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Influence of a CO₂ long term exposure on the mobilisation and speciation of metals in soils

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TABLE 5. Variation of SI of mineral phases in function of pH and CO₂ input gas. The initial solution is the oven-dried, 20% θ_m , and 30% θ_m ground soils pore water.

TABLE 1

	Oven-dried Non-incubated	Oven-dried incubated	20% θ m Non-incubated	20% θ m Incubated	30% θ m Non-incubated	30% θ m Incubated
OC(% $\pm 3\sigma$)	0.53% ± 0.01	0.50% ± 0.02	0.61% ± 0.03	0.62% ± 0.03	0.91% ± 0.02	0.94% ± 0.04
CC(% $\pm 3\sigma$)	0.11% ± 0.01	0.11% ± 0.01	0.13% ± 0.02	0.11% ± 0.01	0.12% ± 0.03	0.13% ± 0.02

OC: organic content; CC: carbonate content

TABLE 2

	Oven-dried non-incubated control	Oven-dried incubated	20% θ m Non-incubated control	20% θ m Incubated	30% θ m Non-incubated control	30% θ m Incubated
Initial pH	5.86	5.86	5.36	5.36	6.33	6.33
Final pH	-	6.45	-	7.33	-	8.09
Modelled pH	2.67	-	2.68	-	2.83	-

TABLE 3

	Oven-dried non-incubated	SD	Oven-dried incubated	SD	<i>r</i>	<i>t</i>	<i>p</i> -value (<i><0.05</i>)
$\mu\text{g/L}$							
Al	323	23.5	582	70.14	1.8	4.78	0.04
Cr	0.8	0.05	1.4	0.13	1.8	6.51	0.02
Fe	220	7.3	480	34.2	2.2	12.10	0.006
Ni	<0.01	0.0	15	10.19	>15	2.59	0.001
Cu	11	0.78	16	0.87	1.3	5.26	0.03
Zn	80	15.66	110	50.47	1.5	-	-
As	2.1	0.48	2.9	0.07	1.3	4.20	0.05
Pb	2.6	0.13	0.5	0.018	5.2	27.09	0.01
	20% θm Non-incubated	SD	20% θm Incubated	SD	<i>r</i>	<i>t</i>	<i>p</i> -value (<i><0.05</i>)
Al	904	16.02	895	177	-	-	-
Cr	1.2	0.18	1.4	0.15	1.2	-	-
Fe	689	0.001	705	151	1.0	-	-
Ni	0.6	0.08	3.7	0.26	6.2	19.73	0.02
Cu	8.9	0.21	9.7	0.35	1.1	-	-
Zn	132	0.8	35	16.93	-	-	-
As	1.6	0.5	1.6	0.02	-	-	-
Pb	0.7	0.4	2.9	0.7	4.4	-	0.04
	30% θm Non-incubated	SD	30% θm Incubated	SD	<i>r</i>		<i>p</i> -value (<i><0.05</i>)
Al	822	81	929	586	1.1	-	-
Cr	1.1	0.031	0.2	0.3	-	-	-
Fe	628	60.75	778	499	1.2	-	-
Ni	0.1	1.69.10 ⁻⁷	8.0	7.1	>8.0	1.93	0.002
Cu	8.4	0.52	13	3.93	1.5	-	-
Zn	37	31.56	92	39.6	2.5	5.69	0.02
As	1.7	0.07	2.8	0.49	1.6	-	-
Pb	2.8	0.73	3.8	1.6	1.4	-	-

SD: standard deviation

r: concentration factor*t*: t-student

-: no significant differences

n: degrees of freedom

TABLE 4

		Activity					
		OD Non-I	OD incubated	20%θm Non-I	20%θm I	30%θm Non-I	30%θm I
Al	Al(OH) ₂ ⁺	6.689e-006	3.412e-011	1.502e-005	9.910e-11	9.872e-006	1.946e-010
	AlOH ₂ ⁺	1.178e-006	3.142e-008	8.365e-006	8.918e-08	5.892e-007	1.240e-007
	Al(OH) ₄ ⁻	9.747e-007	-	2.189e-007	-	1.253e-005	-
	Al ³⁺	1.637e-007	5.997e-006	3.676e-006	1.663e-05	2.774e-008	1.637e-005
Fe	Fe ²⁺	3.189e-006	3.071e-006	9.733e-006	7.814e-006	8.191e-006	8.005e-006
	Fe(OH) ₂ ⁺	3.417e-009	4.543e-013	1.043e-009	2.171e-014	7.644e-008	3.350e-014
Cr	Cr ³⁺	4.384e-11	4.922e-009	2.460e-10	7.526e-09	7.685e-012	5.587e-009
	CrOH ₂ ⁺	3.176e-09	2.302e-010	5.635e-09	3.602e-10	1.643e-009	3.777e-010
	Cr(OH) ₂ ⁺	4.590e-09	2.148e-013	2.576e-09	3.439e-13	7.009e-009	5.095e-013
Ni	Ni ²⁺	3.137e-08	3.021e-007	8.861e-09	3.125e-07	-	3.155e-07
Cu	Cu ⁺	1.031e-08	9.655e-009	5.581e-009	4.411e-009	4.673e-009	2.073e-008
	Cu ²⁺	2.228e-07	1.764e-007	1.063e-007	1.008e-007	8.904e-008	9.394e-008
Zn	Zn ²⁺	9.169e-007	8.855e-007	1.591e-006	1.230e-006	6.601e-007	6.413e-007
	ZnHCO ₃ ⁺	-	1.855e-007	-	3.241e-007	-	1.836e-007
As	H ₂ AsO ₄ ⁻	2.859e-08	3.466e-014	1.862e-08	2.288e-14	1.773e-008	7.049e-014
	HAsO ₄ ²⁻	3.438e-09	4.626e-015	7.081e-10	1.818e-18	6.291e-009	7.910e-018
	HAsO ₂	4.107e-12	1.850e-008	8.458e-11	1.140e-08	9.907e-014	1.246e-008
Cd	Cd ²⁺	1.536e-008	1.480e-008	1.393e-008	1.235e-008	6.834e-009	6.620e-009
	CdHCO ₃ ⁺	-	8.948e-010	-	8.170e-010	-	5.282e-010
Pb	Pb ²⁺	4.539e-009	4.815e-009	1.127e-008	7.579e-009	8.681e-009	8.578e-008
	PbHCO ₃ ⁺	-	3.052e-009	-	4.560e-009	-	8.036e-009

OD: oven-dried; Non-I: non-incubated; I: incubated; %θm: % gravimetric moisture content

TABLE 5

Oven-dried ground soil							
mmoles CO ₂	pH	SI FeOOH	SI Fe ₂ O ₃	SI KAlSi ₃ O ₈	SI Al ₂ Si ₂ O ₅ (OH) ₄	SI CuCr ₂ O ₄	SI ZnCr ₂ O ₄
0	5.9	4.1	10	2.9	8.8	3.2	12
125	3.6	-2.4	-2.7	-4.4	-1.4	-10.5	-1.5
500	3.3	-3.3	-4.6	-5.6	-3.3	-12.9	-3.9
1000	3.2	-3.8	-5.6	-6.2	-4.2	-14.1	-5.1
2500	3.0	-4.4	-6.8	-6.9	-5.4	-15.7	-6.7
5000	2.8	-4.9	-7.8	-7.4	-6.3	-16.9	-8.0
12500	2.7	-5.6	-9.0	-7.8	-7.4	-18.6	-9.6
20% θ m ground soil							
mmoles CO ₂	pH	SI FeOOH	SI Fe ₂ O ₃	SI KAlSi ₃ O ₈	SI Al ₂ Si ₂ O ₅ (OH) ₄	SI CuCr ₂ O ₄	SI ZnCr ₂ O ₄
0	5.4	3.0	8.1	2.3	8.5	0.5	9.9
125	3.7	-2.0	-1.9	-3.8	-0.3	-10.4	-0.9
500	3.3	-2.9	-3.9	-5.1	-2.2	-12.9	-3.4
1000	3.2	-3.4	-4.8	-5.7	-3.2	-14.1	-4.7
2500	3.0	-4.1	-6.1	-6.4	-4.4	-15.8	-6.3
5000	2.8	-4.6	-7.1	-7.0	-5.3	-17.0	-7.6
12500	2.7	-5.2	-8.3	-7.4	-6.4	-18.7	-9.2
30% θ m ground soil							
mmoles CO ₂	pH	SI FeOOH	SI Fe ₂ O ₃	SI KAlSi ₃ O ₈	SI Al ₂ Si ₂ O ₅ (OH) ₄	SI CuCr ₂ O ₄	SI ZnCr ₂ O ₄
0	6.3	5.9	14	3.9	10	5.4	9.9
125	3.7	-3.1	-8.2	-3.8	-0.2	-2.4	1.2
500	3.4	-2.6	-7.1	-5.1	-2.2	-3.9	-3.4
1000	3.2	-2.3	-6.6	-5.8	-3.2	-6.1	-5.7
2500	3.0	-1.9	-5.8	-6.5	-4.4	-8.8	-8.3
5000	2.9	-1.6	-5.2	-7.1	-5.4	-10.0	-9.6
12500	2.8	-1.1	-4.3	-7.5	-6.5	-11.7	-10.2

SI: saturation index