Electronic Supplementary Material (ESI) for RSC Advances.

Barrier effect of coal bottom ash-based geopolymers on soil contaminated by heavy metals

*Yiqie Dong[1], Min Zhou[1,2], Yuwei Xiang[1], Sha Wan[1], He Li[1], Haobo Hou[1,2]**

1. School of Resource and Environmental Sciences, Wuhan University, Wuhan, China

2. Hubei Environmental Remediation Material Engineering Technology Research Center, Wuhan, China

**corresponding author, email: houhb@whu.edu.cn*

Supporting Information

Figures

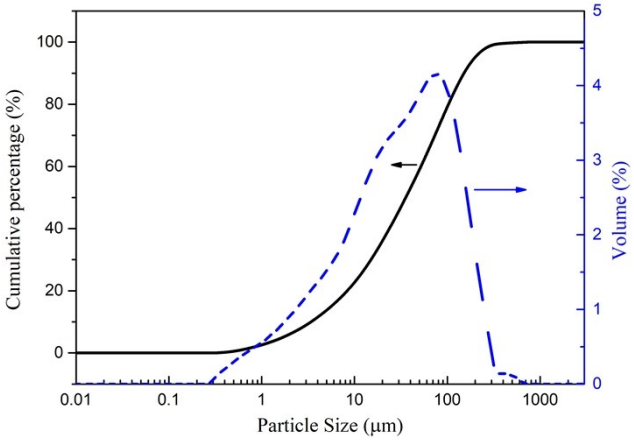


Fig. S1 Particle size distribution of CBA

Fig. S2 Geopolymer of S1

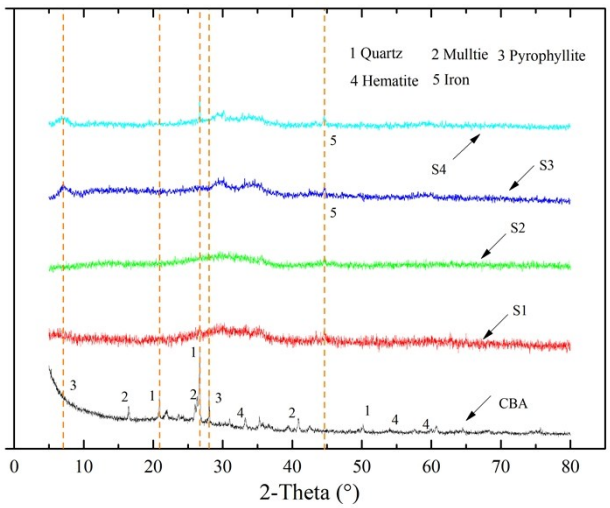
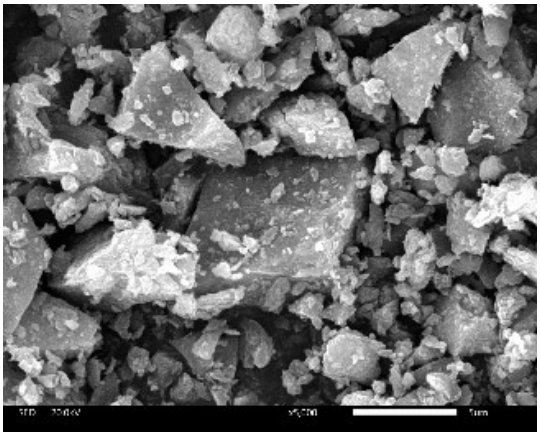
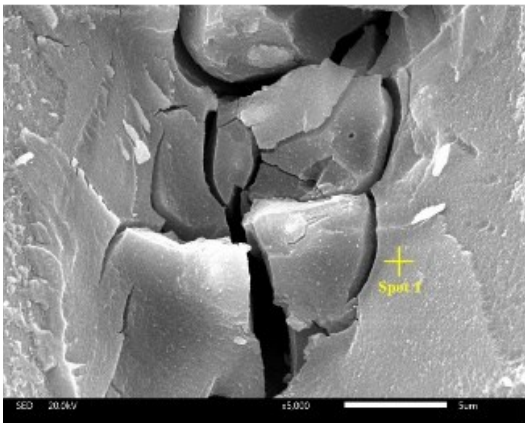


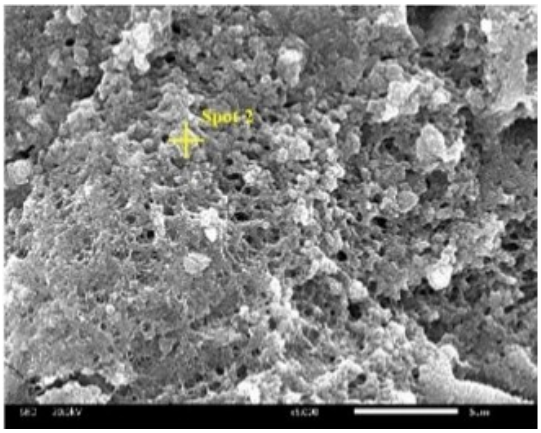
Fig. S3 XRD diagram of solidified geopolymers



(CBA)



(S1)



(S4)

Fig. S4 Micromorphology of CBA and geopolymers (5000 times)

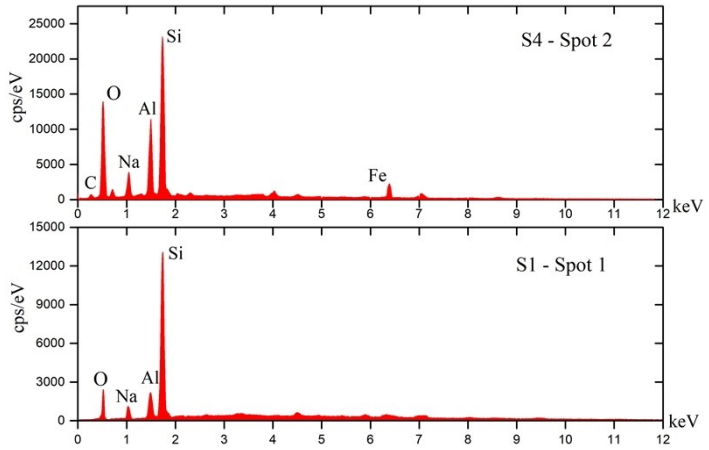
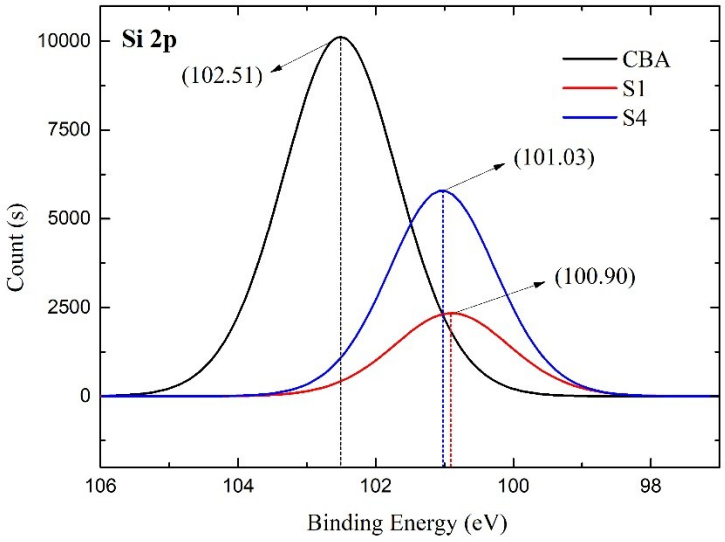
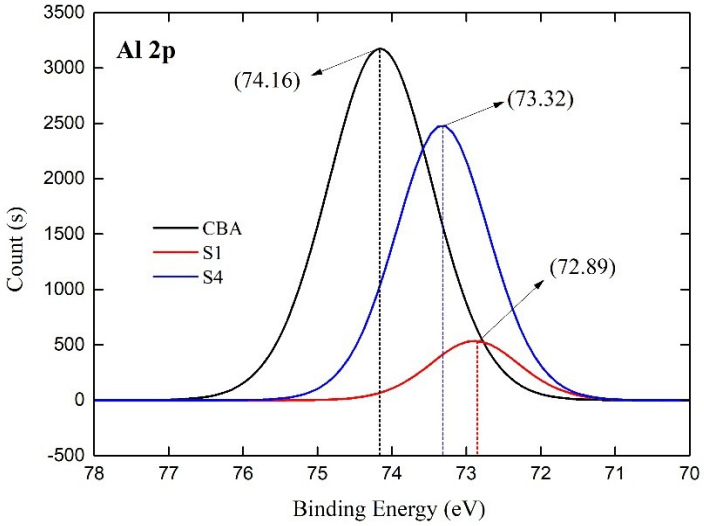


Fig. S5 Energy spectrum curves of characteristic points in S1 and S4

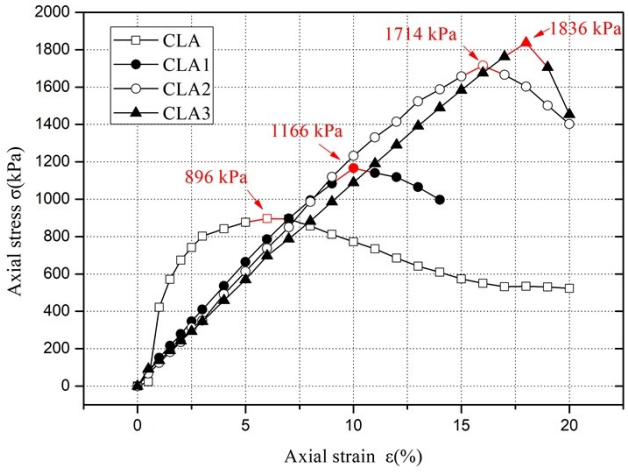


(a)

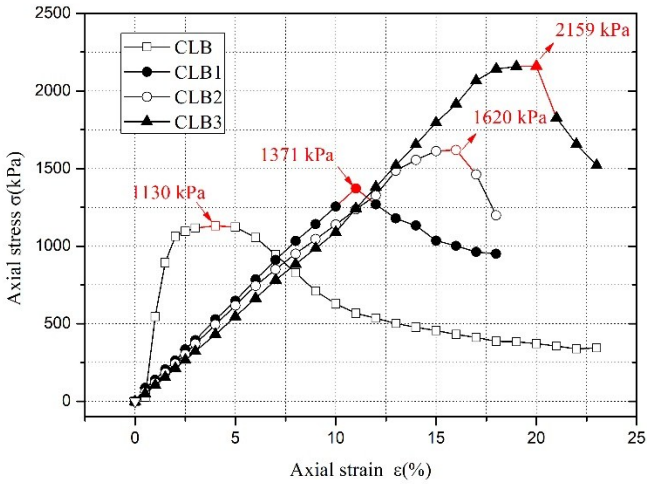


(b)

Fig. S6 Si 2p and Al 2p binding energies of CBA and geopolymers



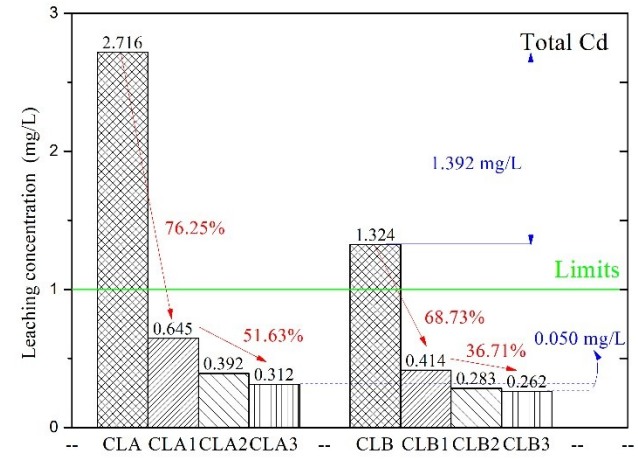
(a)



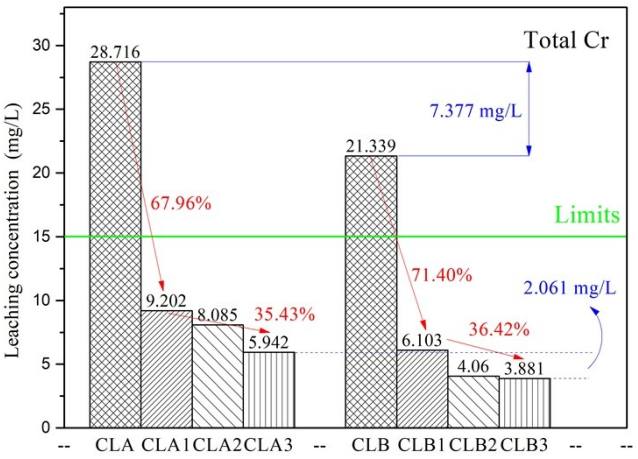
(b)

Fig. S7 Stress–strain curve of CLA, CLB, and remolded soils

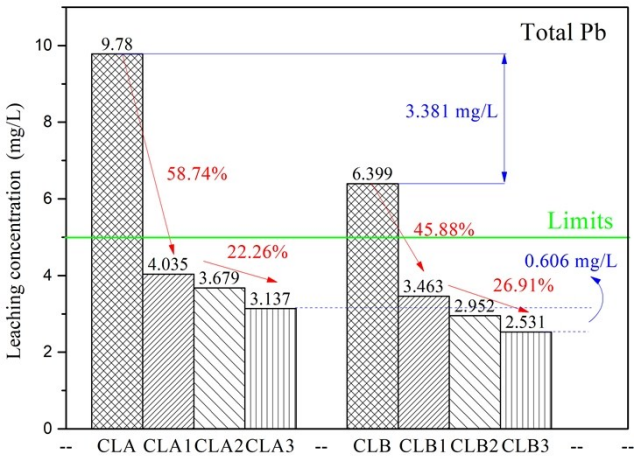
Fig. S8 CLA3 and CLB3



(a)

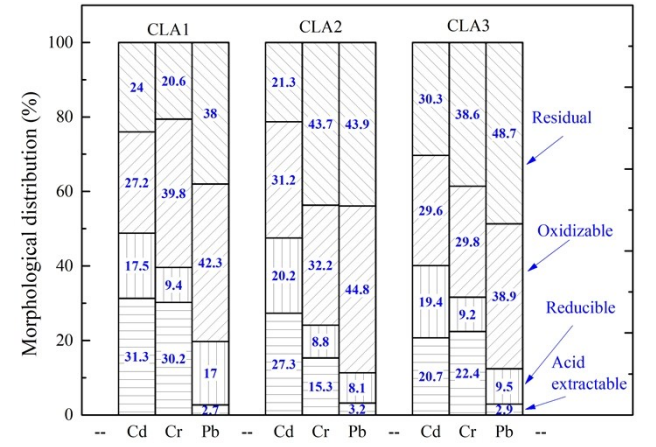


(b)

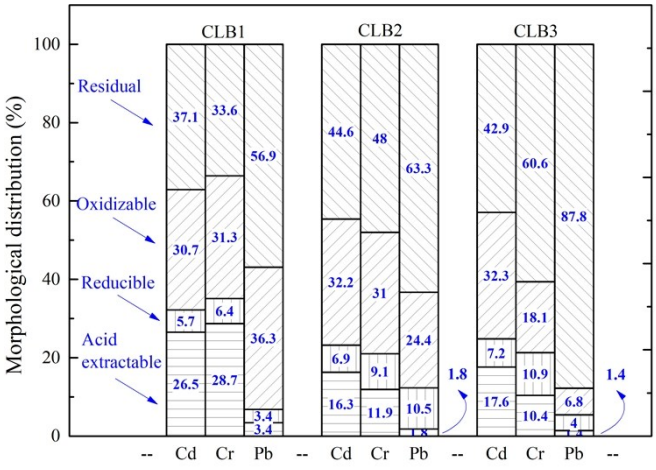


(c)

Fig. S9 Leaching concentration of heavy metals in undisturbed and remolded soils



(a)



(b)

Fig. S10 Chemical fraction distribution of remolded soils

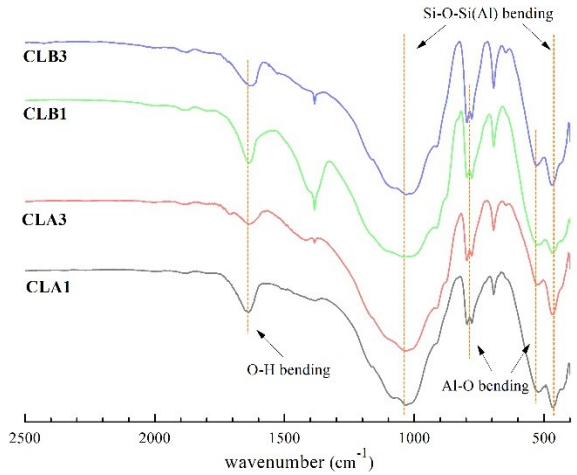
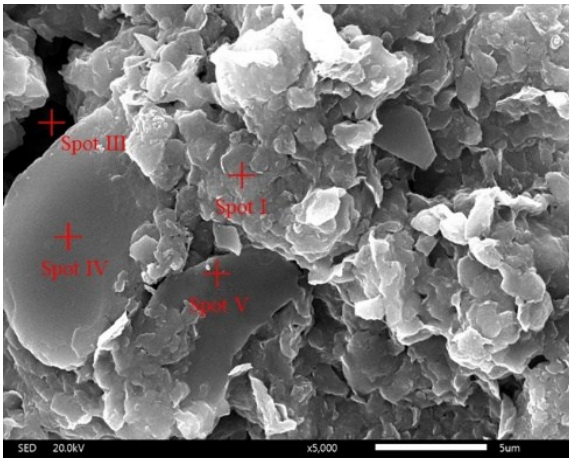
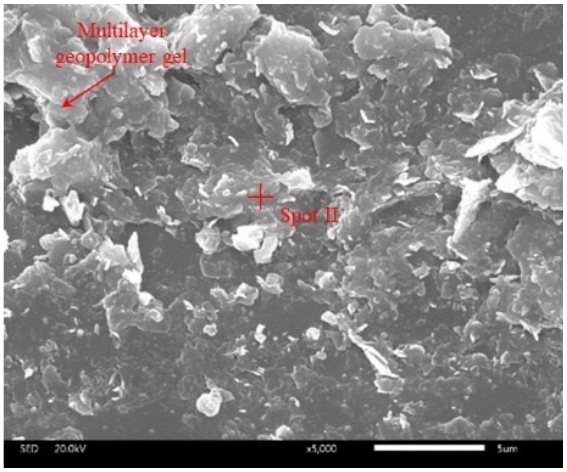


Fig. S11 IR spectrum of remolded soils



(a) CLA1



(b) CLA3

Fig. S12 Micromorphology of remolded soils (5000 times)

Tables:

Table S1 Chemical compositions of CBA

	SiO_2	$Al2O_3$	Fe_2O_3	K_2O	CaO	MgO	Loss
CBA	59.93	22.98	7.90	1.74	2.16	1.28	4.01

Table S2 Content of heavy metals in soil (mg/kg)
(ND: No heavy metal was detected.)

Content	Cd	Hg	As	Cu	Pb	Cr	Zn	Ni
CLA	58.4	0.2	7.3	25.9	1817	1365	462	ND
CLB	31.6	ND	3.6	33.7	672	794	71.3	ND

Table S3 Experimental range and levels of independent variables

Variable	Symbols	Range and levels		
	Coded	−1	0	1
n(Si):*n*(Al)	X1	2	2.4	2.7
n(Na):*n*(Al)	X2	0.6	0.7	0.8
n(Water):*n*(Binder)	X3	2	2.4	2.8

Table S4 Contents of geopolymers and HMS in remolded soils (%)

Content	CLA1	CLA2	CLA3	CLB1	CLB2	CLB3
Geopolymer	10	20	30	10	20	30
CLA	90	80	70	0	0	0
CLB	0	0	0	90	80	70

Table S5 The procedure of chemical fraction distribution

Fractions	Operating scheme
Step 1 (Acid extractable)	0.5 g samples were continuously shaken for 16 h at 25 °C with 20 ml of 0.1 mol/L HAc.
Step 2 (Reducible)	The residual was continuously shaken for 16 h at 25 °C with 20 ml of 0.5 mol/L $NH_2OH{\cdot}HCl$.
Step 3 (Oxidizable)	The residual was added in 5 ml of 30% H_2O_2, and was heated to 85 °C in a water bath for 1 h with 5 ml of 30% H_2O_2 an hour later, 25 ml of 1 mol/L NH_4Ac was added to the cooled sample at 25 °C, Continuous shaking was maintained for 16 h at 25 °C.
Step 4 (Residual)	The residual was digested using a mixture of HNO_3, HF and HCl in a 3:1:1 ratio.