

Supplementary materials

The Eh-pH diagrams for Zn-O-H and Fe-O-H are presented in Figure S1. The batch leaching data and leaching values with standard deviations of the analyzed elements for the batch leaching tests are presented in Tables S1 and S2. The detailed leaching data for static pH titration are presented in Table S3.

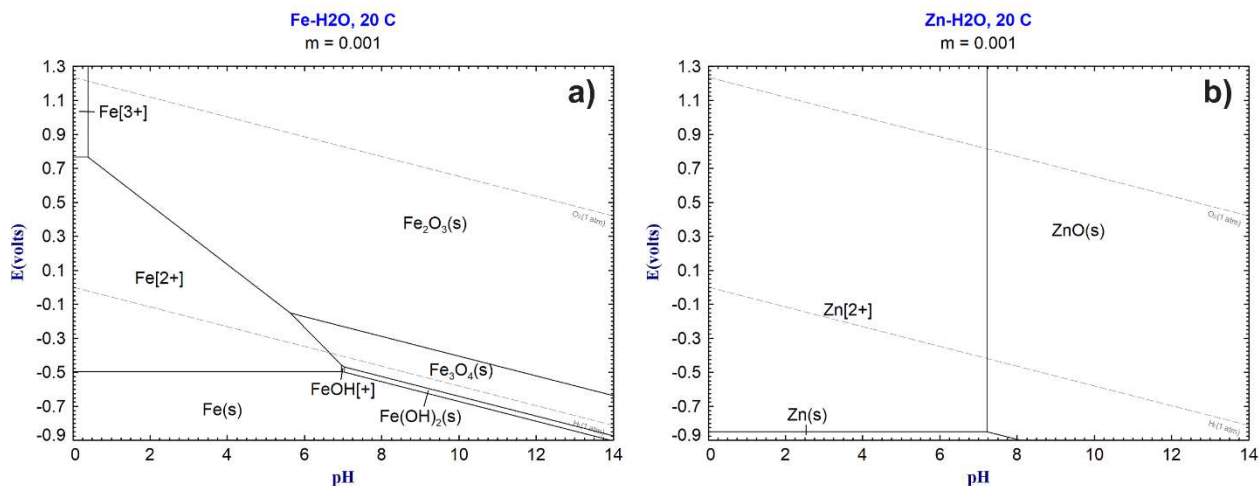


Figure S1. Pourbaix diagrams plotted using FactSage 8.3, $m = 0.001$ mol/kg, $T = 20$ °C: (a) Fe-O-H and (b) Zn-O-H.

Table S1. Leaching data for EN12457-3 with pH, conductivity, and redox with standard deviations, $n = 2$.

Sample	ZFS13-01	ZFS13-05	ZFS13-10	ZFS14-01	ZFS14-05	ZFS14-10	ZFS13-01	ZFS13-05	ZFS13-10	ZFS14-01	ZFS14-05	ZFS14-10
¹ L/S	2	2	2	2	2	2	10	10	10	10	10	10
² pH1	6.9	6.7	6.6	6.4	6.6	6.6	6.7	7.0	6.9	6.8	6.8	6.9
³ pH2	7.3	6.8	6.9	6.8	6.7	6.7	6.8	6.9	6.7	6.5	6.7	6.7
Average												
⁴ EC	29.7	19.8	15.2	15.6	12.8	11.5	5.4	3.6	3.5	3.4	3.9	3.1
⁵ Redox	0.17	0.19	0.19	0.20	0.20	0.20	0.16	0.17	0.18	0.19	0.22	0.22
St.dev												
EC	8.1	0.2	4.3	4.2	1.4	1.1	2.7	0.8	1.4	1.3	1.6	0.7
Redox	0.04	0.04	0.05	0.06	0.06	0.05	0.01	0.02	0.02	0.02	0.05	0.04

¹Liquid/solid (v/w), ²first run, ³second run, ⁴electric conductivity ($\mu\text{S}/\text{cm}$), ⁵redox, volt (V).

Table S2. Leaching data for EN12457-3 with average leaching values and standard deviations, n = 2.

Sample	ZFS13-01	ZFS13-05	ZFS13-10	ZFS14-01	ZFS14-05	ZFS14-10	ZFS13-01	ZFS13-05	ZFS13-10	ZFS14-01	ZFS14-05	ZFS14-10
*L/S	2	2	2	2	2	2	10	10	10	10	10	10
Average	mg/kg											
Al	0.03	0.04	0.02	0.01	0.01	0.01	0.07	0.10	0.07	0.04	0.06	0.05
Ca	6.82	3.62	3.15	2.52	2.19	1.55	9.20	6.64	4.97	4.26	3.79	3.15
Fe	0.31	0.50	0.06	0.02	0.01	0.01	0.42	0.57	0.12	0.05	0.05	0.04
Mg	1.13	0.75	0.54	0.58	0.49	0.38	1.87	1.47	1.26	1.30	1.21	1.10
Zn	0.61	0.36	0.45	1.12	1.50	1.98	1.13	0.92	2.69	2.34	4.38	6.23
St. dev	mg/kg											
Al	0.01	0.02	0.00	0.00	0.00	0.00	0.04	0.04	0.02	0.01	0.02	0.02
Ca	2.78	0.08	0.69	0.40	0.19	0.13	3.02	0.37	0.91	0.54	0.19	0.13
Fe	0.23	0.37	0.05	0.01	0.01	0.00	0.31	0.40	0.07	0.01	0.01	0.00
Mg	0.20	0.26	0.16	0.15	0.10	0.08	0.21	0.26	0.16	0.15	0.10	0.08
Zn	0.26	0.01	0.06	0.08	0.30	0.96	0.57	0.10	0.54	0.12	0.37	1.27

*Liquid/solid (v/w).

Table S3. Leaching data for static pH titrations at pH 5 with average values and standard deviations, n = 2.

Average	mg/kg					
Sample	ZFS13-01	ZFS13-05	ZFS13-10	ZFS14-01*	ZFS14-05*	ZFS14-10
Al	0.58	1.71	0.47	55.4	0.38	0.59
Ca	53.1	98.8	32.1	306	9.64	6.95
Fe	43.5	54.4	45.6	112	27.5	38.1
Mg	10.5	19.8	6.73	14.3	2.3	1.43
Zn	17.5	33.0	94.8	16.2	54.7	193
Si	22.4	33.4	27.7	21.8	20.3	30.3
St. dev	mg/kg					
Al	0.00	0.34	0.01	-	-	0.27
Ca	10.1	30.3	17.6	-	-	0.72
Fe	2.3	6.4	1.3	-	-	0.1
Mg	3.3	4.9	3.96	-	-	0.19
Zn	0.3	4.6	3.1	-	-	15
Si	5.2	3.9	4.2	-	-	2.2

*n = 1.