

## Supporting information

### Supporting analytical methods

#### Determination of Fe(II) and Mn(II) concentrations

Aluminum sulfate extract solution  $[Al_2(SO_4)_3]$  with the concentration of 0.1 mol/L was prepared and then adjusted its pH to 2.5 by sodium hydroxide. Weighing 10.0000 g of fresh soil (accurate to 0.0001 g) and then placed it into a 250 mL conical bottle, capped and shaken well after 200.00 mL aluminum sulfate was added. The extraction was filtered with slow filter paper to another 250 mL conical bottle 5 min later. Fe(II) was determined by ICP-MS after filtrated and diluted. Adding 5.00 mL filtrate, 1.6 mL sulphuric acid (1 + 1), 0.8 mL phosphoric acid, 8 mL water, and 0.1 g potassium periodate into a 25 mL calibration colorimetric tube in turn for the determination of Mn(II). And then the calibration colorimetric tube was bathed into boiling water, kept it above 90°C for 30 min until the purple-red color was fully developed. Diluting the mixture to 25 mL and shake immediately after cooling. Then, the absorbance was measured with a 1 cm absorbent dish on a spectrophotometer at a wavelength of 540 nm.

#### Additional figures

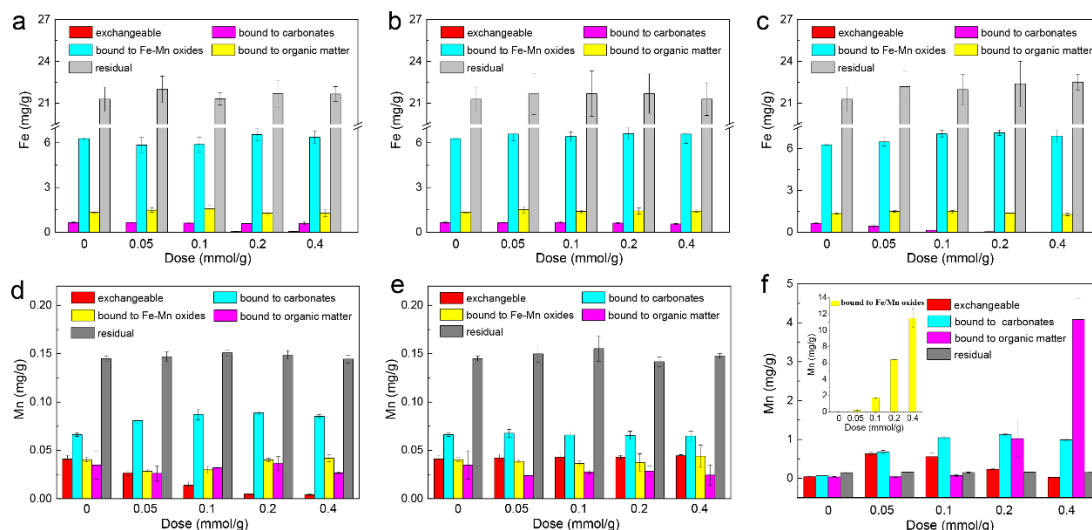


Fig. S1 Fraction distributions of iron and manganese. (a) The fraction distributions of iron at different doses of NaClO; (b) The fraction distributions of iron at different doses of H<sub>2</sub>O<sub>2</sub>; (c) The fraction distributions of iron at different doses of KMnO<sub>4</sub>; (d) The fraction distributions of manganese at different doses of NaClO; (e) The fraction distributions of manganese at different doses of H<sub>2</sub>O<sub>2</sub>; (f) The fraction distributions of manganese at different doses of KMnO<sub>4</sub>. Error bars indicate standard deviation ( $n = 3$ )

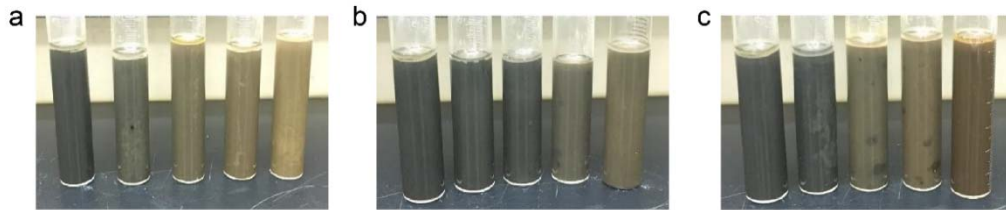


Fig. S2 Color of sediments under different doses of NaClO (a), H<sub>2</sub>O<sub>2</sub> (b), KMnO<sub>4</sub> (c). Each picture presents five glass tubes from left to right, representing the sediment amended with 0 mmol/g, 0.05 mmol/g, 0.1 mmol/g, 0.2 mmol/g, 0.4 mmol/g of oxidants, respectively

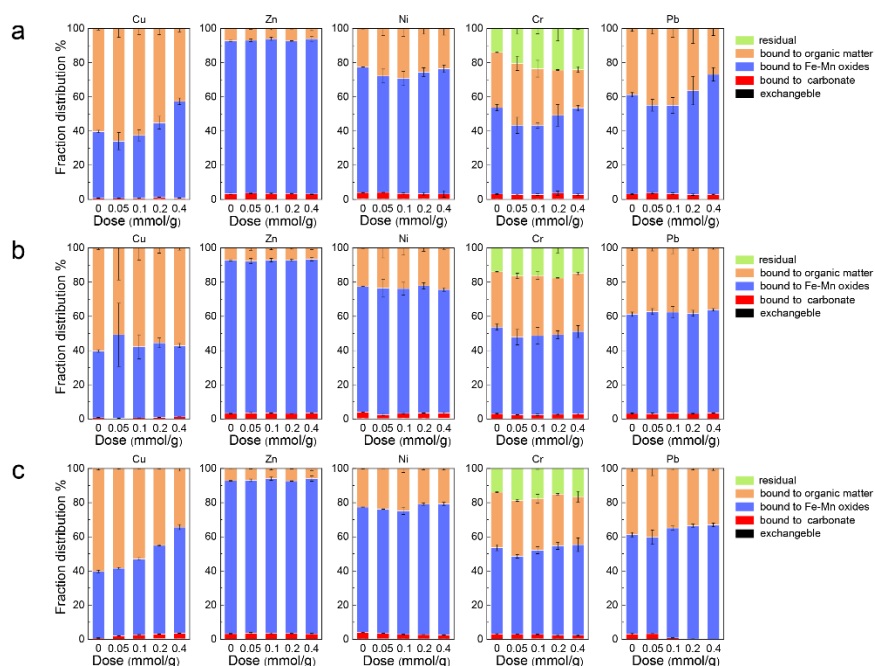


Fig. S3 Fraction distributions of heavy metals. (a) Fraction distributions of heavy metals at different doses of NaCO<sub>3</sub>; (b) Fraction distributions of heavy metals at different doses of H<sub>2</sub>O<sub>2</sub>; (c) Fraction distributions of heavy metals at different doses of KMnO<sub>4</sub>; Error bars indicate standard deviation ( $n = 3$ )

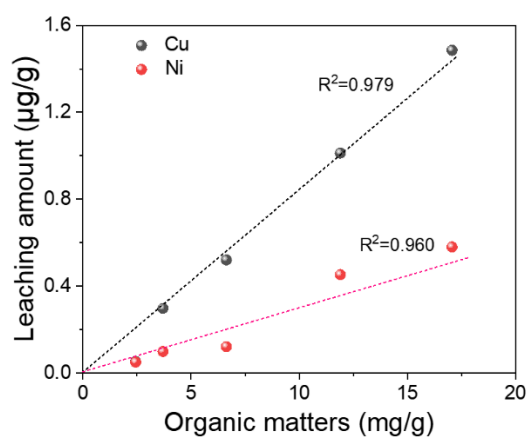


Fig. S4 Correlation between leaching amount of copper and nickel and the release amount of organic matters

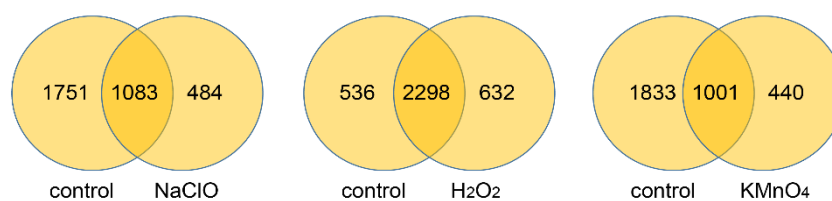


Fig. S5 The number of common OTUs between the original sediment and the sediment amended with 0.4 mmol/g NaClO, H<sub>2</sub>O<sub>2</sub> and KMnO<sub>4</sub>, respectively

### Additional table

Table S1 Diversity index and the number of OTUs at different doses of NaClO, H<sub>2</sub>O<sub>2</sub>, and KMnO<sub>4</sub>

Sample	Dose (mmol/g)	Sobs	Simpson	Ace	Chao	Coverage	Shannon	OUT
Control	0	2834	0.0033	3486	3475.95	0.98	6.72	2904
NaClO	0.05	2917	0.0030	3542	3559.78	0.98	6.77	3017
	0.1	3087	0.0027	3757	3736.24	0.97	6.84	3140
	0.2	3016	0.0042	3799	3887.60	0.97	6.65	3104
	0.4	1567	0.0228	1827	1821.52	0.99	5.19	1677
H <sub>2</sub> O <sub>2</sub>	0.05	2838	0.0036	3544	3558.92	0.97	6.67	2838
	0.1	2875	0.0032	3582	3560.84	0.97	6.75	2958
	0.2	2785	0.0033	3434	3453.36	0.98	6.72	2853
	0.5	2930	0.0036	3586	3533.50	0.97	6.72	3106
KMnO <sub>4</sub>	0.05	2940	0.0028	3616	3587.97	0.97	6.79	3022
	0.1	3125	0.0029	3768	3745.18	0.97	6.89	3221
	0.2	3021	0.0038	3709	3647.47	0.97	6.70	3139
	0.4	1441	0.0232	1846	1825.50	0.99	4.95	1553