

Table S1. Geochemical characteristics of Boulder Clay Brines and similar environments.

Site	Ref.	ID	pH	Conductivity	Cl ⁻	SO ₄ ²⁻	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺	Ionic strength*	C _{tot}	N _{tot}	P _{tot}
				(mS cm ⁻¹)	(meq L ⁻¹)	(meq L ⁻¹)	(meq L ⁻¹)	(meq L ⁻¹)	(meq L ⁻¹)	(meq L ⁻¹)	(M)	(mM)	(mM)	(μM)
BC	This study	BC-1	7.2±0.1	172±3	3800±300	60±7	2700±110	110±10	160±30	1100±15	4.6	28±1	43±1	14±2
BC	This study	BC-2	7.2±0.1	176±4	3800±230	60±8	2700±110	110±10	170±25	1100±10	4.7	27±1	42±1	21±2
EnB	[1]	EnB	-	-	2043	117	1683	31	157	398	2.5	108 ^a	0.009 ^b	1.3 ^c
BF	[1]	BF-1	-	-	1320	102	1117	19	109	270	1.7	-	-	-
“	[1]	BF-2	-	-	1450	97	1104	18	104	254	1.7	-	0.17 ^b	0.7 ^c
“	[1]	BF-3	-	-	1347	96	1106	20	105	258	1.7	55.4 ^a	0.09 ^b	-
WLB	[1]	WLB-1	-	-	2172	88	1535	34	108	688	2.8	78.8 ^a	0.30 ^b	0.3 ^c
“	[2]	WLB-2	-	-	2299	94	1789	43	124	804	3.1	-	-	-
“	[3]	WLB-3	-	-	1246	78	970	15	79	392	1.7	-	-	-
“	[3]	WLB-4	-	-	1942	94	1474	26	99	587	2.5	-	-	-
“	[3]	WLB-5	-	-	2529	103	1930	34	111	775	3.2	-	-	-
ELB	[4]	ELB-1	-	-	4635	66	2140	70	69	2556	6.1	-	-	-

“	[4]	ELB-2	-	-	4798	67	2265	74	72	2588	6.3	-	-	-
“	[4]	ELB-3	-	-	5133	74	2553	73	68	2639	6.7	-	-	-
“	[4]	ELB-4	-	-	4949	70	2441	74	70	2634	6.5	-	-	-
LV	[5]	LV	-	-	217	16	294	20	1210	632	2.1	-	-	-
VD	[6]	VD	6.2	188 (psu)	3318	117	1914	83	60	1330	4.2	109 ^a	4.8 ^a	5 ^a
TF	[7]	TF-1	-	-	< lod	221	< lod	14	40	167	0.4	58.8	-	-
“	[7]	TF-2	-	-	< lod	227	< lod	22	38	230	0.5	64.5	-	-
	[8]	SW	-	-	559	58	481	11	15	108	0.7	-	-	-

^a total C given as the individual sum of HCO₃⁻+dissolved organic carbon (DOC)+dissolved inorganic carbon (DIC). ^btotal N given as the individual sum of NH₄⁺+NO₂⁻+NO₃⁻. ^c given as soluble reactive phosphate. ^dgiven as P-PO₄. [1] Lyons et al. 2019 [2] Lyons et al. 2020 [3] Dowling and Jones 2014 [4] Doran 2014 [5] Cartwright and Harris 1981 [6] Murray et al. 2012 [7] Borruso et al. 2018 [8] Pilson 2013. * The ionic strength was calculated as $\frac{1}{2} \sum z_i^2 C_i$ where z_i is the charge and C_i the molar concentration of the i-th ion.

Table S2 Eigenvalues and explained variance from the Principal Component Analysis performed for the 6 major ion concentrations (Cl, SO₄, Na, K, Ca and Mg) and 20 objects

Principal Component (PC)	Eigenvalue	Variance
PC1	3.55	59.1
PC2	1.57	26.2
PC3	0.47	7.8
PC4	0.35	5.9

PC5	0.05	0.9
PC6	0.004	0.06

Table S3 Loadings from the Principal Component Analysis performed for the 6 major ion concentrations (Cl, SO₄, Na, K, Ca and Mg) and 20 objects

Variable	PC1	PC2	PC3	PC4	PC5	PC6
Ca	0.351	-0.783	0.511	-0.041	0.024	0.003
Mg	-0.870	-0.270	-0.052	-0.406	-0.040	-0.030
Na	-0.937	0.204	0.144	0.180	0.165	-0.018
K	-0.900	-0.209	0.084	0.344	-0.145	-0.005
Cl	-0.975	0.117	0.089	-0.161	0.008	0.048
SO ₄	0.177	0.886	0.411	-0.099	-0.064	-0.010

Table S4 Scores from the Principal Component Analysis performed for the 6 major ion concentrations (Cl, SO₄, Na, K, Ca and Mg) and 20 objects

	PC1	PC2	PC3	PC4	PC5	PC6
BC-1	-2.19	-0.56	0.24	1.37	0.02	0.08
BC-2	-2.24	-0.60	0.30	1.43	0.02	0.04
EnB	0.76	0.46	0.23	0.22	0.26	-0.04

BF-1	1.59	0.27	-0.36	0.06	-0.03	-0.04
BF-2	1.57	0.24	-0.42	0.04	0.01	0.06
BF-3	1.58	0.20	-0.44	0.09	-0.02	0.00
WLB-1	0.53	0.06	-0.30	0.08	0.13	0.01
TF-1	1.03	2.40	1.14	-0.33	0.02	0.09
TF-2	0.89	2.43	1.23	-0.26	-0.18	0.01
LV	3.03	-4.01	1.48	-0.38	-0.06	0.01
WLB-2	0.14	0.10	-0.07	0.22	0.17	-0.14
WLB-3	1.65	-0.04	-0.81	-0.06	-0.01	0.00
WLB-4	0.84	0.20	-0.33	0.01	0.20	-0.03
WLB-5	0.11	0.35	0.02	0.07	0.46	-0.06
ELB-1	-2.32	-0.49	-0.31	-0.79	-0.13	0.02
ELB-2	-2.55	-0.47	-0.22	-0.72	-0.09	0.02
ELB-3	-2.87	-0.28	-0.04	-0.74	0.18	0.03
ELB-4	-2.75	-0.39	-0.13	-0.71	0.06	-0.01
VD	-1.18	0.34	0.25	0.34	-0.70	-0.13
SW	2.38	-0.23	-1.45	0.06	-0.30	0.07

Table S5 Major ion ratios (meq/meq)

Site	ID	Na/Cl	Mg/K	Ca/K	Cl/SO ₄	Mg/Ca	Ca/Cl	Ca/SO ₄	SO ₄ /Na
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BC	BC-1	0.70	10.3	1.5	63.9	7.0	0.041	2.60	0.022
BC	BC-2	0.71	10.0	1.5	63.6	6.5	0.045	2.83	0.022
EnB	EnB	0.82	12.8	5.1	17.5	2.5	0.077	1.34	0.070
BF	BF-1	0.85	14.2	5.7	12.9	2.5	0.082	1.07	0.091
“	BF-2	0.76	14.1	5.8	14.9	2.4	0.072	1.07	0.088
“	BF-3	0.82	12.9	5.3	14.0	2.5	0.078	1.10	0.087
WLB	WLB-1	0.71	20.2	3.2	24.7	6.4	0.050	1.22	0.058
“	WLB-2	0.78	18.7	2.9	24.5	6.5	0.054	1.32	0.053
“	WLB-3	0.78	26.1	5.3	16.0	5.0	0.064	1.02	0.080
“	WLB-4	0.76	22.6	3.8	20.7	5.9	0.051	1.06	0.064
“	WLB-5	0.76	22.8	3.3	24.6	7.0	0.044	1.09	0.053
ELB	ELB-1	0.46	36.5	1.0	70.2	37.0	0.015	1.05	0.031
“	ELB-2	0.47	35.0	1.0	71.6	35.9	0.015	1.06	0.031
“	ELB-3	0.50	36.2	0.9	69.4	38.8	0.013	0.91	0.030
“	ELB-4	0.49	35.6	0.9	70.7	37.6	0.014	1.00	0.029
LV	LV	1.35	31.6	60.5	13.6	0.5	5.58	75.50	0.055
VD	Vida	0.58	16.0	0.7	28.4	22.2	0.018	0.52	0.061
TF	TF-1	-	11.9	2.9	-	4.2	-	0.18	-
“	TF-2	-	10.5	1.7	-	6.1	-	0.17	-
SW	SW	0.86	9.8	1.4	9.6	7.2	0.027	0.26	0.120

Table S6 Seawater Enrichments [meq/meq] of the major ions. Seawater chemical composition from Pilson 2013.

Site	ID	Cl ⁻	SO ₄ ²⁻	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺
BC	BC-1	6.9	1.0	5.6	10.2	10.4	10.1
BC	BC-2	6.8	1.0	5.7	10.5	11.4	10.5
EnB	EnB	3.7	2.0	3.5	2.9	7.3	2.5
BF	BF-1	2.4	1.8	2.3	1.8	7.3	2.5
“	BF-2	2.6	1.7	2.3	1.7	7.0	2.5
“	BF-3	2.4	1.7	2.3	1.9	7.1	2.3
WLB	WLB-1	3.9	1.5	3.2	3.2	7.3	2.4
“	WLB-2	4.1	1.6	3.7	4.1	8.3	7.4
“	WLB-3	2.2	1.3	2.0	1.5	5.3	3.6
“	WLB-4	3.5	1.6	3.1	2.5	6.7	5.4
“	WLB-5	4.5	1.8	4.0	3.2	7.5	7.2
ELB	ELB-1	8.3	1.1	4.5	6.6	4.6	23.6
“	ELB-2	8.6	1.2	4.7	7.0	4.8	23.9
“	ELB-3	9.2	1.3	5.3	7.0	4.5	24.4
“	ELB-4	8.9	1.2	5.1	7.1	4.7	24.3

LV	LV	0.4	0.3	0.6	1.9	81.1	5.8
VD	VD	5.9	2.0	4.0	7.9	4.0	12.3
TF	TF-1	-	3.8	-	1.3	2.7	1.5
“	TF-2	-	3.9	-	2.1	2.6	2.1