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Comparison of organic materials for the passive treatment of synthetic neutral mine drainage contaminated by nickel: Short- and medium-term batch experiments

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Electronic Supplementary Material

Table S1 Number and distribution of reactors during short-term and medium-term batch experiments.

Short-term experiment					Medium-term experiment		
	Natural pH of the substrate	pH 6	pH 7	pH 8		Experimental duplicate reactors	Sacrificial triplicate reactor ²
Number of Algae reactors	2	2	2	2	Number of Wood ash reactors	2	1
Number of Sawdust reactors	2	2	2	2	Number of Compost reactors	2	1
Number of Wood ash reactors	2	2	2	0 ¹	Number of HD-peat reactors	2	1
Number of Compost reactors	2	2	0 ¹	2	Number of LT-peat reactors	2	1
Number of HD-peat reactors	2	2	2	2			
Total number of reactors		36			Total number of reactors		12

¹The natural pH of compost and wood ash was 7 and 8, respectively, and thus, no pH 7 and pH 8 experiments were conducted for these substrates. ²These reactors were sampled at t = 21 days to measure the parameters used in geochemical modeling.

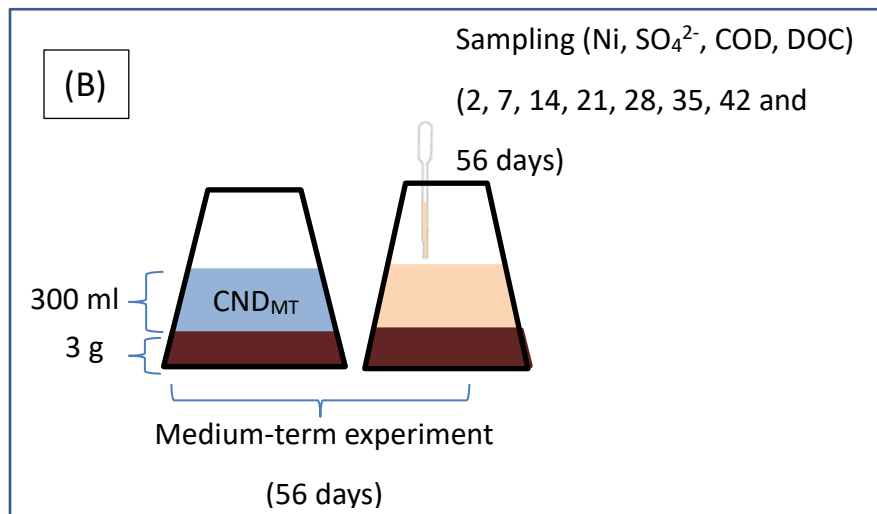
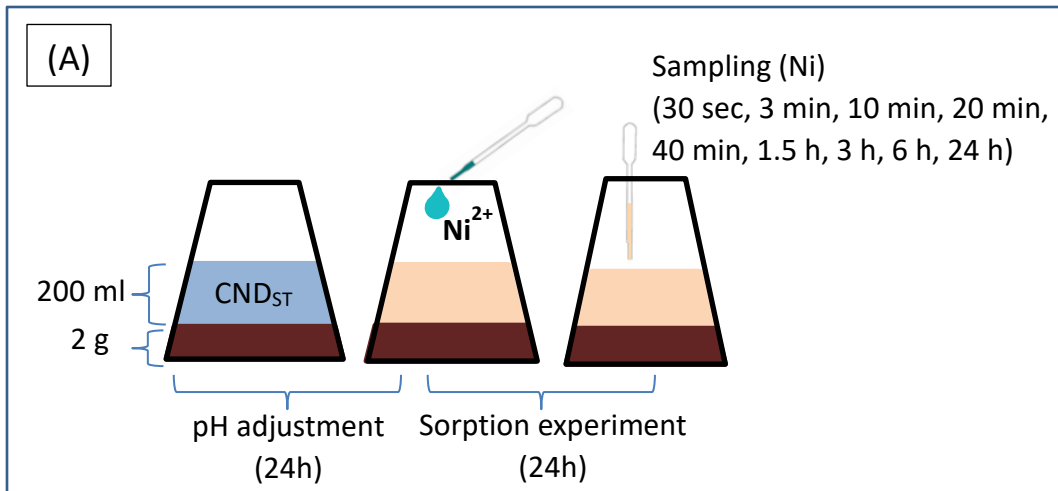


Fig. S1 Experimental conditions during (A) short-term and (B) medium-term batch experiments (experimental duplicate reactors).

Table S2 Composition of filtered solutions following 21 days of equilibration in medium-term batch reactors used as input to VMINTEQ geochemical equilibrium model. Eleven elements (Al, Be, Bi, Cd, Sn, Fe, Pb, Se, Ti, Br, NO₂) were not included in the models because they were below their respective detection limits (10 µg/L, 2 µg/L, 1 µg/L, 0.2 µg/L, 2 µg/L, 60 µg/L, 0.5 µg/L, 3 µg/L, 10 µg/L, 0.1 mg/L, 0.2 mg/L) in all reactor solutions.

Parameter	Unit	DL	Wood-ash	Compost	HD-peat	LT-peat
pH	-	-	8.08	7.24	7.60	7.58
Eh	mV	-	560	560	560	560
Alkalinity	mg/L CaCO ₃	4	64	10	32	34
DOC	mg/L	3	8.6	23	42	33
Temperature	°C	-	22	22	22	22
ICP-MS						
Ca	mg/L	5.0	250	250	250	320
Mg	mg/L	0.1	74	68	67	50
Na	mg/L	0.5	89	83	90	77
K	mg/L	0.5	51	63	6.0	7.4
Ni	µg/L	2.0	450	320	75	300
Zn	µg/L	7.0	<DL	18	<DL	<DL
Mn	µg/L	1.0	130	170	220	320
Co	µg/L	1.0	97	150	53	210
Cu	µg/L	1.0	<DL	3.8	<DL	<DL
Mo	µg/L	1.0	25	7.3	<DL	<DL
Cr	µg/L	5.0	5.3	<DL	<DL	<DL
As	µg/L	1.0	16	15	<DL	2.6
B	µg/L	50	550	180	60	<DL
Ba	µg/L	2.0	52	6	145	25
Sb	µg/L	1.0	2.2	1.9	<DL	<DL
Ion chromatography						
SO ₄ ²⁻	mg/L	0.2	983	946	976	950
NO ₃ ⁻	mg/L	0.2	<DL	25.5	<DL	<DL
Cl ⁻	mg/L	0.5	95	104	93	89
PO ₄ ³⁻	mg/L	0.1	0.1	1.6	<DL	<DL
F ⁻	mg/L	0.1	<DL	<DL	330	460

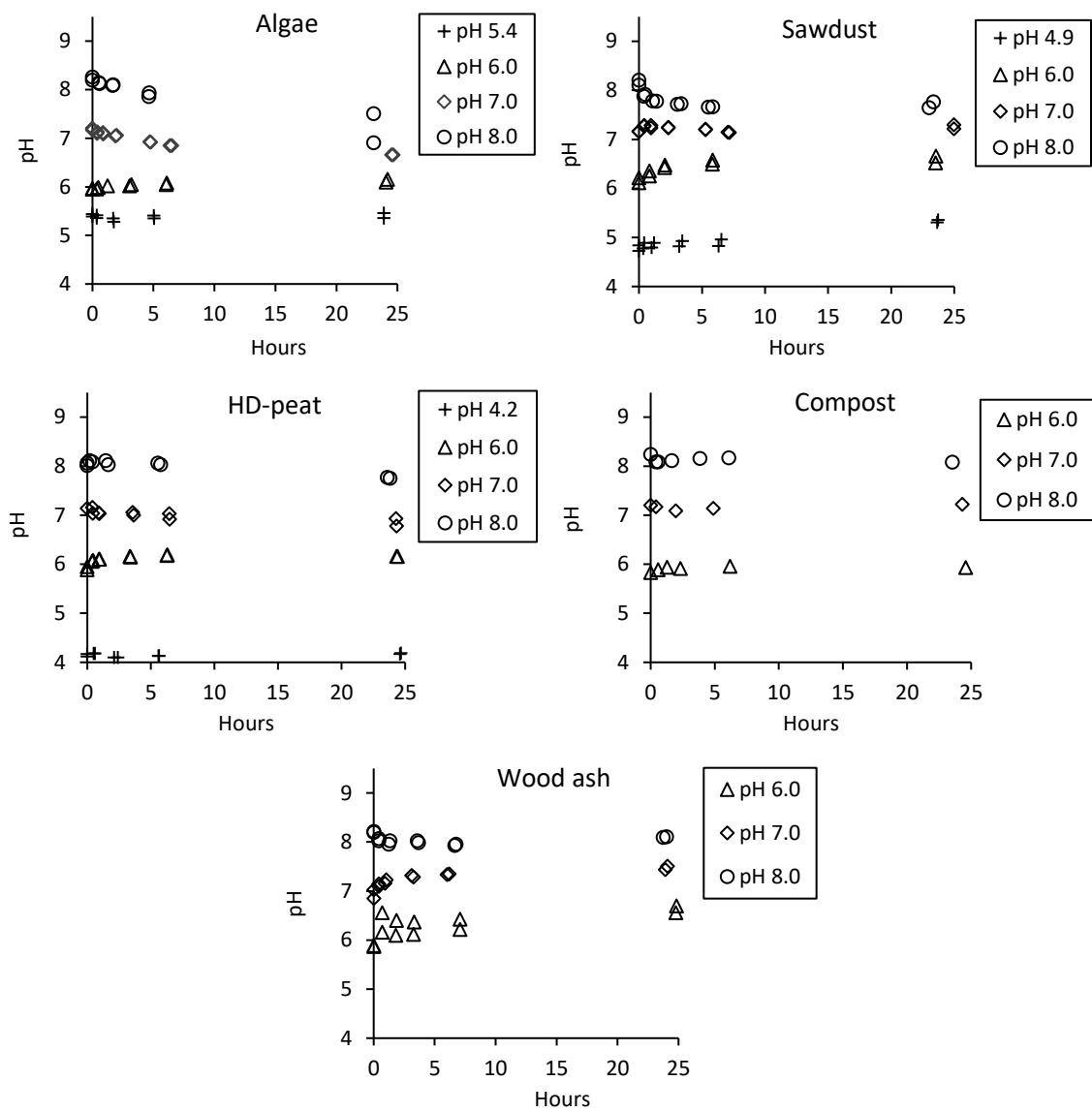


Fig. S2 Temporal evolution of solution pH during short-term batch experiments for the five materials tested

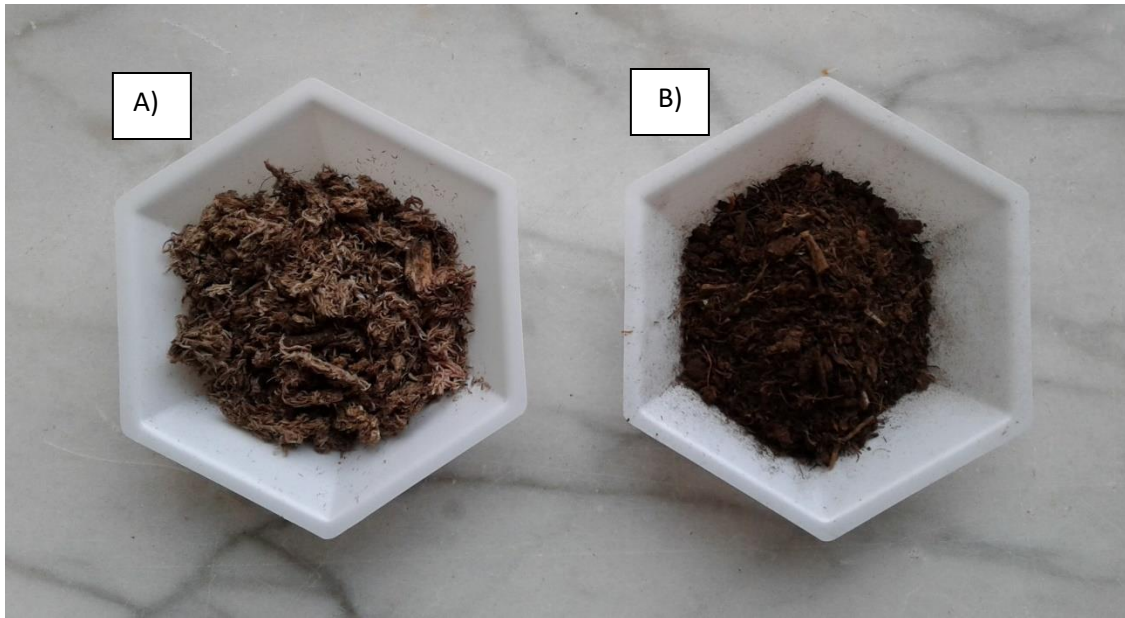


Fig. S3 A) Surface sphagnum peat moss (LT-peat), manually crumbled B) Horticultural sphagnum peat moss (HD-peat) purchased from a local retailer (Home Depot, Montreal), sieved to less than 5 mm.

Table S3 VMINTEQ equilibrium model results for solutions in batch reactors at t=21 days

	Charge imbalance (%)	Ionic strength (M)	Solids	Oversaturated species (SI) ¹
Wood ash	1.23	0.0324	Calcium carbonates Nickel carbonate Cobalt oxide Manganese oxides Barium sulfate Manganese phosphate Calcium phosphate	Calcite (0.39), Aragonite (0.24), Dolomite (disordered) (0.021), Dolomite (ordered) (0.58) NiCO ₃ (s) (0.10) Co ₃ O ₄ (s) (10.5) Birnessite (1.72), Bixbyite (4.76), Hausmannite (3.71), Manganite (2.37), Nsutite (2.31), Pyrolusite (3.50) Barite (0.79) MnHPO ₄ (s) (0.35) Hydroxyapatite (6.50)
Compost	0.29	0.0315	Cobalt oxide Manganese oxide Manganese Phosphate Calcium phosphate	Co ₃ O ₄ (s) (4.45) Pyrolusite (0.26) MnHPO ₄ (s) (1.58) Hydroxyapatite (6.45)
HD-peat-calcite	4.79	0.0309	Cobalt oxide Manganese oxides Barium sulfate	Co ₃ O ₄ (s) (5.91) Birnessite (0.010), Bixbyite (2.300), Hausmannite (0.50), Manganite (1.14), Nsutite (0.60), Pyrolusite (1.78) Barite(1.24)
LT-peat-calcite	2.15	0.0313	Cobalt oxide Manganese oxides Barium sulfate	Co ₃ O ₄ (s) (7.60) Birnessite (0.12), Bixbyite (2.561), Hausmannite (0.91), Manganite (1.27), Nsutite (0.71), Pyrolusite (1.89), Barite (0.45)

¹SI = $-\log (IAP/K_{sp}^{\circ})$, where IAP is the ion activity product of the ionic constituents of the solid and K_{sp}° is the thermodynamic solubility of the solid at the experimental temperature and 1 atm total pressure.