Electronic Supplementary Material

Insights into influence of aging processes on zero-valent iron modified biochar in copper(II) immobilization: from batch solution to pilot-scale investigation

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Table. S1 Adsorption kinetics and fitting parameters of Cu(II).

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Table. S3 The Ca(II) and Mg(II) concentration of BC, A-BC, ZVI/BC-1, A-ZVI/BC-1, ZVI/BC-2 and A-ZVI/BC-2 with Cu(II) before and after the reaction.

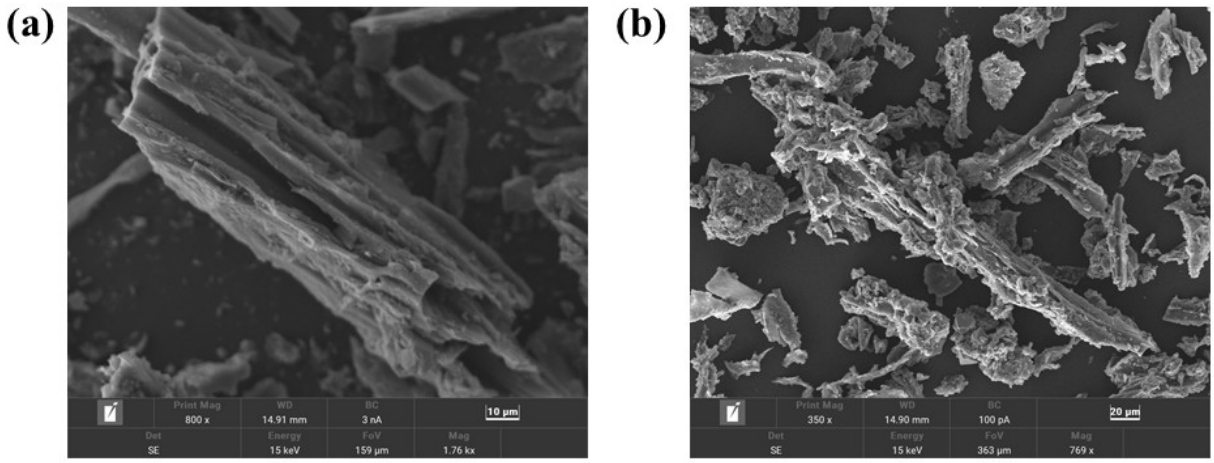


Fig. S1 The SEM images of BC (a), A-BC (b).

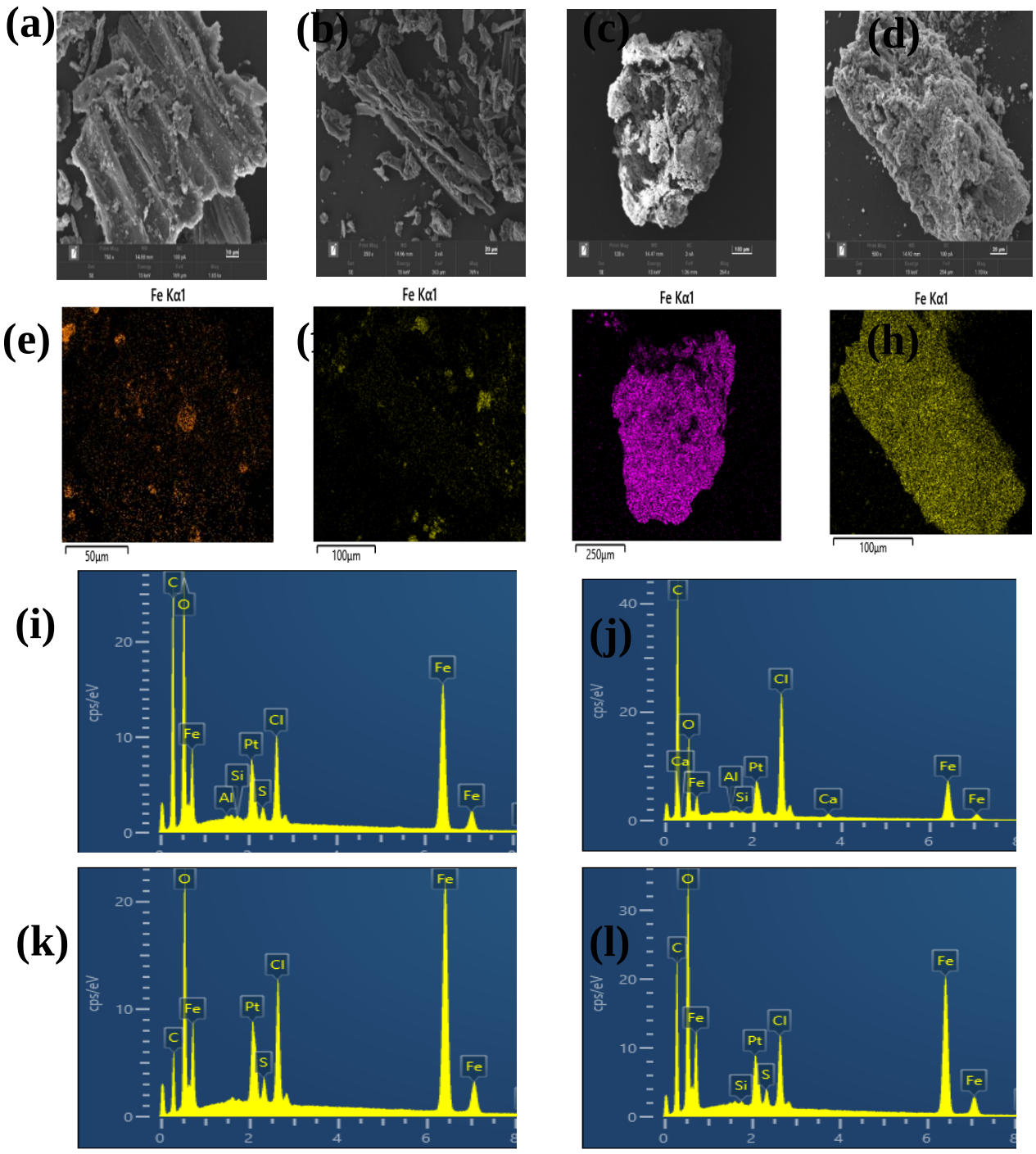
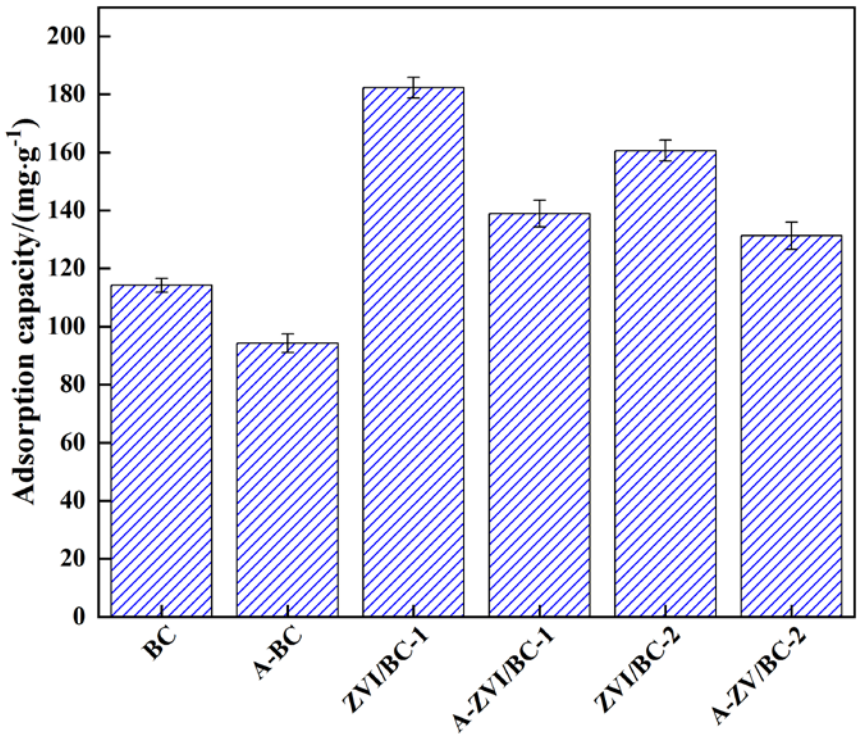


Fig. S2 The SEM images of ZVI/BC-1 (a), A-ZVI/BC-1 (b), ZVI/BC-2 (c), and A-ZVI/BC-2 (d), and mapping pictures of ZVI/BC-1 (e), A-ZVI/BC-1 (f), ZVI/BC-2 (g), and A-ZVI/BA-2 (h), the EDS element picture of ZVI/BC-1(i), A-ZVI/BC(j), ZVI/BC-2(k), A-ZVI/BC-2(l).



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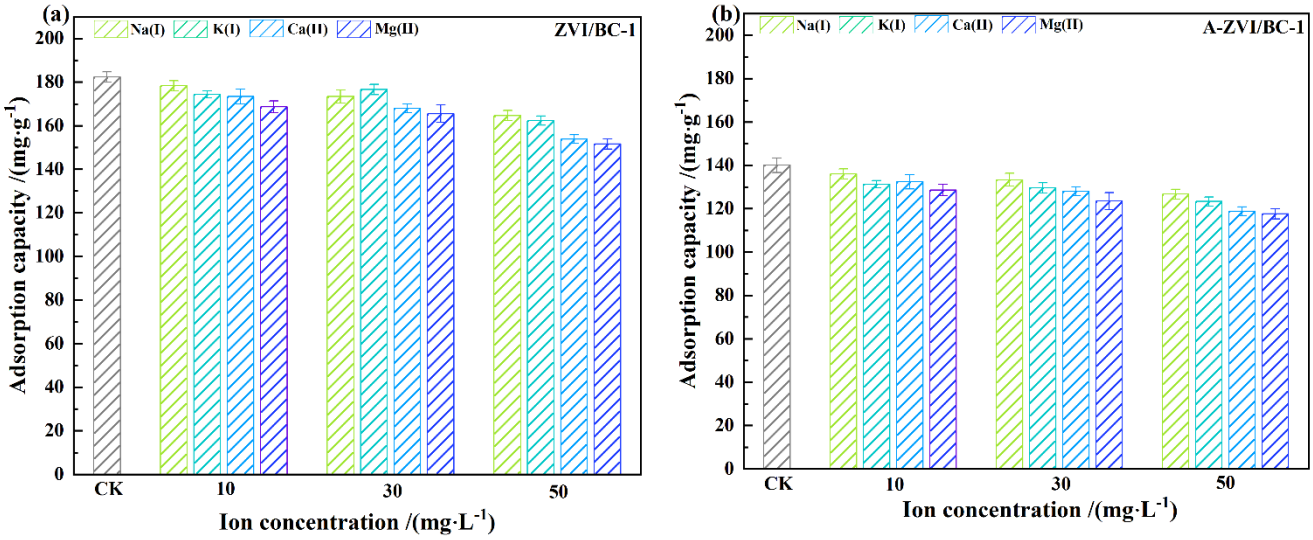

Fig. S4 Adsorption capacity of ZVI/ bC-1 and A-ZVI/BC-1 under cationic co-existence.

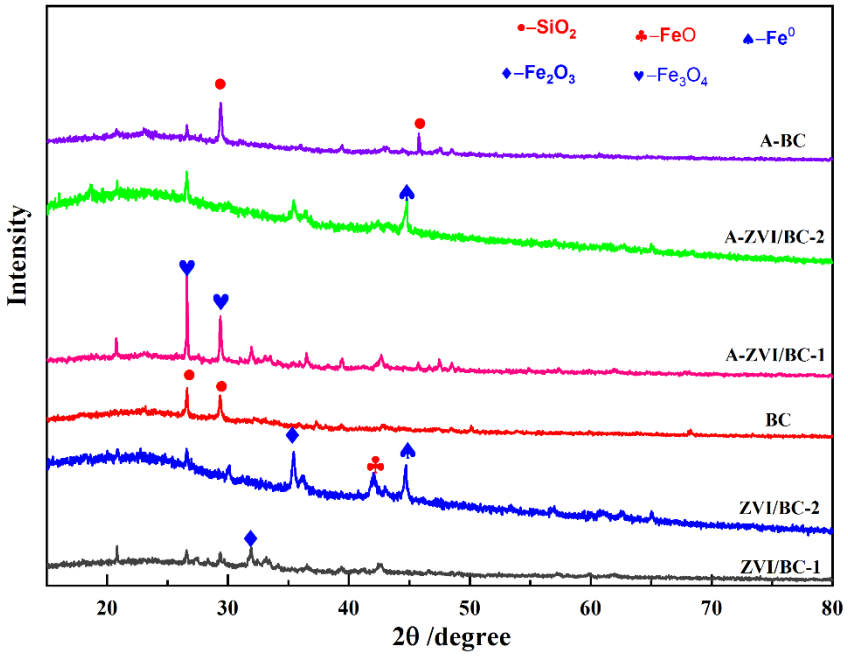

Fig. S5 XRD spectra of adsorbent after reaction.

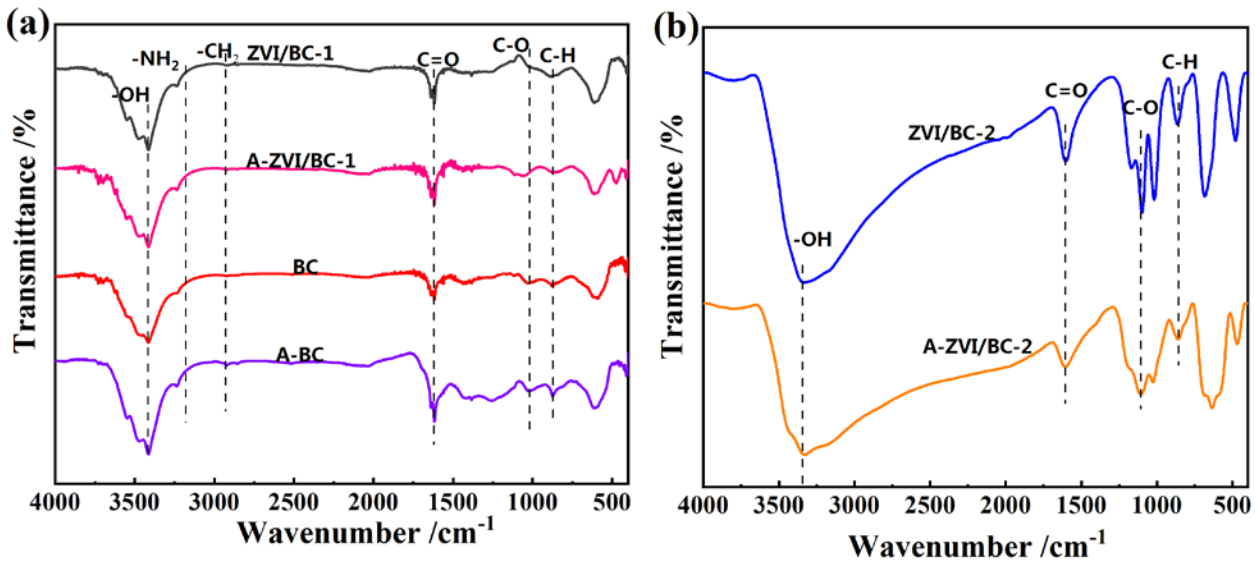

Fig. S6 FTIR spectra of adsorbent after reaction.

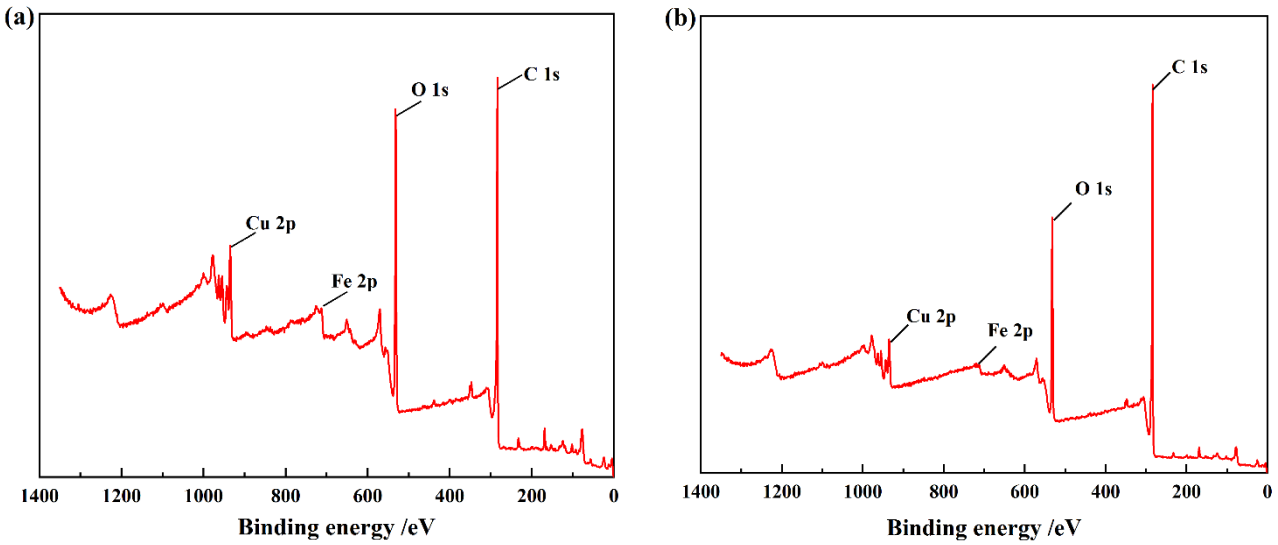

Fig. S7 The full XPS spectra of ZVI/BC-1 (a) and A-ZVI /BC-1 (b) after adsorbed.

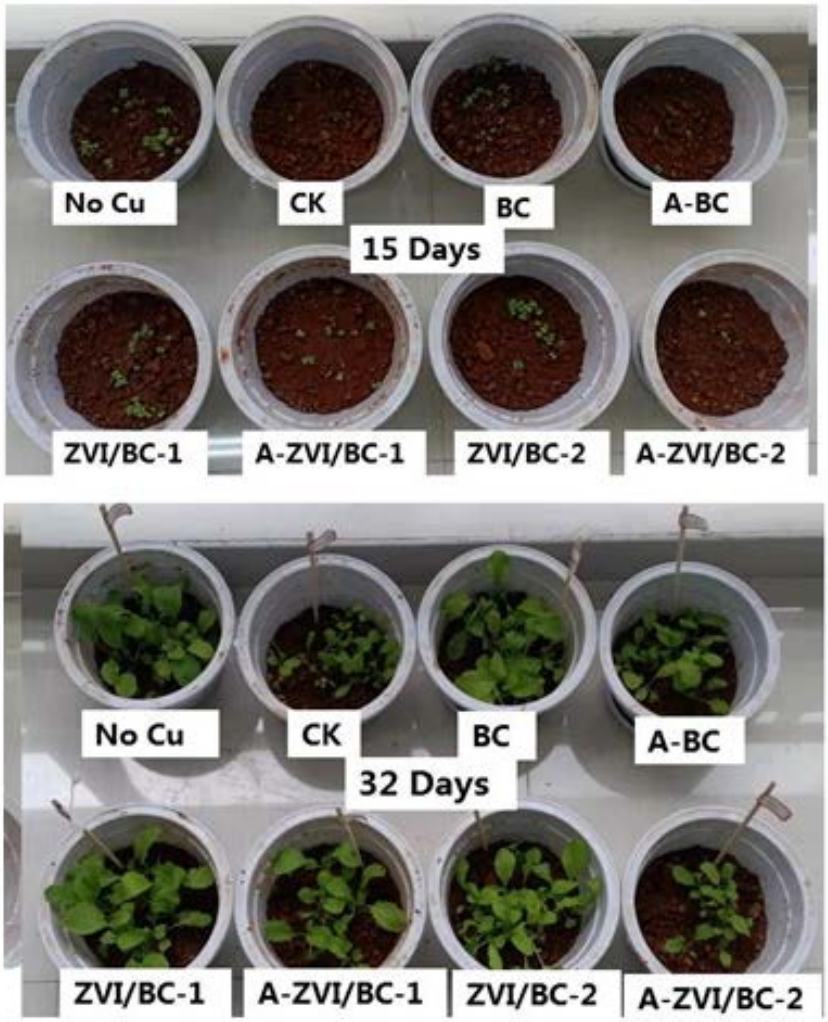

Fig. S8 Bok choy grown in soil treated with various adsorbents.

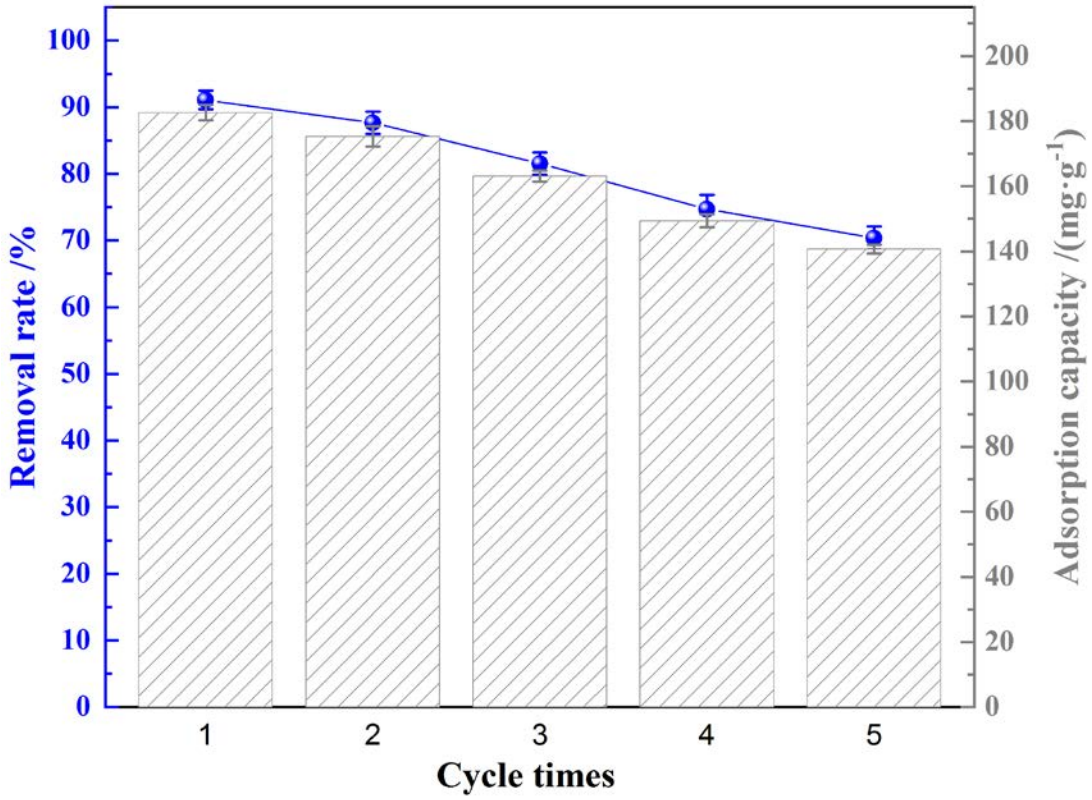

Fig. S9 Removal rates and adsorption capacities of ZVI/BC-1 in regeneration experiment.

Table. S1 Adsorption kinetics and fitting parameters of Cu(II).

	Pseudo-first-order			Pseudo-second-order		
	q_e /(mg·g^{-1})	K_1 /min^{-1}	R^2	q_e /(mg·g^{-1})	K_2 /(mg·g^{-1}·min^{-1})	R^2
BC	102.56	0.028	0.872	108.72	0.112	0.969
A-BC	98.06	0.011	0.903	94.78	0.126	0.929
ZVI/BC-1	160.52	0.059	0.886	172.34	0.313	0.969
A-ZVI/BC-1	135.61	0.019	0.902	146.82	0.094	0.921
ZVI/BC-2	154.11	0.026	0.911	163.70	0.189	0.971
A-ZVI/BC-2	122.18	0.008	0.876	139.46	0.378	0.917

Table. S2 Langmuir and Freundlich isothermal adsorption model parameters for Cu(II).

		Langmuir isotherm			Freundlich isotherm		
		$q_m/(mg \cdot g^{-1})$	$K/(L \cdot mg^{-1})$	R^2	$K_F/(mg \cdot g^{-1})$	1/n	R^2
298 K	BC	206.34	0.0067	0.975	8.84	0.392	0.956
	A-BC	188.72	0.0055	0.971	7.90	0.432	0.964
	ZVI/BC-1	334.75	0.0059	0.955	20.12	0.409	0.967
	A-ZVI/BC-1	254.90	0.0059	0.975	14.59	0.415	0.988
	ZVI/BC-2	269.77	0.0078	0.980	19.85	0.383	0.994
	A-ZVI/BC-2	231.59	0.0044	0.976	12.05	0.482	0.984
308 K	BC	217.55	0.0087	0. 993	17.36	0.397	0.984
	A-BC	197.41	0.0049	0.982	9.77	0.456	0.971
	ZVI/BC-1	363.36	0.0051	0.978	20.14	0.416	0.996
	A-ZVI/BC-1	243.27	0.0064	0.985	17.14	0.383	0.994
	ZVI/BC-2	296.51	0.0063	0.917	19.80	0.391	0.814
	A-ZVI/BC-2	239.35	0.0050	0.970	10.37	0.449	0.954
318 K	BC	245.04	0.0056	0.995	15.85	0.382	0.970
	A-BC	217.42	0.0057	0.986	9.88	0.425	0.971
	ZVI/BC-1	422.70	0.0046	0.943	19.25	0.471	0.973
	A-ZVI/BC-1	307.53	0.0046	0.977	12.16	0.466	0.986
	ZVI/BC-2	323.78	0.0067	0.986	18.73	0.434	0.997
	A-ZVI/BC-2	262.42	0.0047	0.955	11.30	0.464	0.973

Table. S3 The Ca(II) and Mg(II) concentration of BC, A-BC, ZVI/BC-1, A-ZVI/BC-1, ZVI/BC-2 and A-ZVI/BC-2 with Cu(II) before and after the reaction.

	Sample	Cationic concentration ($mg \cdot L^{-1}$)	
		Ca(II)	Mg(II)
Before	BC	74.92	1.37
	A-BC	28.95	0.10
	ZVI/BC-1	31.85	0.18
	A-ZVI/BC-1	15.03	0.59
	ZVI/BC-2	20.12	0.07
	A-ZVI/BC-2	5.49	0.18
After	BC	228.86	20.64
	A-BC	55.81	5.57
	ZVI/BC-1	50.07	9.21
	A-ZVI/BC-1	16.03	0.95
	ZVI/BC-2	18.67	2.40
	A-ZVI/BC-2	7.32	0.29