase III small-scale laboratory SCB fracture test results for saline ice aged 85 days.

Core	**Depth (mm)**	**Temp. (°C)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	-3.0	5.1	68	57	37	150.5	46.2
	0	-3.0	5.1	67	57	37	149.6	48.4
	60	-3.0	4.6	68	57	38	192.3	62.0
	60	-2.9	4.6	67	58	37	117.9	37.5
	120	-2.8	4.0	69	58	38	208.9	62.9
	120	-2.8	4.0	67	58	37	96.4	30.6
	180	-2.6	4.4	68	57	36	113.8	33.3
	180	-2.7	4.4	66	57	39	38.0	14.3
Core 2	0	-3.0	5.1	68	55	34	286.9	78.9
	0	-3.0	5.1	68	55	37	195.5	62.2
	60	-3.0	4.6	69	58	39	72.0	22.2
	120	-2.8	4.0	69	54	37	171.9	53.0
Core 3	0	-3.0	5.1	68	58	38	172.6	54.7
	0	-3.0	5.1	69	58	36	181.1	49.1
	60	-3.0	4.6	69	57	40	94.4	31.8
	60	-2.8	4.6	69	57	37	230.4	67.3
	120	-2.7	4.0	70	56	38	148.0	43.9
	120	-2.7	4.0	67	56	37	45.9	15.1
	180	-2.6	4.4	69	58	37	132.9	36.3
	180	-2.6	4.4	68	58	38	110.1	34.9

Table S9. Phase III small-scale laboratory SCB fracture test results for saline ice aged 119 days.

Core	**Depth (mm)**	**Temp. (°C)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	-2.9	5.0	69	57	38	195.1	59.8
	0	-2.9	5.0	68	57	38	107.0	34.5
	60	-2.8	4.5	69	55	37	168.3	50.9
	60	-2.8	4.5	67	54	38	167.9	60.2
	120	-2.6	4.0	67	56	39	217.9	79.2
	180	-2.5	4.4	68	54	40	97.6	36.6
	180	-2.5	4.4	67	55	36	220.3	70.3
	240	-2.4	7.8	70	60	41	130.6	41.7
	240	-2.5	7.8	66	59	40	87.4	33.4
Core 2	0	-2.9	5.0	66	58	37	165.0	55.3
	0	-2.8	5.0	69	57	38	162.8	49.9
	60	-2.8	4.5	65	57	38	142.9	54.1
	60	-2.8	4.5	68	57	38	262.9	84.8
	120	-2.7	4.0	69	55	40	188.5	65.9
	120	-2.7	4.0	66	54	39	138.3	55.0
	180	-2.5	4.4	68	57	40	132.4	47.1
	180	-2.5	4.4	66	57	40	109.5	43.4
	240	-2.5	7.8	68	57	38	215.1	69.4
	240	-2.3	7.8	65	57	40	140.3	58.7

Phase IV: Small-scale field SCB experiments (2026)

Table S10. Summary of the Phase IV small-scale field SCB fracture tests conducted in Svalbard (March 2026). The table details the environmental parameters (temperature, density, and salinity measured at the given core depth) alongside the extracted fracture properties.

Core	**Depth (mm)**	**Temp. (°C)**	**Density (kg/m^3)**	**Salinity (ppt)**	R **(mm)**	B **(mm)**	a_0 **(mm)**	P_p **(N)**	K_{IC} **(kPa$\sqrt{}$m)**
Core 1	0	-4.4	879.6	8.9	70	68	36	132.5	34.7
	70	-4.4	902.3	8.1	70	61	35	276.9	71.5
	140	-4.0	908.4	6.7	67	65	38	254.3	82.5
	210	-4.3	914.0	5.3	69	63	39	262.9	83.3
	280	-3.5	915.1	4.9	66	66	35	186.6	54.2
	350	-2.9	914.3	4.7	65	63	33	200.0	58.0
	420	-2.8	913.5	5.1	70	63	38	209.8	60.3
	490	-2.6	914.1	5.1	70	62	33	84.5	19.4