



Supplement of

Imprint of minute hydrocarbon seepage on solid phase and pore water geochemistry in organic-poor seafloor sediment

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Supplementary Material

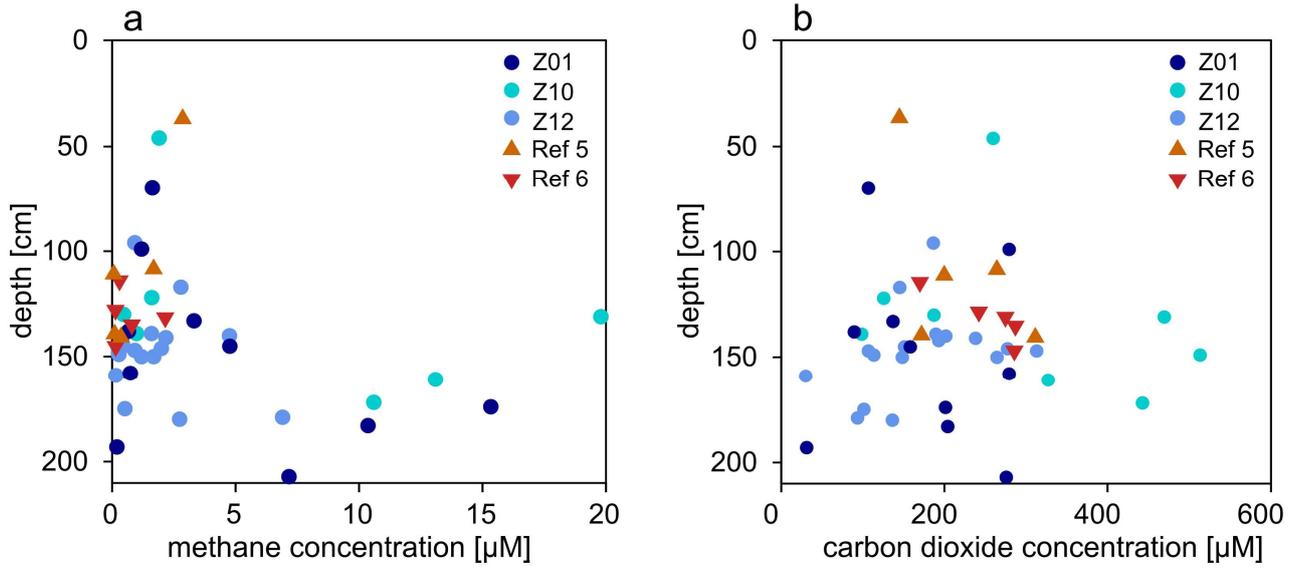
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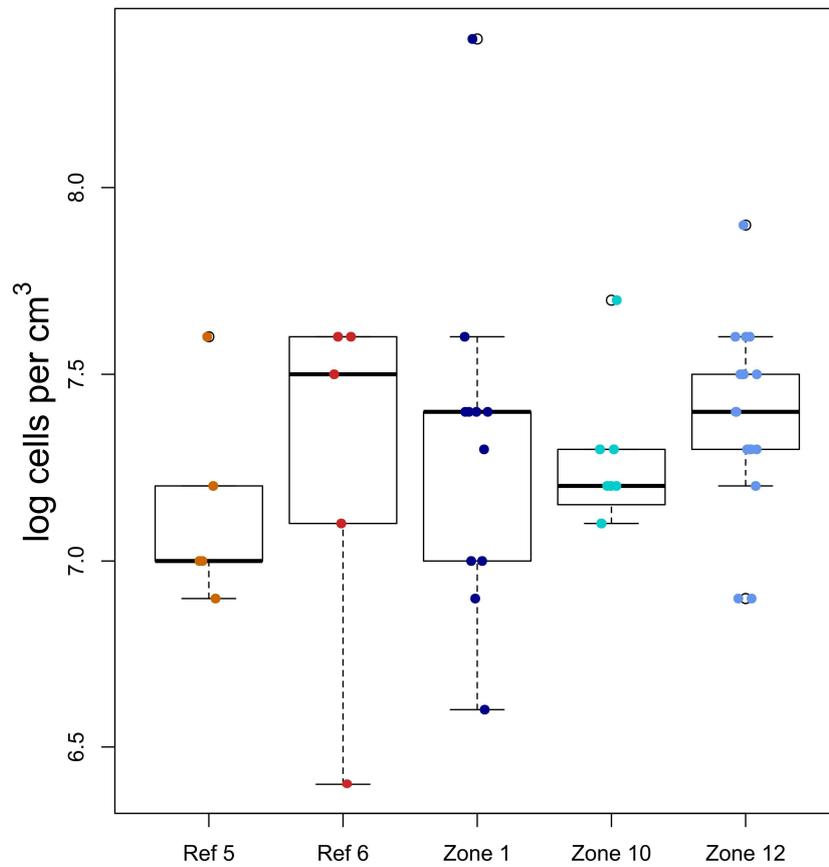
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Supplementary Tables

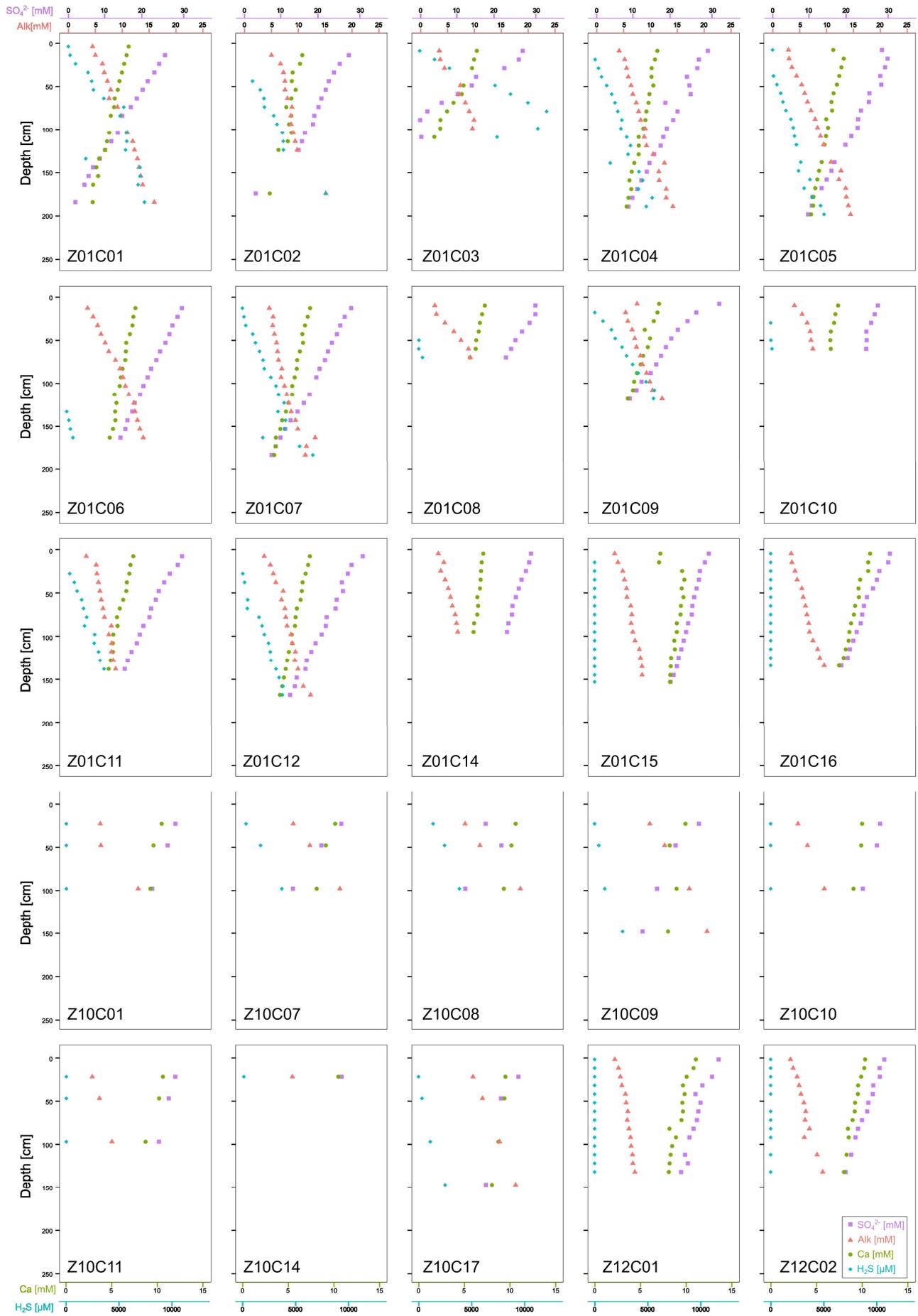
- Supplementary Table S1. Core locations
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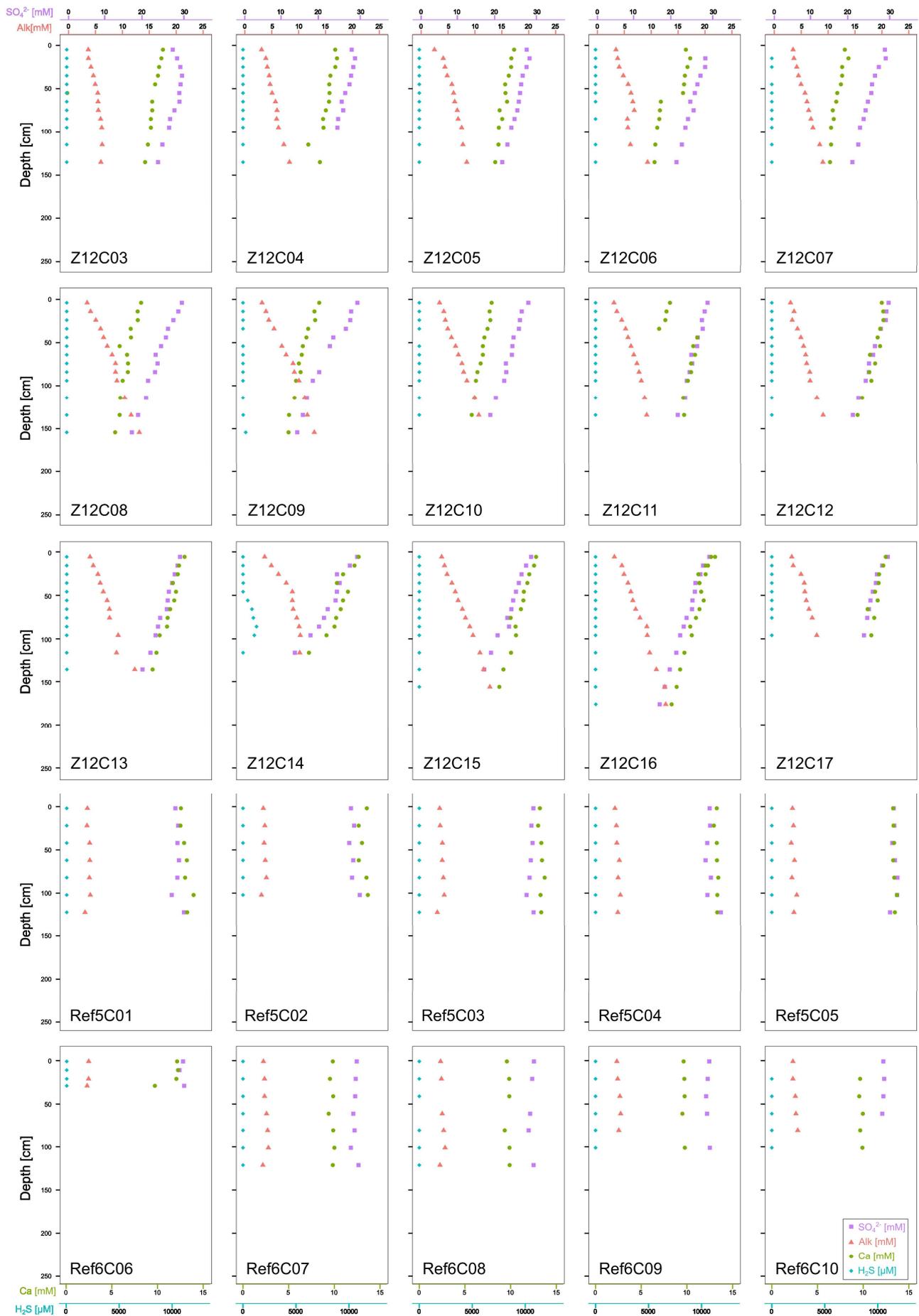
Supplementary Figure S1. CO₂ and CH₄ concentrations. This figure was modified after (Schnabel et al., 2025).



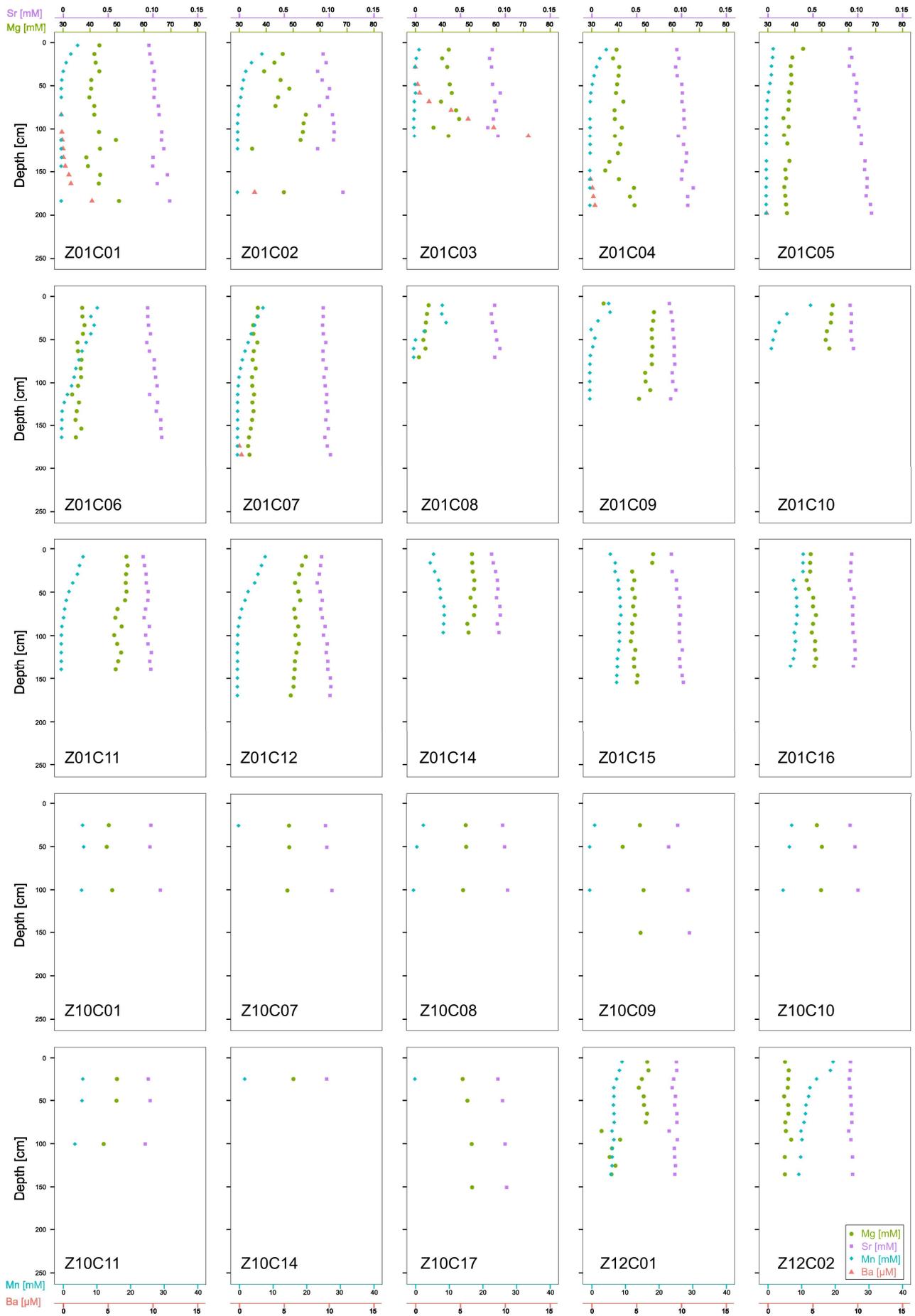
Supplementary Figure S2. Cell counts. The cell counts of HC sites equal those from the reference sites.



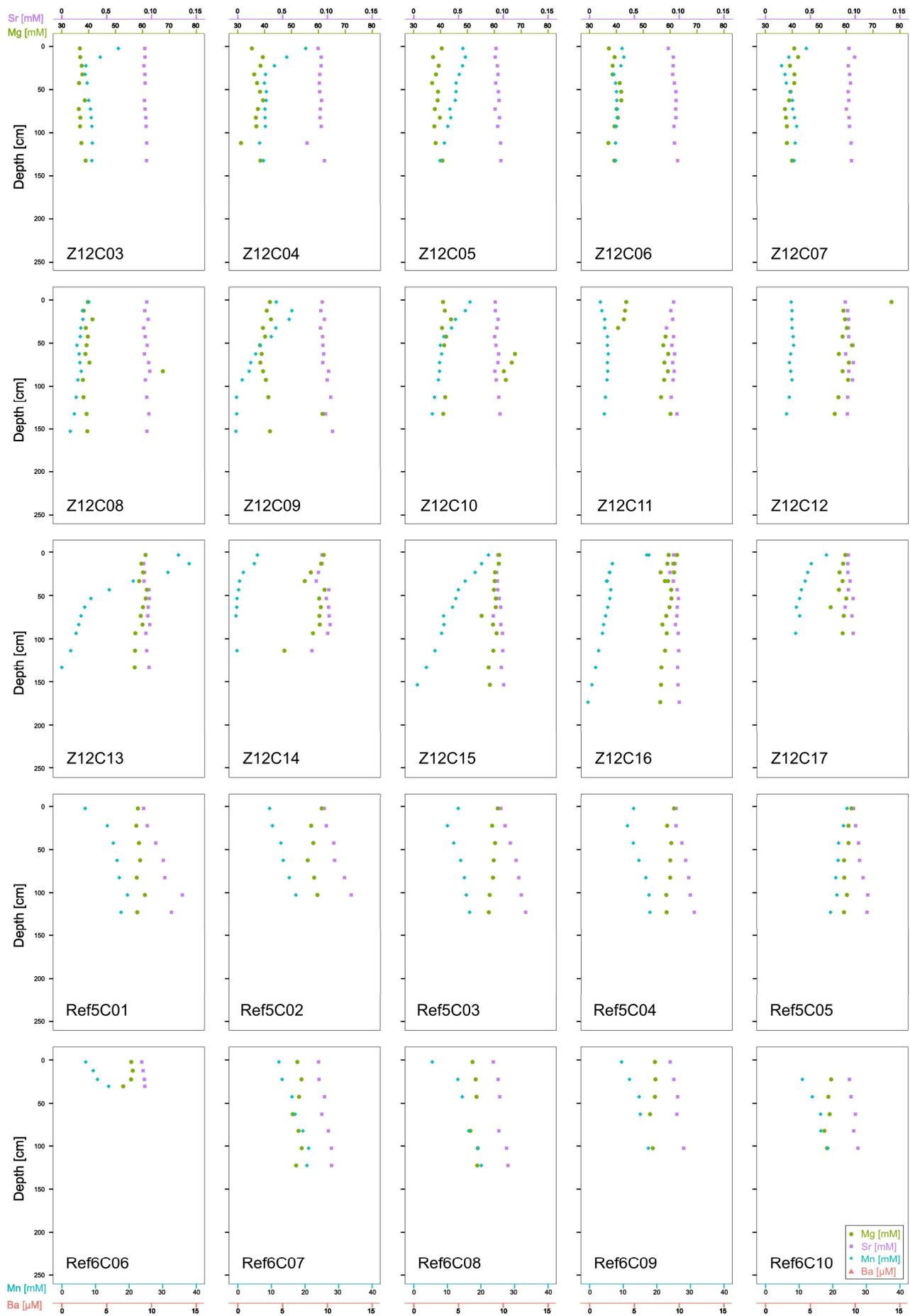
Supplementary Figure S3. All 50 downcore profiles for pore water SO_4^{2-} , alkalinity, Ca^{2+} , and H_2S (part 1).



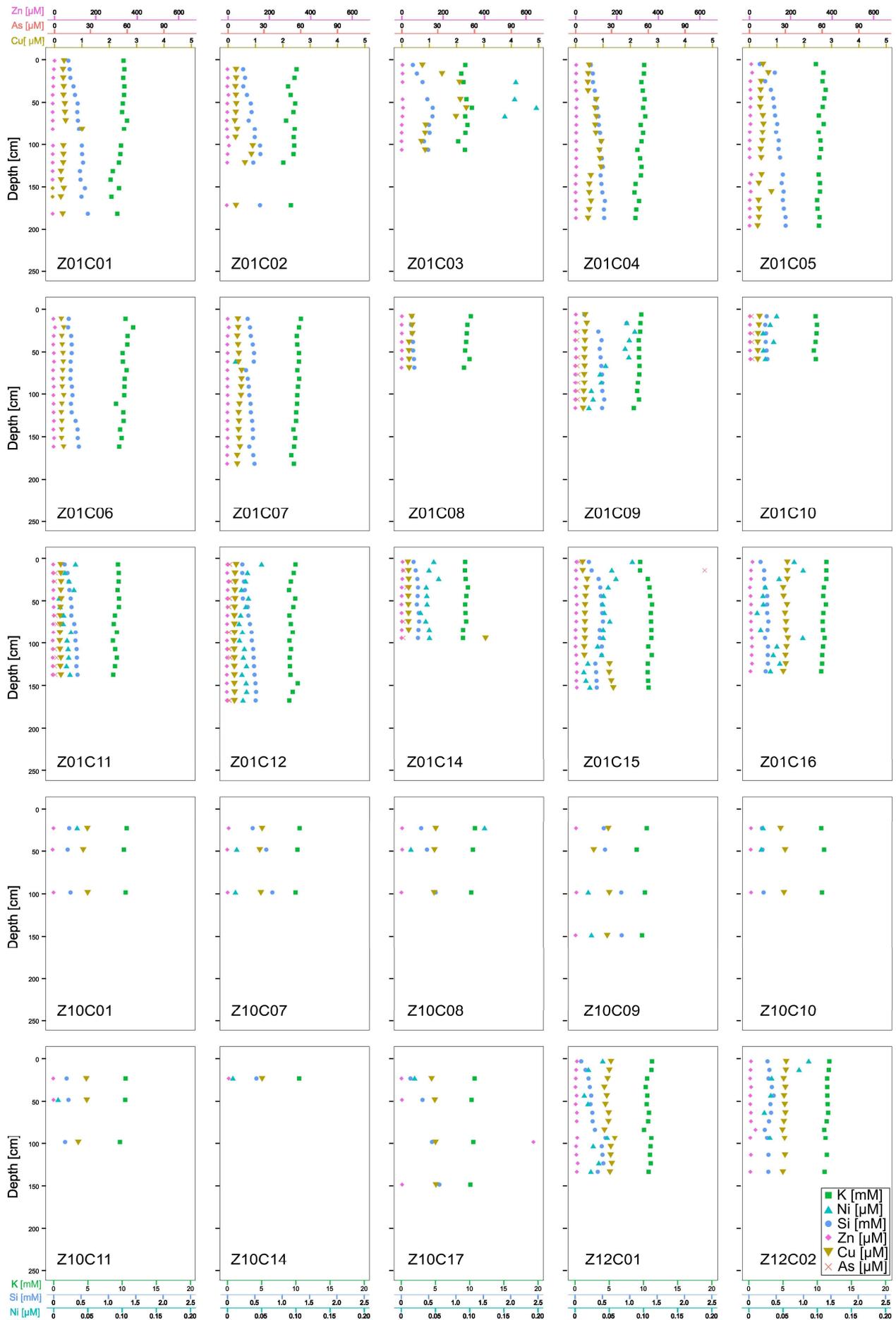
Supplementary Figure S3. All 50 downcore profiles for pore water SO_4^{2-} , alkalinity, Ca^{2+} , and H_2S (part 2).



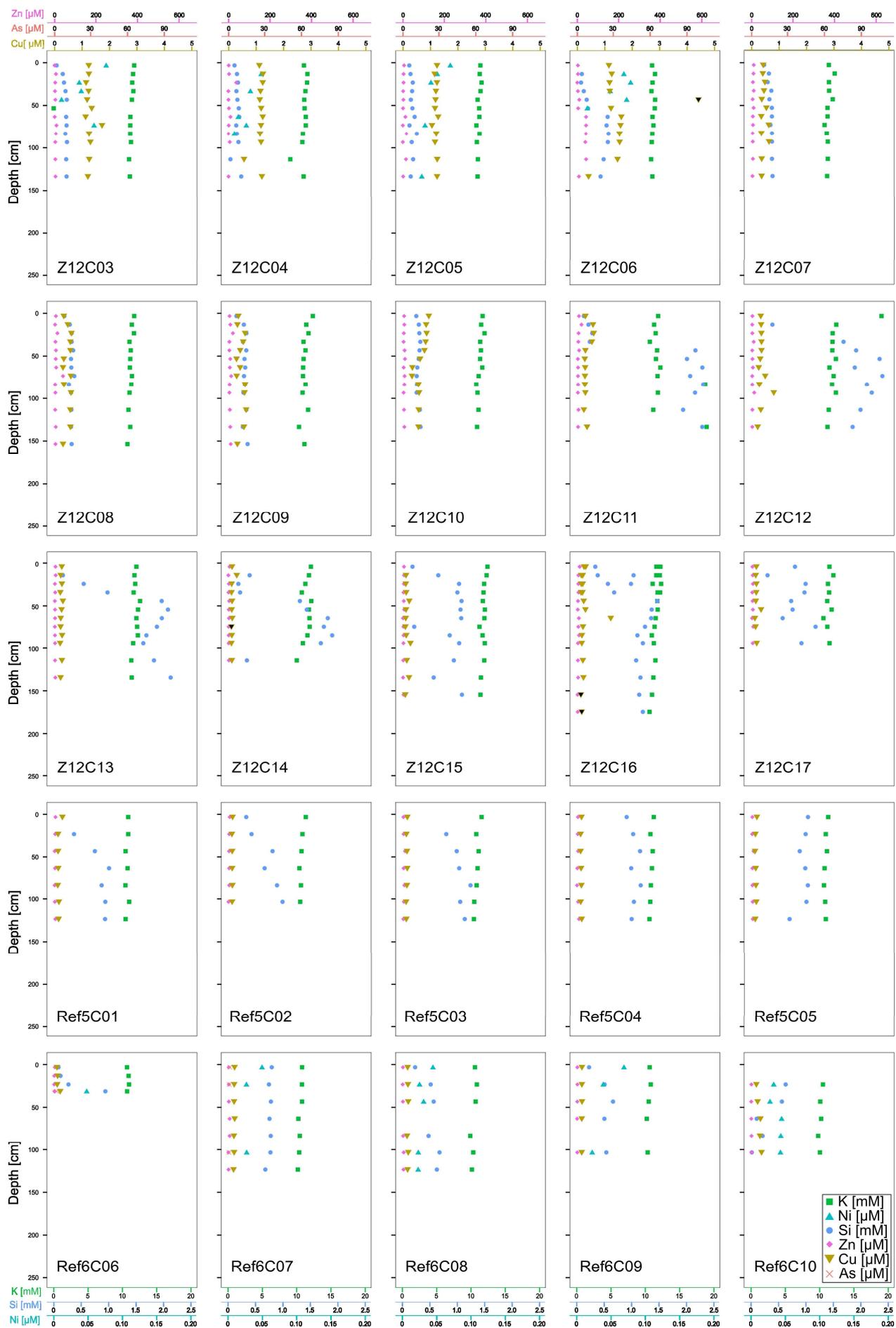
Supplementary Figure S4. All 50 downcore profiles for pore water for Sr²⁺, Mg²⁺, Mn²⁺ and Ba²⁺ (part 1).



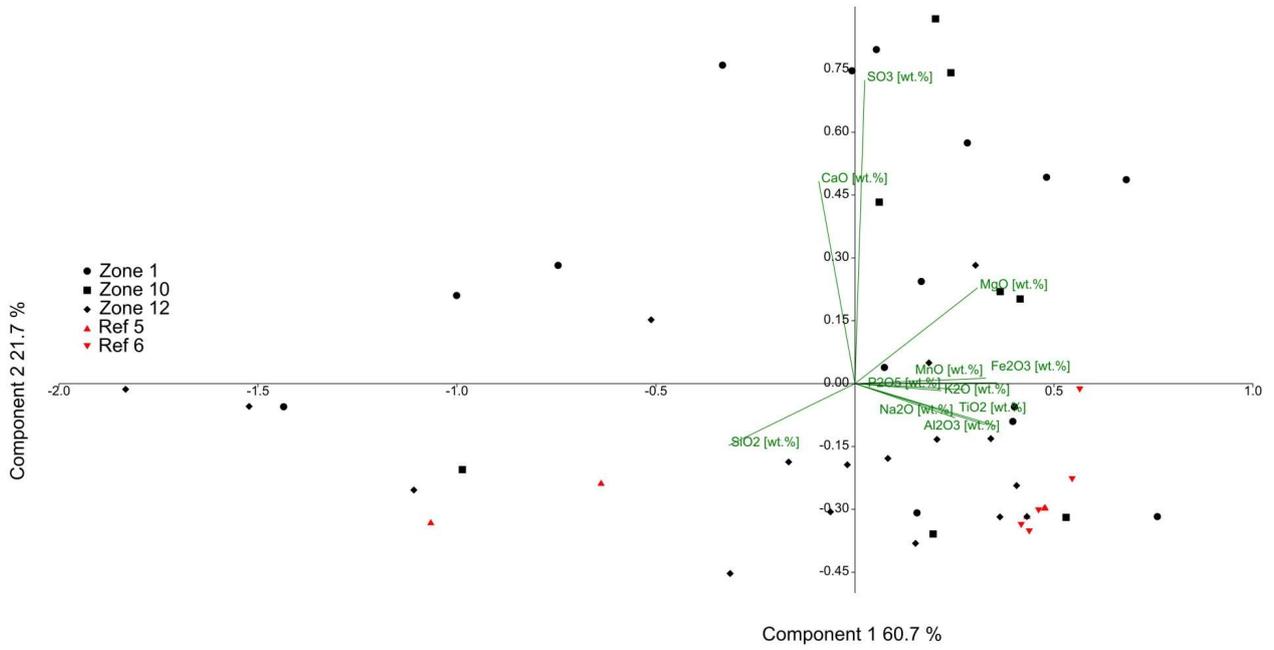
Supplementary Figure S4. All 50 downcore profiles for pore water for Sr^{2+} , Mg^{2+} , Mn^{2+} and Ba^{2+} (part 2).



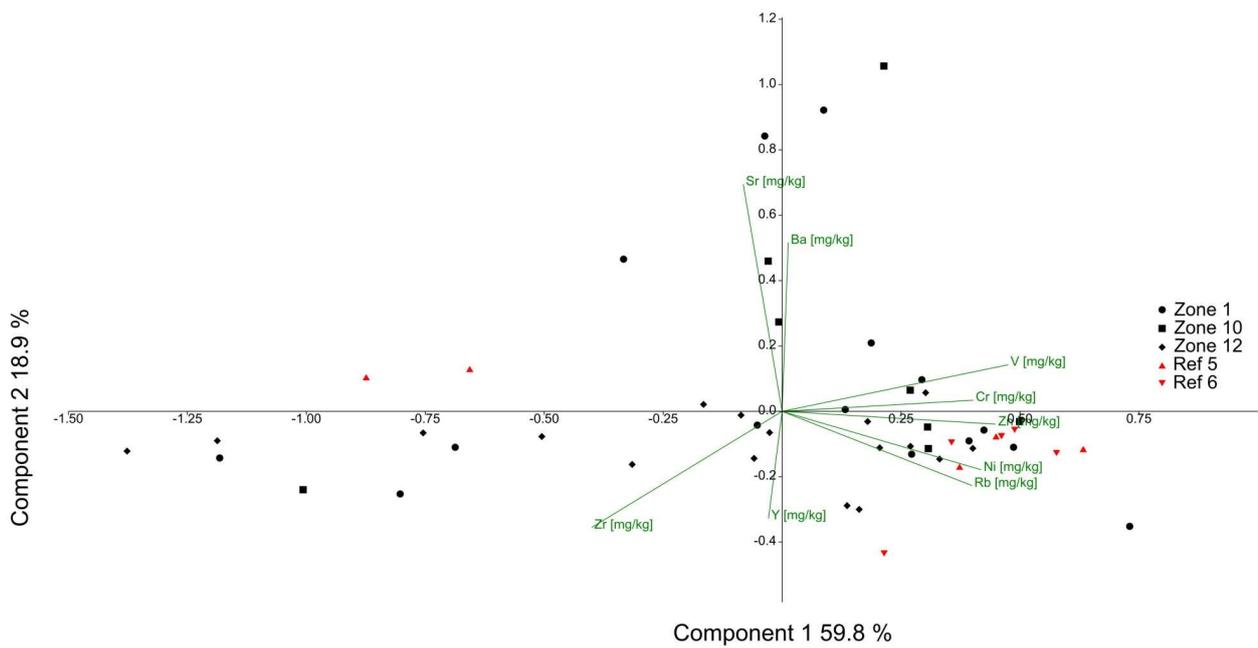
Supplementary Figure S5. All 50 downcore profiles for pore water Zn^{2+} , As^{2+} , Cu^{2+} , K^+ , Si^{4+} , and Ni^{2+} (part 1).



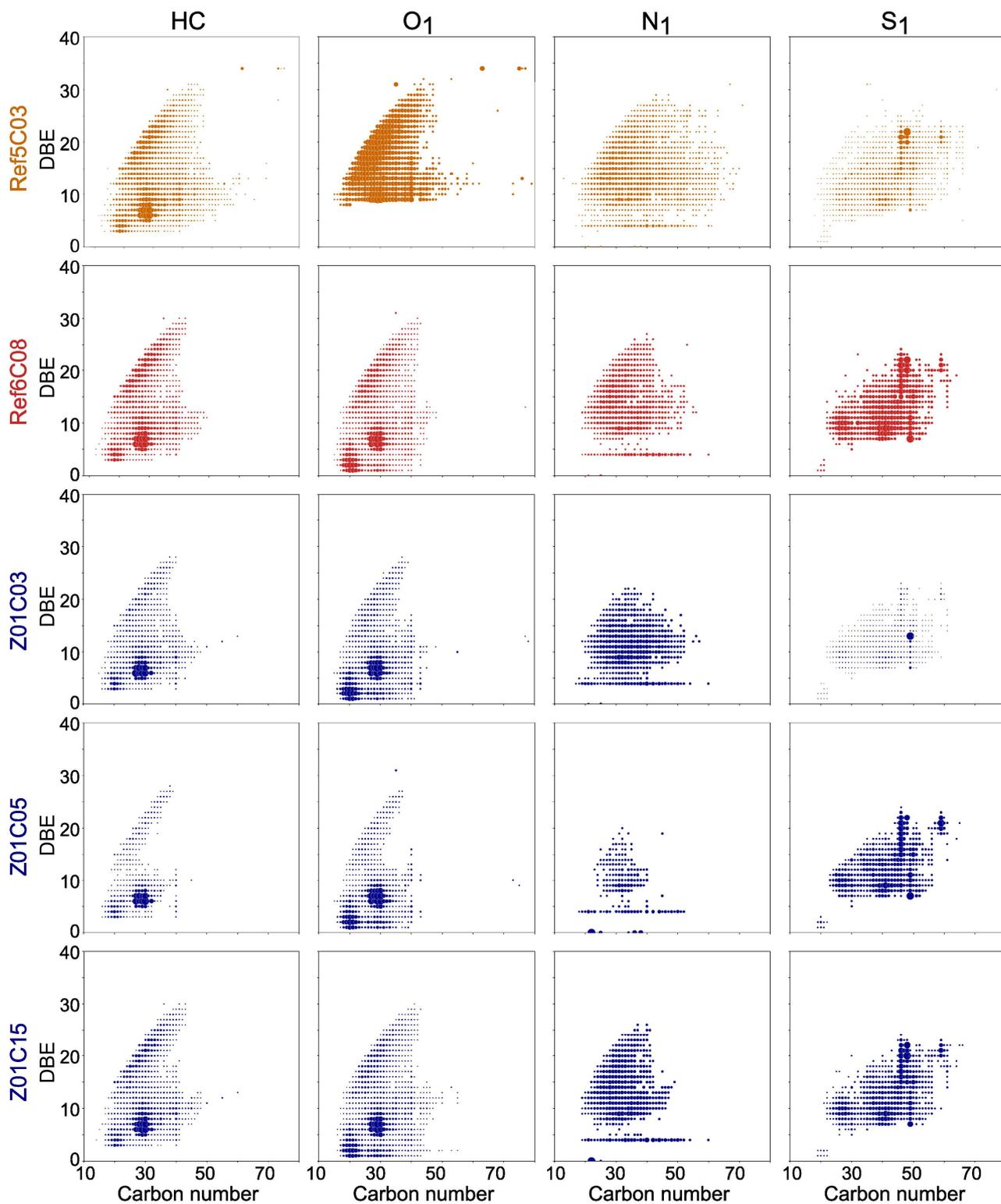
Supplementary Figure S5. All 50 downcore profiles for pore water Zn^{2+} , As^{2+} , Cu^{2+} , K^+ , Si^{4+} , and Ni^{2+} (part 2).



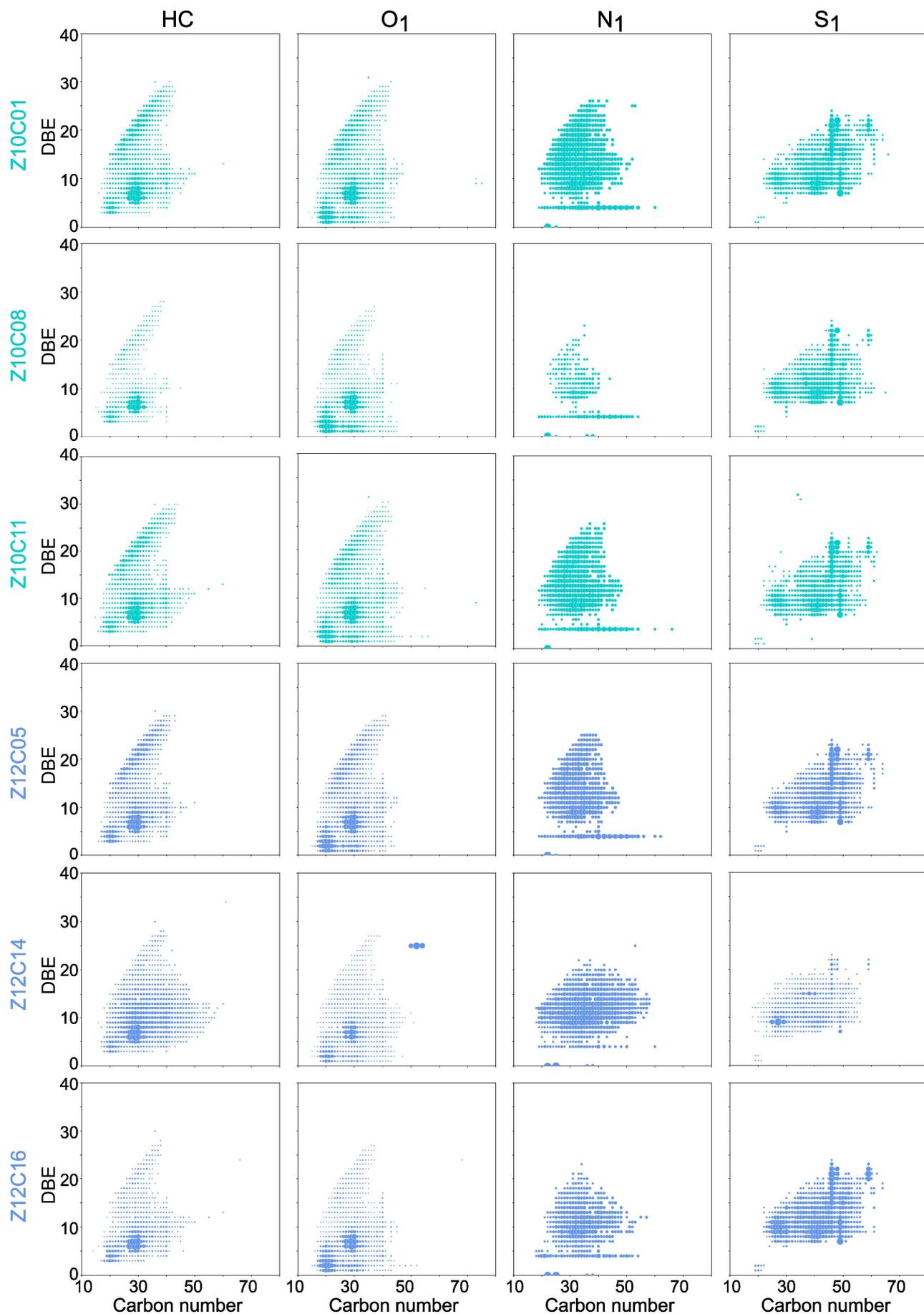
Supplementary Figure S6. PCA results for main elements in the solid phase. The reference sites (red) cluster together but do not separate clearly from HC sites (black).



Supplementary Figure S7. PCA results for trace elements in the solid phase. The reference sites (red) cluster together but do not separate clearly from HC sites (black).



Supplementary Figure S8. Additional FT-ICR-MS plot. HC sites and reference sites behave similar (part 1).



Supplementary Figure S8. Additional FT-ICR-MS plot. HC sites and reference sites behave similar (part 2).

Supplementary Table S1. List of cores and locations

Core ID	Water Depth (m)	Latitude °N	Longitude °E	Length (cm)
Ref5_C01	348	71.97933	21.47071	155
Ref5_C02	348	71.97981	21.47196	134
Ref5_C03	348	71.98036	21.47260	148
Ref5_C04	348	71.98101	21.47407	151
Ref5_C05	348	71.98166	21.47530	166
Ref6_C06	356	71.98547	21.64422	56
Ref6_C07	355	71.98622	21.64560	159
Ref6_C08	355	71.98661	21.64785	160
Ref6_C09	355	71.98732	21.64951	130
Ref6_C10	355	71.98796	21.65151	128
Z01_C01	350	71.95798	21.60425	208
Z01_C02	350	71.95833	21.60526	148
Z01_C03	350	71.95702	21.60438	133
Z01_C04	352	71.95702	21.60563	198
Z01_C05	351	71.95805	21.60683	222
Z01_C06	350	71.95865	21.60804	184
Z01_C07	350	71.95622	21.60521	209
Z01_C08	350	71.95673	21.60574	90
Z01_C09	350	71.95834	21.60936	95
Z01_C10	351	71.95872	21.61053	85
Z01_C11	350	71.95634	21.60738	160
Z01_C12	350	71.95689	21.60840	189
Z01_C14	350	71.95792	21.61093	114
Z01_C15	350	71.95658	21.60940	173
Z01_C16	351	71.95712	21.61078	153
Z10_C01	350	71.96500	21.58215	150
Z10_C07	351	71.96338	21.58318	169
Z10_C08	350	71.96394	21.58400	151
Z10_C09	350	71.96423	21.58475	192
Z10_C10	350	71.96497	21.58581	142
Z10_C11	350	71.96544	21.58675	159
Z10_C14	350	71.96424	21.58673	66
Z10_C17	351	71.96388	21.58783	181
Z12_C01	350	71.96418	21.62277	155
Z12_C02	350	71.96345	21.62211	162
Z12_C03	350	71.96367	21.62405	154
Z12_C04	350	71.96400	21.62517	161
Z12_C05	350	71.96265	21.62182	161
Z12_C06	350	71.96299	21.62352	170
Z12_C07	350	71.96325	21.62504	162
Z12_C08	350	71.96355	21.62653	179
Z12_C09	346	71.96387	21.62788	200
Z12_C10	350	71.96241	21.62251	165
Z12_C11	350	71.96276	21.62386	169
Z12_C12	350	71.96297	21.62520	170
Z12_C13	350	71.96331	21.62662	167
Z12_C14	350	71.96362	21.62819	137
Z12_C15	350	71.96222	21.62506	195
Z12_C16	350	71.96247	21.62681	199
Z12_C17	350	71.99610	21.62838	116

Supplementary Table S2. Mann-Whitney test results

Pore water				
Variable	U Value	P Value	Z Value	What larger?
SO4	0	3.86E-10	-4.81	HC
Alkalinity	333	2.74E-05	3.85	Ref
Ca	332	0.00014	3.82	Ref
Mn	342	5.38E-06	4.08	Ref
Solid phase				
Variable	U Value	P Value	Z Value	What larger?
SiO2	171.5	0.5	-	HC
Al2O3	277.5	0.06	-	Ref
Fe2O3	290.5	0.03	-	Ref
MnO	261.5	0.12	-	Ref
MgO	172.5	0.51	-	HC
CaO	92.5	0.01	-	HC
Na2O	243.5	0.3	-	Ref
K2O	221	0.62	-	Ref
P2O5	280	0.05	-	Ref
TiO2	295	0.02	-	Ref
SO3	61	0	-	HC
S	114.5	0.04	-	HC
LOI	63	0	-	Ref
Ba	266.5	0.11	-	HC
Cr	299.5	0.02	-	Ref
Zn	308.5	0.01	-	Ref
Ni	280.5	0.05	-	Ref
Rb	230	0.47	-	Ref
Sr	143	0.17	-	HC
V	280.5	0.05	-	Ref
Y	198.5	0.98	-	HC
Zr	153.5	0.26	-	HC

Supplementary Table S3. Brown-Forsythe test

Pore water				
Variable	Group1	Group2	F Value	P Value
Sulfate_slope	Ref5	Ref6	0.1	7.59E-01
Sulfate_slope	Ref5	Z01	10.11	5.19E-03
Sulfate_slope	Ref5	Z10	2.39	1.61E-01
Sulfate_slope	Ref5	Z12	11.97	2.47E-03
Sulfate_slope	Ref6	Z01	12	2.77E-03
Sulfate_slope	Ref6	Z10	2.71	1.38E-01
Sulfate_slope	Ref6	Z12	14.44	1.12E-03
Sulfate_slope	Z01	Z10	2.74	1.15E-01
Sulfate_slope	Z01	Z12	0.07	7.96E-01
Sulfate_slope	Z10	Z12	4.57	4.50E-02
Sulfate_slope	Ref	Z	53.79	3.27E-09
Alkalinity_slope	Ref5	Ref6	5	5.58E-02
Alkalinity_slope	Ref5	Z01	11.48	3.27E-03

Alkalinity_slope	Ref5	Z10	3.82	8.64E-02
Alkalinity_slope	Ref5	Z12	10.86	3.61E-03
Alkalinity_slope	Ref6	Z01	21.95	1.84E-04
Alkalinity_slope	Ref6	Z10	6.56	3.36E-02
Alkalinity_slope	Ref6	Z12	24.93	6.99E-05
Alkalinity_slope	Z01	Z10	0.09	7.62E-01
Alkalinity_slope	Z01	Z12	0.04	8.41E-01
Alkalinity_slope	Z10	Z12	0.1	7.52E-01
Alkalinity_slope	Ref	Z	17.77	1.19E-04
Ca_slope	Ref5	Ref6	0.04	8.43E-01
Ca_slope	Ref5	Z01	42.37	4.04E-06
Ca_slope	Ref5	Z10	14.4	5.28E-03
Ca_slope	Ref5	Z12	35.05	8.64E-06
Ca_slope	Ref6	Z01	19.96	2.97E-04
Ca_slope	Ref6	Z10	5.6	4.55E-02
Ca_slope	Ref6	Z12	18.12	3.86E-04
Ca_slope	Z01	Z10	0.92	3.49E-01
Ca_slope	Z01	Z12	0.23	6.36E-01
Ca_slope	Z10	Z12	0.25	6.23E-01
Ca_slope	Ref	Z	19.27	6.79E-05
Mn_slope	Ref5	Ref6	2.91	1.26E-01
Mn_slope	Ref5	Z01	0.55	4.67E-01
Mn_slope	Ref5	Z10	0.13	7.32E-01
Mn_slope	Ref5	Z12	1.74	2.02E-01
Mn_slope	Ref6	Z01	3.27	8.73E-02
Mn_slope	Ref6	Z10	8.65	1.87E-02
Mn_slope	Ref6	Z12	6.66	1.78E-02
Mn_slope	Z01	Z10	0.26	6.19E-01
Mn_slope	Z01	Z12	0.36	5.55E-01
Mn_slope	Z10	Z12	1.13	3.00E-01
Mn_slope	Ref	Z	5.08	2.92E-02
Solid phase				
Variable	Group1	Group2	F Value	P Value
SiO2	Ref5	Ref6	8.119	0.022
SiO2	Ref5	Z01	0.015	0.904
SiO2	Ref5	Z10	0.234	0.638
SiO2	Ref5	Z12	0.011	0.918
SiO2	Ref6	Z01	4.71	0.044
SiO2	Ref6	Z10	2.156	0.17
SiO2	Ref6	Z12	4.596	0.045
SiO2	Z01	Z10	0.503	0.486
SiO2	Z01	Z12	0.098	0.756
SiO2	Z10	Z12	0.262	0.613
AL2O3	Ref5	Ref6	20.41	0.002
AL2O3	Ref5	Z01	0.827	0.375
AL2O3	Ref5	Z10	3.007	0.111
AL2O3	Ref5	Z12	1.222	0.282
AL2O3	Ref6	Z01	0.994	0.332
AL2O3	Ref6	Z10	0.204	0.66
AL2O3	Ref6	Z12	0.774	0.39
AL2O3	Z01	Z10	0.452	0.509
AL2O3	Z01	Z12	0.041	0.841
AL2O3	Z10	Z12	0.279	0.603

Fe2O3	Ref5	Ref6	40.521	0
Fe2O3	Ref5	Z01	2.601	0.124
Fe2O3	Ref5	Z10	4.49	0.058
Fe2O3	Ref5	Z12	1.906	0.183
Fe2O3	Ref6	Z01	5.574	0.03
Fe2O3	Ref6	Z10	2.609	0.135
Fe2O3	Ref6	Z12	4.508	0.046
Fe2O3	Z01	Z10	0.522	0.478
Fe2O3	Z01	Z12	0.006	0.938
Fe2O3	Z10	Z12	0.539	0.47
MnO	Ref5	Ref6	26.884	0.001
MnO	Ref5	Z01	3.889	0.064
MnO	Ref5	Z10	7.161	0.022
MnO	Ref5	Z12	1.583	0.223
MnO	Ref6	Z01	3.373	0.083
MnO	Ref6	Z10	1.903	0.195
MnO	Ref6	Z12	3.432	0.079
MnO	Z01	Z10	0.443	0.513
MnO	Z01	Z12	0.281	0.6
MnO	Z10	Z12	1.004	0.327
MgO	Ref5	Ref6	0.658	0.441
MgO	Ref5	Z01	0.142	0.711
MgO	Ref5	Z10	3.284	0.097
MgO	Ref5	Z12	0.058	0.812
MgO	Ref6	Z01	0.056	0.815
MgO	Ref6	Z10	0.789	0.394
MgO	Ref6	Z12	0.154	0.698
MgO	Z01	Z10	1.278	0.271
MgO	Z01	Z12	0.038	0.847
MgO	Z10	Z12	1.833	0.189
CaO	Ref5	Ref6	9.906	0.014
CaO	Ref5	Z01	2.615	0.123
CaO	Ref5	Z10	2.797	0.123
CaO	Ref5	Z12	0.199	0.661
CaO	Ref6	Z01	4.487	0.048
CaO	Ref6	Z10	5.212	0.043
CaO	Ref6	Z12	4.442	0.048
CaO	Z01	Z10	0.077	0.784
CaO	Z01	Z12	9.913	0.004
CaO	Z10	Z12	10.526	0.004
Na2O	Ref5	Ref6	23.9	0.001
Na2O	Ref5	Z01	13.052	0.002
Na2O	Ref5	Z10	7.525	0.019
Na2O	Ref5	Z12	4.108	0.056
Na2O	Ref6	Z01	0.187	0.67
Na2O	Ref6	Z10	0.343	0.57
Na2O	Ref6	Z12	0.177	0.678
Na2O	Z01	Z10	0.097	0.758
Na2O	Z01	Z12	0.052	0.821
Na2O	Z10	Z12	0.003	0.96
K2O	Ref5	Ref6	0.261	0.623
K2O	Ref5	Z01	0.577	0.457
K2O	Ref5	Z10	2.839	0.12
K2O	Ref5	Z12	0.033	0.857

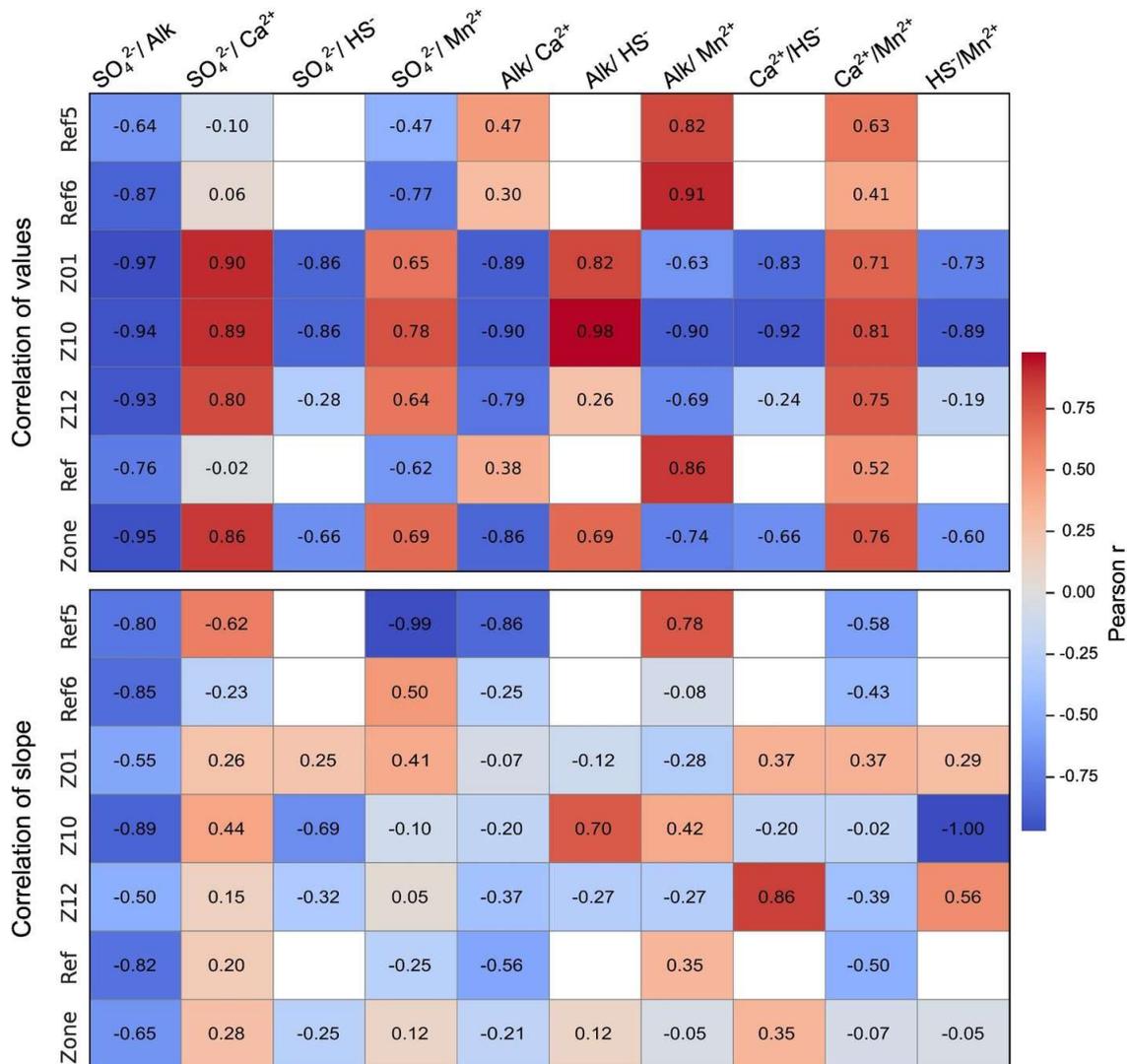
K20	Ref6	Z01	0.183	0.674
K20	Ref6	Z10	5.306	0.042
K20	Ref6	Z12	0.005	0.947
K20	Z01	Z10	5.531	0.029
K20	Z01	Z12	0.319	0.576
K20	Z10	Z12	1.701	0.205
P2O5	Ref5	Ref6	0.46	0.517
P2O5	Ref5	Z01	0.037	0.849
P2O5	Ref5	Z10	0.228	0.642
P2O5	Ref5	Z12	0.031	0.863
P2O5	Ref6	Z01	0.748	0.398
P2O5	Ref6	Z10	0.096	0.762
P2O5	Ref6	Z12	0.592	0.451
P2O5	Z01	Z10	0.49	0.492
P2O5	Z01	Z12	0	0.987
P2O5	Z10	Z12	0.394	0.536
TiO	Ref5	Ref6	18.368	0.003
TiO	Ref5	Z01	1.918	0.183
TiO	Ref5	Z10	6.095	0.031
TiO	Ref5	Z12	0.924	0.348
TiO	Ref6	Z01	2.21	0.154
TiO	Ref6	Z10	1.143	0.308
TiO	Ref6	Z12	2.327	0.143
TiO	Z01	Z10	0.572	0.458
TiO	Z01	Z12	0.117	0.734
TiO	Z10	Z12	0.931	0.345
Ba	Ref5	Ref6	1.691	0.23
Ba	Ref5	Z01	3.753	0.069
Ba	Ref5	Z10	6.94	0.023
Ba	Ref5	Z12	4.201	0.054
Ba	Ref6	Z01	3.273	0.087
Ba	Ref6	Z10	6.554	0.027
Ba	Ref6	Z12	0.721	0.406
Ba	Z01	Z10	4.493	0.046
Ba	Z01	Z12	10.229	0.003
Ba	Z10	Z12	22.976	0
Cr	Ref5	Ref6	13.413	0.006
Cr	Ref5	Z01	0.213	0.65
Cr	Ref5	Z10	1.584	0.234
Cr	Ref5	Z12	0.115	0.739
Cr	Ref6	Z01	4.557	0.047
Cr	Ref6	Z10	2.549	0.139
Cr	Ref6	Z12	4.215	0.053
Cr	Z01	Z10	0.719	0.406
Cr	Z01	Z12	0.017	0.898
Cr	Z10	Z12	0.836	0.37
Zn	Ref5	Ref6	29.88	0.001
Zn	Ref5	Z01	1.293	0.27
Zn	Ref5	Z10	3.666	0.082
Zn	Ref5	Z12	0.882	0.359
Zn	Ref6	Z01	4.956	0.039
Zn	Ref6	Z10	2.986	0.112
Zn	Ref6	Z12	5.421	0.03
Zn	Z01	Z10	0.594	0.45

Zn	Z01	Z12	0.054	0.818
Zn	Z10	Z12	0.923	0.347
Ga	Ref5	Ref6	0.186	0.679
Ga	Ref5	Z01	0.752	0.398
Ga	Ref5	Z10	0.041	0.844
Ga	Ref5	Z12	0.019	0.892
Ga	Ref6	Z01	1.8	0.196
Ga	Ref6	Z10	0.446	0.518
Ga	Ref6	Z12	0.408	0.53
Ga	Z01	Z10	0.838	0.37
Ga	Z01	Z12	1.611	0.214
Ga	Z10	Z12	0.008	0.928
Nb	Ref5	Ref6	14.059	0.033
Nb	Ref5	Z01	8.935	0.024
Nb	Ref5	Z10	0.36	0.575
Nb	Ref5	Z12	0.701	0.424
Nb	Ref6	Z01	1.281	0.309
Nb	Ref6	Z10	16.069	0.016
Nb	Ref6	Z12	0.459	0.517
Nb	Z01	Z10	14.112	0.007
Nb	Z01	Z12	5.644	0.037
Nb	Z10	Z12	1.67	0.225
Ni	Ref5	Ref6	2.326	0.166
Ni	Ref5	Z01	2.046	0.17
Ni	Ref5	Z10	2.487	0.143
Ni	Ref5	Z12	0.599	0.448
Ni	Ref6	Z01	0.124	0.729
Ni	Ref6	Z10	0.016	0.901
Ni	Ref6	Z12	0.86	0.365
Ni	Z01	Z10	0.068	0.796
Ni	Z01	Z12	0.733	0.399
Ni	Z10	Z12	0.93	0.345
Rb	Ref5	Ref6	7.594	0.025
Rb	Ref5	Z01	0.87	0.363
Rb	Ref5	Z10	10.923	0.007
Rb	Ref5	Z12	0.872	0.362
Rb	Ref6	Z01	0.763	0.394
Rb	Ref6	Z10	0.78	0.396
Rb	Ref6	Z12	0.178	0.677
Rb	Z01	Z10	3.297	0.084
Rb	Z01	Z12	0.118	0.734
Rb	Z10	Z12	1.26	0.273
Sr	Ref5	Ref6	6.478	0.034
Sr	Ref5	Z01	1.701	0.209
Sr	Ref5	Z10	1.858	0.2
Sr	Ref5	Z12	6.386	0.02
Sr	Ref6	Z01	4.387	0.051
Sr	Ref6	Z10	6.196	0.03
Sr	Ref6	Z12	0.191	0.666
Sr	Z01	Z10	0.199	0.66
Sr	Z01	Z12	13.061	0.001
Sr	Z10	Z12	16.14	0.001
V	Ref5	Ref6	18.764	0.003
V	Ref5	Z01	0.975	0.336

V	Ref5	Z10	1.18	0.301
V	Ref5	Z12	2.063	0.166
V	Ref6	Z01	1.421	0.249
V	Ref6	Z10	1.686	0.221
V	Ref6	Z12	1.214	0.284
V	Z01	Z10	0	0.993
V	Z01	Z12	0.121	0.73
V	Z10	Z12	0.089	0.769
Y	Ref5	Ref6	0.004	0.953
Y	Ref5	Z01	0.245	0.627
Y	Ref5	Z10	0.442	0.52
Y	Ref5	Z12	0.163	0.691
Y	Ref6	Z01	0.318	0.58
Y	Ref6	Z10	0.529	0.482
Y	Ref6	Z12	0.292	0.595
Y	Z01	Z10	1.519	0.231
Y	Z01	Z12	0.206	0.653
Y	Z10	Z12	2.345	0.139
Zr	Ref5	Ref6	0.257	0.626
Zr	Ref5	Z01	0.439	0.516
Zr	Ref5	Z10	0.162	0.695
Zr	Ref5	Z12	2.209	0.153
Zr	Ref6	Z01	1.323	0.265
Zr	Ref6	Z10	0.56	0.47
Zr	Ref6	Z12	3.343	0.082
Zr	Z01	Z10	0.001	0.97
Zr	Z01	Z12	0.619	0.437
Zr	Z10	Z12	0.339	0.566
SO3	Ref5	Ref6	2.239	0.173
SO3	Ref5	Z01	9.07	0.007
SO3	Ref5	Z10	23.037	0.001
SO3	Ref5	Z12	6.468	0.019
SO3	Ref6	Z01	6.208	0.023
SO3	Ref6	Z10	17.687	0.001
SO3	Ref6	Z12	3.488	0.077
SO3	Z01	Z10	3.48	0.076
SO3	Z01	Z12	2.446	0.128
SO3	Z10	Z12	13.057	0.001
LOI	Ref5	Ref6	0.632	0.449
LOI	Ref5	Z01	0.57	0.46
LOI	Ref5	Z10	0.118	0.738
LOI	Ref5	Z12	0.195	0.663
LOI	Ref6	Z01	2.871	0.107
LOI	Ref6	Z10	3.034	0.109
LOI	Ref6	Z12	1.764	0.199
LOI	Z01	Z10	0.346	0.562
LOI	Z01	Z12	0.22	0.643
LOI	Z10	Z12	0.028	0.867
SiO2	Ref	Z	1.552	0.219
Al2O3	Ref	Z	0.032	0.86
Fe2O3	Ref	Z	0.067	0.797
MnO	Ref	Z	0.466	0.498
MgO	Ref	Z	0.015	0.904
CaO	Ref	Z	3.028	0.088

Na2O	Ref	Z	2.004	0.163
K2O	Ref	Z	0.071	0.791
P2O5	Ref	Z	0.238	0.628
TiO	Ref	Z	0.043	0.837
Ba	Ref	Z	4.364	0.042
Cr	Ref	Z	0.186	0.669
Zn	Ref	Z	0	0.988
Ga	Ref	Z	1.921	0.172
Nb	Ref	Z	2.354	0.141
Ni	Ref	Z	0.514	0.477
Rb	Ref	Z	0.194	0.662
Sr	Ref	Z	1.195	0.28
V	Ref	Z	0.024	0.877
Y	Ref	Z	0.368	0.547
Zr	Ref	Z	1.851	0.18
SO3	Ref	Z	34.855	0
S	Ref	Z	21.614	0
LOI	Ref	Z	2.165	0.148

Supplementary Table S4. Pearson correlations



Reference

Schnabel, E., Vuillemin, A., Laczny, C. C., Kunath, B. J., Soares, A. R., Probst, A. J., Di Primio, R., Kallmeyer, J., and the, P. C.: Influence of minor hydrocarbon seepage on sulfur cycling in marine subsurface sediments, *Biogeosciences*, 22, 767-784, 10.5194/bg-22-767-2025, 2025.