Supporting Information

Influence of organic matters on the adsorption-desorption of 1,2-dichloroethane on soil in water and model saturated aquifer

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Introduction

Supplementary information includes a brief description and discussion of the following: **(i)** Adsorption model (S1); **(ii)** Comparisons of UV spectra of FA, HA, and 1,2-DCA with different combinations (Fig. S1); **(iii)** Fourier Transform infrared spectroscopy (FT-IR) spectra of FA and HA-treated loamy sand, sandy loam, and FA and HA. (Fig. S2); **(iv)** X-Ray Diffraction (XRD) patterns of FA and HA-treated loamy sand, sandy loam, and the FA and HA, respectively (Fig. S3); **(v)** Particle size distribution of original and treated soils (Table S1); **(vi)** Properties of original soils (Table S2); **(vii)** Chemical analysis for the original and treated soils with high temperature and H_2O_2 (Table S3); **(viii)** Zeta potential of soils under different conditions (Table S4); **(ix)** The pH of soils under different conditions (Table S5); **(x)** Percentages of 1,2-DCA mass recovered from the column effluents during the retention and release phases (Table S6); **(xi)** Percentages of 1,2-DCA mass recovered from the column effluents during the retention and release phases (Table S7).

S1. Adsorption model

The pseudo-first-order[1] and second-order kinetic models[2] were used to describe the adsorption kinetics of 1,2-DCA by soil. Linear model and Freundlich model[3] were used to fit the adsorption isotherms.

Pseudo-first-order kinetic equation:

$$Q_{\mathrm{t}} = Q_{e1}(1 - e^{-K_1 t}) \tag{S1}$$

Pseudo-second-order kinetic equation:

$$Q_{\mathrm{t}} = \frac{K_2 Q_{e2}^2 t}{1+K_2 Q_{e2} t} \tag{S2}$$

where K_1 is the pseudo-first-order kinetic rate constant (h^{-1}), K_2 is the pseudo-second-order kinetic rate constant ($g\ mg^{-1}\ h^{-1}$), Q_t is the adsorption capacity ($mg\ g^{-1}$) with the variable t (time, h), Q_{e1} and Q_{e2} are the equilibrium adsorption capacities ($mg\ g^{-1}$).

Linear equation:

$$\mathrm{Q} = K_d C_e \tag{S3}$$

Freundlich equation:

$$\mathrm{Q} = K_f C_e^{\frac{1}{n}} \tag{S4}$$

where Q is the adsorbed amount of 1,2-DCA ($mg\ g^{-1}$), C_e is the aqueous concentration of 1,2-DCA at equilibrium ($mg\ L^{-1}$), K_d is the distribution coefficient from linear equation ($L\ kg^{-1}$), K_f is the Freundlich constant associated with adsorption capacity ($L\ kg^{-1}$), and n is the favorability degree of the adsorption process.

References

1. Ho, Y. and McKay, G., 1998a. The kinetics of sorption of basic dyes from aqueous solution by sphagnum moss peat. The Canadian Journal of Chemical Engineering 76, 822-827.
2. Ho, Y. and McKay, G., 1998b. Kinetic models for the sorption of dye from aqueous solution by wood. Process Safety and Environmental Protection 76 (2), 183-191.
3. Freundlich, H.F.M., 1906. Über die adsorption in lösungen. Zeitschrift für Physikalische Chemie 57, 115-124.

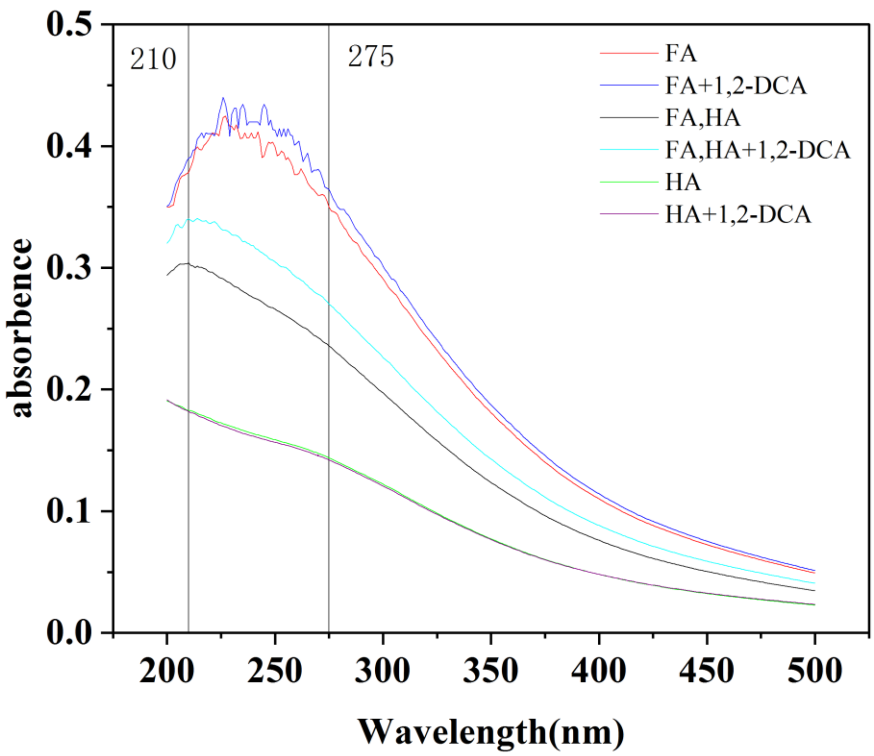

Fig. S1. Comparisons of UV spectra of fulvic acid (FA), humic acid (HA), and 1,2-Dichloroethane (1,2-DCA) with different combinations.

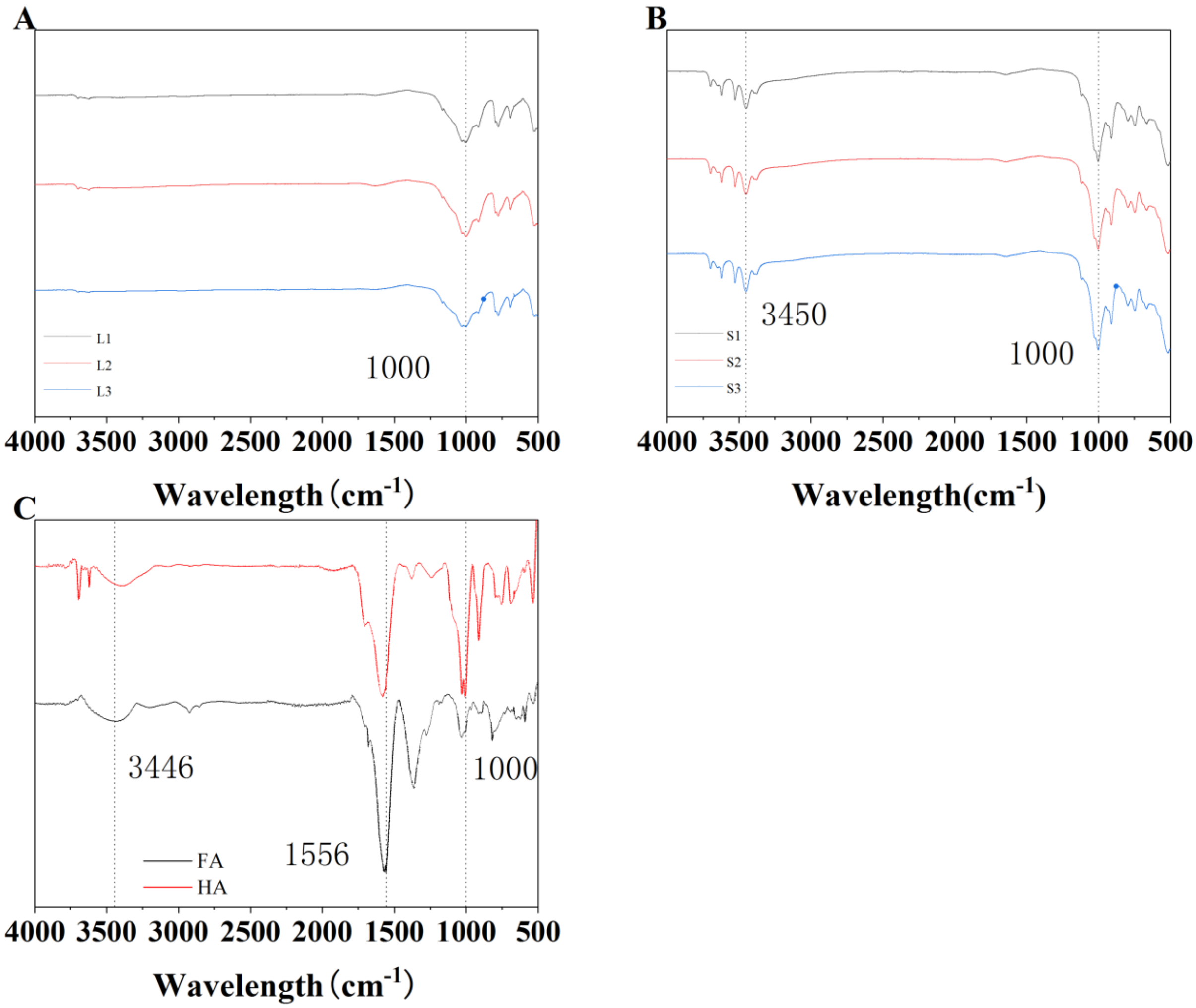

Fig. S2. The FTIR spectra of FA and HA-treated loamy sand (A), sandy loam (B), and FA and HA (C). The L1 and S1 contain 50 ppm FA, L2 and S2 contain 25 ppm FA and 25 ppm HA mixtures, and the L3 and S3 contain 50 ppm HA.

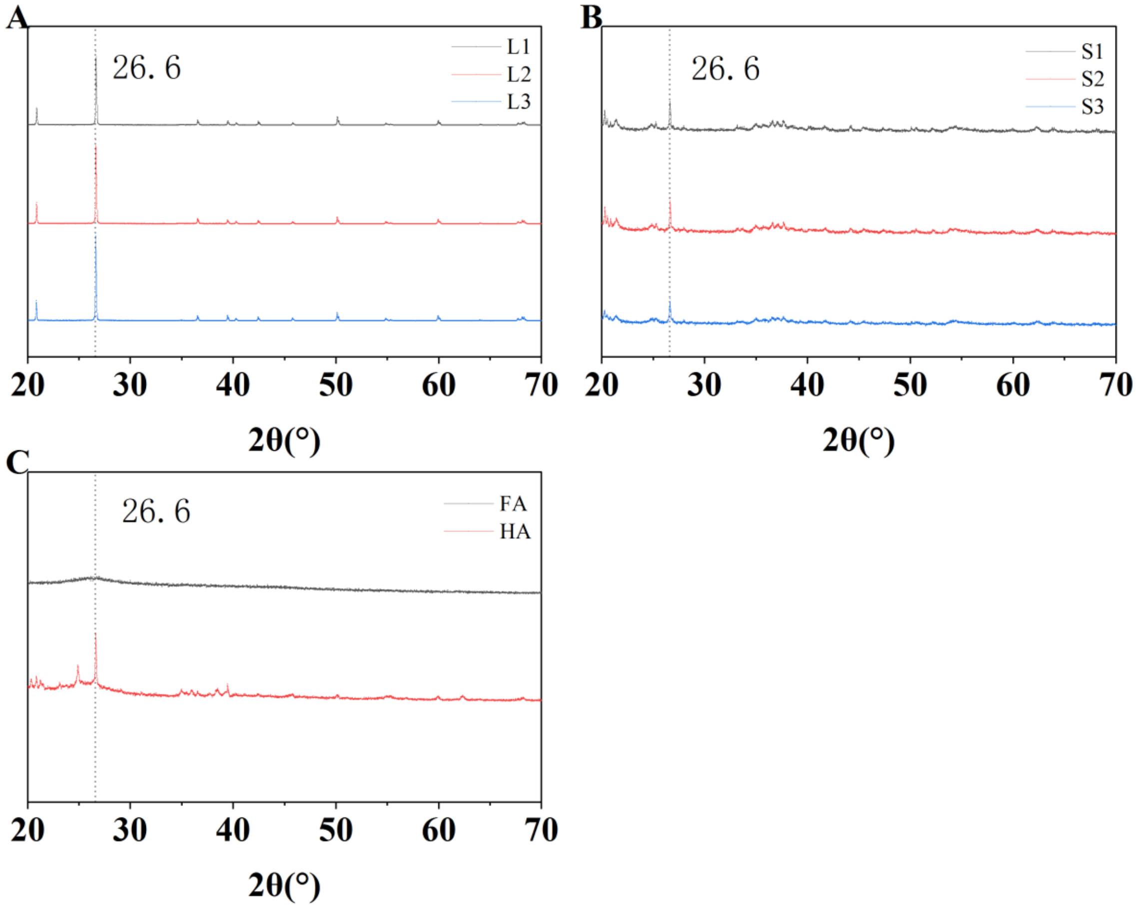

Fig. S3. The XRD patterns of FA and HA-treated loamy sand (A), sandy loam (B), and the FA and HA (C), respectively. L1 and S1 contain 50 ppm FA, L2, and S2 contain 25 ppm FA with 25 ppm HA, and L3 and S3 contain 50 ppm HA.

Table S1. Particle size distribution of original and treated soils.

Particle size (mm)	0.45-2	0.25-0.45	0.15-0.25	0.075-0.15	0.05-0.075	Total
Loamy sand	34.5%	10.3%	6.9%	29.5%	18.8%	100.0%
Treated loamy sand	46.9%	9.4%	8.4%	20.1%	15.2%	100.0%
Sandy loam	48.0%	23.7%	11.2%	13.0%	4.1%	100.0%
Treated sandy loam	53.9%	14.3%	16.4%	9.6%	5.8%	100.0%

Table S2. Properties of original soils.

Type	Loamy sand	Sandy loam
pH	6.29±0.09	6.91±0.11
Moisture content (%)	3.13±0.26	7.69±0.33
Humic acid content (%)	0.28±0.02	0.92±0.07
TOC (%)	1.97±0.11	4.83±0.24
Conductivity of solution (mS/cm)	129.4±3.3	33.3±1.4

Table S3. Chemical analysis for the original and treated soils with high temperature and H_2O_2.

Element (%)	C	H	O	N	S
Loamy sand	0.430±0.130	1.147±0.064	4.303±0.375	0.035±0.005	0.776±0.195
Treated loamy sand	—	0.900±0.111	1.875±0.420	0.050±0.000	0.877±0.079
Sandy loam	0.345±0.035	2.135±0.192	17.644±0.380	0.090±0.010	1.010±0.038
Treated sandy loam	—	1.646±0.182	11.431±0.213	0.065±0.015	1.165±0.112

Table S4. Zeta potential of soils under different conditions.

Zeta potential (mV)	Loam sand	Treated loam sand	Sandy loam	Treated sandy loam
Without HA and FA	-14.3±0.3	-27.9±1.9	-6.40±1.3	-6.03±0.3
0 (50 ppm FA)	-14.1±1.2	-23.6±1.5	-15.3±1.5	-4.82±0.2
20% (40 ppm FA, 10 ppm HA)	-14.4±0.7	-28.3±0.3	-22.4±1.4	-6.90±1.4
40% (30 ppm FA, 20 ppm HA)	-13.7±0.4	-30.6±0.6	-23.1±0.4	-13.7±1.5
60% (20 ppm FA, 30 ppm HA)	-13.4±0.9	-40.5±0.8	-24.1±0.4	-16.8±0.5
80% (10 ppm FA, 40 ppm HA)	-13.1±1.5	-44.5±0.7	-26.2±1.3	-18.9±1.4
100% (50 ppm HA)	-8.30±1.7	-48.1±0.7	-26.9±0.2	-20.2±0.6

Table S5. The pH of soils under different conditions.

pH	Loamy sand	Treated loamy sand	Sandy loam	Treated sand
Without HA and FA	6.29±0.21	6.83±0.15	6.91±0.17	7.24±0.14
0 (50 ppm FA)	6.15±0.15	6.77±0.21	5.36±0.16	6.37±0.13
20% (40 ppm FA, 10 ppm HA)	6.30±0.18	7.07±0.14	5.79±0.12	6.55±0.17
40% (30 ppm FA, 20 ppm HA)	6.69±0.11	7.22±0.19	6.40 ± 0.16	6.54±0.19
60% (20 ppm FA, 30 ppm HA)	7.06±0.13	7.57±0.11	6.43 ± 0.15	6.83±0.17
80% (10 ppm FA, 40 ppm HA)	7.31±0.21	7.80±0.14	6.53 ± 0.21	6.83±0.16
100% (50 ppm HA)	7.41±0.25	7.93±0.17	6.52±0.19	6.84±0.15

Table S6. Percentages of 1,2-DCA mass recovered from the column effluents during the retention and release phases (corresponding to Fig. 9).

Type	Infused 50 mg/L 1,2-DCA with mixtures of FA and HA (ppm)	Column porosity	Recovery of transport (%)	Recovery of release (%)
Loamy sand	0	0.459	36.4	17.5
Loamy sand	25	0.453	38.9	17.2
Loamy sand	50	0.464	43.9	15.5
Loamy sand	90	0.461	52.0	15.4
Loamy sand	160	0.452	55.5	12.4
Sandy loam	0	0.466	37.7	11.1
Sandy loam	25	0.455	40.1	11.5
Sandy loam	50	0.467	45.0	12.9
Sandy loam	90	0.459	50.8	13.6
Sandy loam	160	0.454	57.8	16.4

Table S7. Percentages of 1,2-DCA mass recovered from the column effluents during the retention and release phases (corresponding to Fig. 10).

Type	Eluent	Concentration of humic acid added with eluent (ppm)	Recovery of transport (%)	Column porosity	Recovery of release (%)
Loamy sand	pH 8.5 water	0	35.5	0.448	8.8
Loamy sand	_	50	35.3	0.446	11.5
Loamy sand	200 mg/L RL	0	35.6	0.456	15.0
Loamy sand	300 mg/L RL	0	35.4	0.447	16.9
Loamy sand	200 mg/L RL	50	35.5	0.452	15.5
Loamy sand	300 mg/L RL	50	35.5	0.461	17.7
Sandy loam	pH 8.5 water	0	38.7	0.463	14.1
Sandy loam	_	50	37.9	0.447	17.4
Sandy loam	200 mg/L RL	0	37.8	0.452	18.0
Sandy loam	300 mg/L RL	0	37.7	0.457	22.6
Sandy loam	200 mg/L RL	50	37.9	0.455	24.1
Sandy loam	300 mg/L RL	50	37.6	0.443	29.1

RL: rhamnolipid.