

SUPPLEMENTARY INFORMATION

Table S1. Exposed bedrock parameters of *LHS* tip.

Location	Distance from LHS tip (km)	Lithology	Weathering degree	Fracture frequency (m-3)	Rock strength of Schmidt hammer rebound test (MPa)									
NE wall	1.1	Sandstone	Strong	70	23.5	25.5	27	28	30	31	31.5	32	32.5	34
	2.5	Sandstone	Strong	55	20.5	21	24.5	24.5	29	29	30	32	32.5	35.5
	4.5	Sandstone	Intermediate	50	26.5	31	33	36.5	37	38	39	39	39.5	41
	6.7	Sandstone	Strong	45	28.5	28.5	32	33.5	36.5	40	41	42	44	45.5
	10.1	Sandstone	Strong	35	24.5	27	28.5	30.5	38.5	38.5	40.5	41	41.5	43.5
	12.6	Sandstone	Intermediate- Strong	30	30.5	32	35.5	36	36.5	37	37.5	37.5	38.5	38.5
	13.8	Sandstone	Strong	30	34	34.5	35	35	36.5	38	39	40	42.5	42.5
	17.1	Sandstone	Intermediate- Strong	25	41.5	42	42.5	43	44	45.5	46.5	49	49.5	50.5
	19.5	Sandstone	Strong	20	44.5	46	47.5	48.5	51.5	52	52	52.5	53.5	53.5
	25.8	Sandstone	Intermediate	12	49	51.5	52.5	53.5	54.5	54.5	54.5	55	55	56
SW wall	0.2	Sandstone	Strong	60	20.5	21	24.5	24.5	27	29	30	31	32	33.5
	1.5	Sandstone	Strong	90	26	27.5	27.5	29	31	31.5	32	33	33.5	34
	3.3	Sandstone	Strong	70	27.5	28.5	31	33.5	34.5	34.5	35	35	38	39
	3.8	Sandstone	Strong	40	32	34	34	35	37	38.5	39	42	42.5	43
	4.7	Sandstone	Strong	45	21	21	21.5	21.5	22	22.5	22.5	23	24	25
	6.6	Sandstone	Strong	45	30.5	30.5	35.5	36	37.5	37.5	38	39	43.5	44
	10.3	Sandstone	Intermediate- Strong	25	41.5	42	42	42.5	44	44.5	45.5	46.5	46.5	47.5
	15.1	Sandstone	Strong	90	13	13.5	14.5	15	15.5	15.5	16	16	16.5	17
	20.8	Sandstone	Strong	45	21.5	23	23.5	24.5	27	27.5	30	31.5	31.5	32

Table S2. Exposed bedrock parameters of *QNS*.

Location	Distance from QNS (km)	Lithology	Weathering degree	Fracture frequency (m-3)	Rock strength of Schmidt hammer rebound test (MPa)									
NE wall	0.3	Sandstone	Strong	60	14.5	15	15.5	20	20	20.5	21	24	25	26
	0.4	Sandstone	Strong	50	22.5	22.5	24.5	25	26	30	33.5	34.5	37	39
	0.5	Sandstone	Strong	80	15	15.5	16	16	20	20	23	23.5	25.5	30
	0.7	Sandstone	Strong	100	16.5	18	18.5	20.5	21.5	21.5	22.5	22.5	25.5	25.5
	2.3	Granite	Intermediate	30	42	42.5	44	45.5	48	48.5	52	52.5	53	54
	4.4	Granite	Strong	15	50	55	57	58	58.5	59	59.5	60.5	60.5	61.5
	6.3	Granite	Intermediate- Strong	12	53.5	58.5	63	63.5	66	66.5	66.5	67	67	68
	11.5	Sandstone	Intermediate- Strong	40	41.5	44	45	47	49	49.5	50	50	50.5	51
	15.7	Sandstone	Intermediate- Strong	15	41	40	53.5	55	52.5	53.5	41	46.5	45	52.5
SW wall	1	Slate	Strong	>100										
	1.1	Slate	Strong	>100	9.5	11	11	11	11.5	11.5	12	12	12.5	13.5
	3.8	Slate	Strong	75	12	12.5	13	13.5	13.5	13.5	14	14	15.5	16
	4.2	Slate	Strong	65	19	19	19	19	20	21.5	21.5	22.5	23	24
	5.9	Slate	Strong	50	26	26.5	27	27.5	28	28	29	32.5	35	36
	8.8	Slate	Strong	40	26.5	26.5	28.5	29.5	32	37.5	40.5	43	43	44
	11	Slate	Strong	30	46.5	49.5	50	51	53	53	53.5	54	54	55.5
	16	Slate	weak	20	43	45.5	47.5	51	51	52.5	54	55	58	58.5
	18.6	Slate	Intermediate- Strong	12	47	49.5	51	51.5	51.5	52	54	55	56	58

Table S3. Exposed bedrock parameters of *DFS*.

Location	Distance from DFS (km)	Lithology	Weathering degree	Fracture frequency (m-3)	Rock strength of Schmidt hammer rebound test (MPa)									
NE wall	0.9	Slate	Strong	80	21	21.5	25	25	26	31.5	33	33	34	34
	1.4	Slate	Strong	70	13.5	15.5	16.5	19.5	20	23	25.5	26.5	27.5	28.5
	3	Sandstone	Strong	45	23.5	26	26.5	28.5	29.5	30	30.5	31	31	33
	3.5	Sandstone	Strong	55	21.5	21.5	22.5	25	25	25.5	28	29.5	30.5	31
	4.7	Sandstone	Strong	45	25.5	31.5	32.5	32.5	32.5	33	35.5	35.5	36	37
	6.1	Sandstone	Strong	45	27	27	27	28	29	29	32	34	34.5	37
	7.2	Sandstone	Strong	40	29.5	30	31.5	31.5	32	32.5	34	34	34.5	35
	8.3	Sandstone	Strong	30	31.5	31.5	32	36.5	37.5	39.5	41.5	42.5	43.5	44.5
	9.1	Sandstone	Strong	30	40	40.5	40.5	42.5	44	45	46.5	47	47.5	49.5
	10.7	Sandstone	Strong	50	37	42.5	45	46.5	47	51.5	51.5	52.5	53.5	56.5
	13.5	Sandstone	Intermediate	25	48	52.5	54	54.5	58	59.5	62.5	63.5	63.5	65
SW wall	0.2	Slate	Strong	>100	22.5	19	8.5	23	12.5	23.5	16	22.5	18.5	21
	0.7	Slate	Strong	60	31	21	30.5	23	14	19	24.5	32.5	29	22.5
	1.4	Slate	Strong	50	25	25.5	25.5	28	28.5	28.5	31	32	32	34.5
	2.1	Slate	Intermediate- Strong	50	18.5	19	19.5	20	20	21	21.5	23	23	23.5
	3.7	Slate	Strong	50	17	17.5	19	19.5	20	20	21.5	23.5	23.5	24
	5.9	Sandstone	Strong	60	22	22.5	24	28	29	30	31.5	31.5	34.5	36.5
	7	Slate	Strong	30	25.5	27.5	27.5	28	28.5	29	29.5	29.5	35	35.5
	10.7	Slate	Strong	30	37	40	40	40.5	41	43	44	44	45.5	46.5
	16.2	Slate	Strong	20	37.5	39	40	40	40	41.5	45	47.5	49.5	50.5
	19.5	Sandstone	Strong	20	46	50.5	51	51	52.5	52.5	53.5	54.5	55.5	55.5
	25.8	Sandstone	Intermediate	15	58.5	58.5	58.5	59.5	59.5	61.5	61.5	62	62.5	62.5

Table S4. Exposed bedrock parameters of *DFS*.

Location	Distance from KDS (km)	Lithology	Weathering degree	Fracture frequency (m-3)	Rock strength of Schmidt hammer rebound test (MPa)									
NE wall	0.7	Sandstone	Strong	60	20	21	22	27	29.5	35	36	36	36.5	37
	1	Sandstone	Strong	90	11	11.5	12	12.5	13	15	16.5	17	18.5	18.5
	1.3	Sandstone	Intermediate- Strong	30	26.5	26.5	30	31.5	31.5	32.5	33.5	34	34	36
	1.5	Sandstone	Strong	50	31.5	31.5	31.5	32.5	32.5	33	34.5	36	37	38
	2.3	Sandstone	Intermediate	30	28.5	28.5	29	29.5	29.5	30	31	35	35.5	37
	3	Sandstone	Strong	60	21	21	23	23.5	25.5	25.5	25.5	27	28	32
	3.9	Sandstone	Strong	45	27.5	28	28.5	29	29.5	32	33.5	34	34	35.5
	4.7	Sandstone	Strong	40	35	35.5	36	36	36.5	36.5	39	39	41.5	42.5
	7.3	Sandstone	Intermediate	30	32	34	35.5	42	42.5	43	43.5	45.5	47	47.5
	9.4	Sandstone	Strong	30	39	40	41	41	42.5	43	46	47	49	50
	11.4	Sandstone	Strong	25	43	44.5	46	46	46.5	49	50	50.5	51	51
	15	Sandstone	Strong	15	55	56.5	58	59	60.5	60.5	61.5	62	63	65
	19	Sandstone	Intermediate	12	62.5	63	63.5	64	67	67	70	70.5	70.5	71.5
SW wall	1.3	Slate	Strong	60	16.5	18.5	18.5	18.5	18.5	19.5	20.5	21	23	23.5
	2.8	Slate	Strong	50	28.5	29	29.5	29.5	30	31	35	35.5	37	37.5
	4.6	Slate	Intermediate- Strong	35	27	28.5	29	29.5	30	30	32	32	32.5	33
	6.1	Slate	Intermediate	40	23.5	23.5	24	24	24.5	28	28.5	28.5	29	32
	7.6	Slate	Intermediate	40	27	29.5	29.5	31.5	32	33	33	38.5	40.5	41
	8.9	Sandstone	Strong	30	32	35	35.5	36.5	38	38.5	40	42	45	45.5

Table S5. Exposed bedrock parameters of *KDS*.

Location	Distance	Lithology	Weathering degree	Fracture frequency (m-3)	Rock strength of Schmidt hammer rebound test (MPa)									
	from KDS (km)													
NE wall	0.3	Granite	Strong	65	26.5	26.5	28.5	29	31	31	31.5	33	33	33.5
	1.1	Phyllite	Strong	80	16	9	27	12.5	15	12.5	13.5	10.5	9.5	17
	1.6	Phyllite	Strong	50	25	25	25.5	27.5	28	28.5	31	33.5	34.5	34.5
	2.4	Marble	Intermediate	5~10	55.5	56	57	57.5	58	59	60.5	61	63	63.5
	3.1	Marble	Intermediate	15	59.5	62	62	63	65.5	66	66	66.5	66.5	68
	3.9	Phyllite	Strong	50~60	21	24.5	26.5	27	29.5	30	30	30.5	31.5	36.5
	4.2	Granite	Intermediate-Strong	20	49	49.5	50.5	51	52	52	52.5	53	55	55
	5.2	Granite	Intermediate	5~10	51	51.5	53.5	55.5	56.5	57.5	58	58.5	60.5	61
	7	Granite	Intermediate	30	48	49	51	53	54	56	57.5	58	60	61
	9.8	Granite	Intermediate	12~15	52.5	53.5	55	55.5	56.5	58	58	58.5	59.5	62.5
	12.7	Granite	weak	10	49.5	57	58	60	60	60.5	63	64	64	68
	17.3	Granite	Fresh	5	52	53.5	62.5	64.5	69	70	70.5	70.5	72	76
SW wall	0.6	Granite	Full	>100	29	31	31.5	33.5	34	34	34.5	37.5	38.5	42
	2.3	Granite	Intermediate	50	47.5	49	51	51.5	54	55.5	57.5	58	61	61
	3.2	Granite	Intermediate	15	35	37	37.5	38	46.5	48.5	52	52	52.5	56
	4.5	Granite	Intermediate	45	43	46.5	51.5	51.5	55	56.5	56.5	59	59.5	60.5
	5.1	Granite	Intermediate-Strong	15	47	49	52	54	62	65	66	69	69	69
	6.1	Granite	Intermediate-Strong	12~15	27.5	30	31.5	33.5	34	35	40	42	42.5	51
	8	Granite	Intermediate-Strong	30	21	22.5	29	30.5	33.5	35	35.5	36	36	39
	9	Granite	Strong	50	35	36	36	36.5	46	51	52	52.5	54	54.5
	10.3	Granite	weak	20	42	44	45	47	49.5	52	52.5	55	56	57
	16.1	Sandstone	Intermediate	30	55	60	60	60.5	61.5	62	63	64.5	66	66.5