

Supplementary materials

Text numbers: 3

Figure numbers: 6

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Text S1 Analysis of soil physicochemical properties

Briefly, the particle size composition of the soils was analysed by aerometry after dispersal; pH value measured by potentiometric method (HJ 962-2018); The cation exchange capacity (CEC) was determined by ammonium acetate exchange method. Total organic matter in soil was determined by potassium dichromate thermometric oxidation colorimetric method (Mallet et al., 2013; Ding et al., 2018); Determination of available iron and aluminum by diethylenetriaminepentaacetic acid extraction-inductively coupled plasma atomic emission spectrometry (HJ 804-2016); The total arsenic content in the soil was determined by the digestion method with $\text{HNO}_3 + \text{HClO}_4 + \text{HCl}$ at a ratio of 7:3:10 (Ščančar et al., 2000). Available arsenic in soil was determined by NaHCO_3 extraction. GBW07406 and GBW10035 standard soil samples were used as references for the analysis of total arsenic and available arsenic in soil for quality control.

Text S2 Synthesis of As(V)-Fh

Briefly speaking, 80.6 g $\text{Fe}(\text{NO}_3)_3$ is dissolved in MQ water followed by adding NaOH (1 M) and adjust the pH of the solution to 7-8. Stirring is carried out to ensure that $\text{Fe}(\text{NO}_3)_3$ and NaOH are completely reacted. Waiting about 1 h until the Fh settling at the bottom, remove the surface water. Then settled ferrihydrite is repeatedly shaken by ultrapure water, centrifuged and washed at least three times. The washed Fh was then transferred to the dialysis bag and purify to a conductivity of the external solution below 20 $\mu\text{S}/\text{cm}$.

After dialysis, the purified Fh slurry was resuspended in a Teflon flask, As(V)-Fh with As/Fe molar ratios of 0.005 and 0.05 were prepared respectively to simulate the moderately and severely arsenic-contaminated soils after remediated by ferrihydrite (Cai et al., 2009; Yang et al., 2018). Dissolve Na_2HAsO_4 in 100 mL of MQ water, slowly drop it into the ferrihydrite suspension with a dropper within 20 minutes, and shake it in a constant temperature reciprocating oscillator for a week to ensure that arsenic is completely adsorbed onto the ferrihydrite. The suspension was purified and dialyzes again, and the pure As(V)-Fh was obtained and freeze-dried in vacuum freeze dryer for 24 h. The dried As(V)-Fh were sealed in plastic bags and stored at room temperature after sieving through the 100-mesh sieve.

Text S3 Spectral characterization of As(V)-Fh

(1) XRD

XRD analysis was performed by using a Bruker D8 Advance device with Co K α radiation (λ = 0.1541 nm) at a voltage and current of 40 kV and 40 mA, respectively, and a scan range between 5° and 80°. A step size of 0.02° 2 θ with a change rate of 2 s/step was used. The Rietveld refinement method was used to quantify the proportional composition of each component during culture by TOPAS 5.0 (Hu et al., 2018). The compositional composition was determined by comparing the data of the synthesized ferrihydrite and conversion products with the XRD reference data.

(2) SEM

The morphology of the selected surface containing As(V)-Fh was determined by SEM using Hitachi S4800 scanning electron microscope. After carbon coating, the sample was mounted on a pin-shaped aluminum base with double-sided carbon tape for SEM analysis.

(3) XPS

The valence state of the composite was determined with an Amicus XPS instrument (Thermo Escalab 250XI, USA) under monochromatic Al K α radiation (1486.6 eV) at 14.8 kV and 1.6 A. The samples were kept in a sealed plastic bag filled with N₂ before the XPS measurement. Wide and narrow scans were performed at 100 eV and 20 eV, respectively, with an energy step of 1.0 eV. High-resolution scans of elements (O, Fe, and As) in steps of 0.1 eV. XPS data analysis Peak fitting was performed using XPS PEAK 4.1 software (Yang et al., 2021).

(4) BET

In order to characterize the change of specific surface area of As(V) – bearing ferrihydrite during long-term soil suspension culture, The Brunauer – Emmett-Teller (BET) specific surface area of the samples was determined by nitrogen adsorption/desorption on an ASAP 2460 BET surface analyzer system. Prior to measurement, the tested samples were degassed by N₂ at room temperature for at least 24 h.

References

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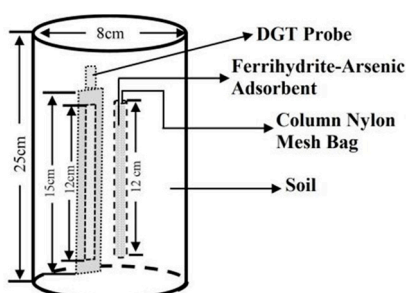


Figure S1. Soil incubation device.

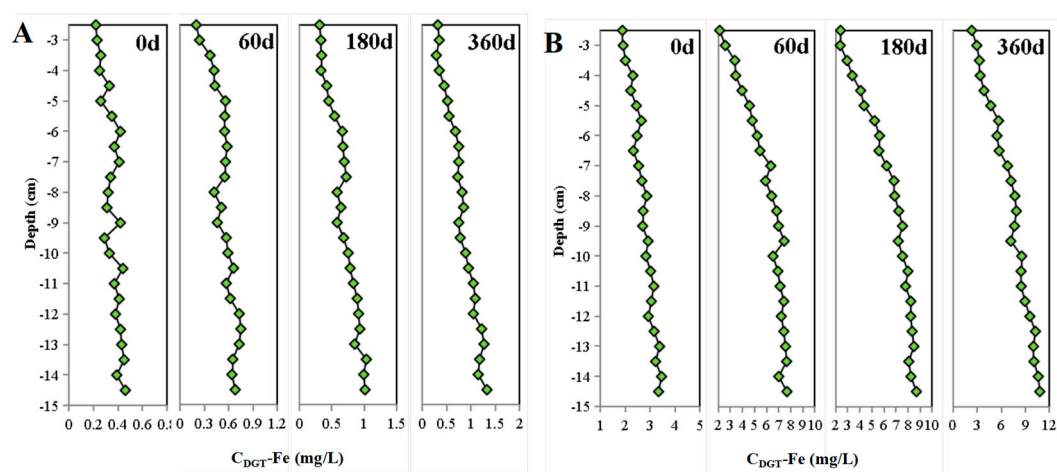


Figure S2. Changes in DGT-Fe in the soil vertical profile with no As(V)-Fh addition (A: 70% SWHC; B: 120% SWHC).

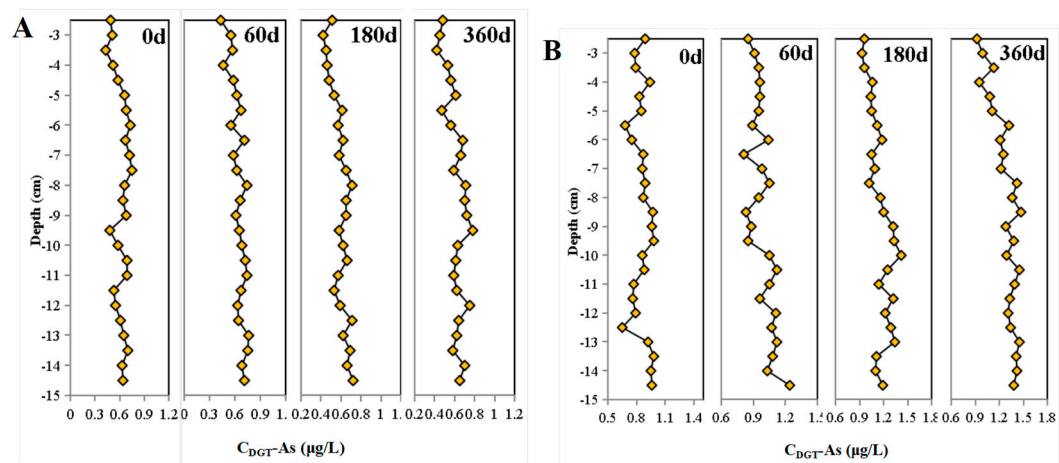


Figure S3. Changes in DGT-As in the soil vertical profile with no As(V)-Fh addition (A: 70%SWHC; B: 120% SWHC).

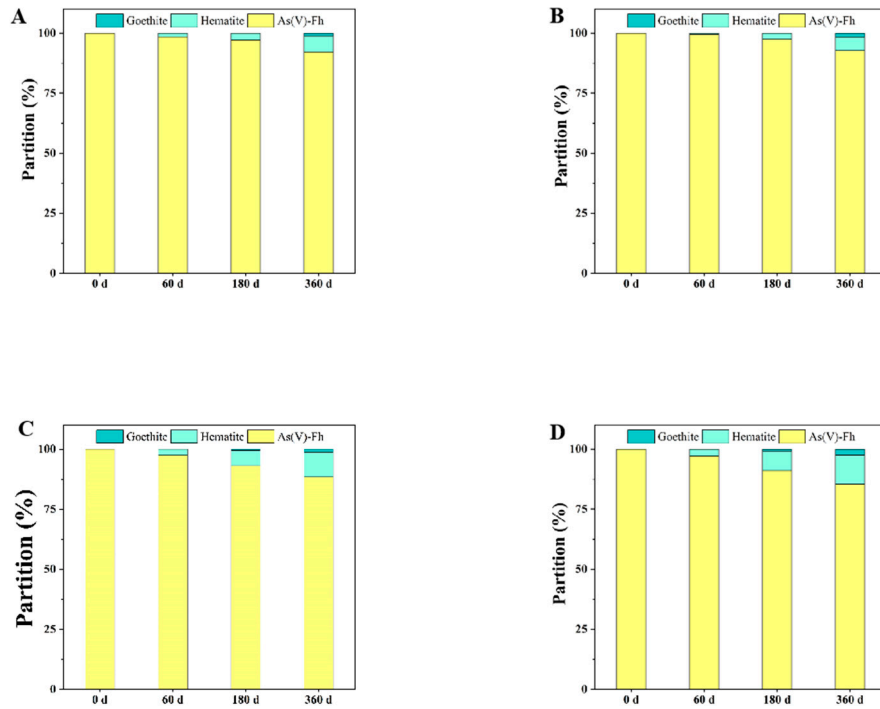


Figure S4. Composition of As(V)-Fh under 70% SWHC moisture conditions after incubation for 360 days (A: As/Fe molar ratio=0.05, -2.5 — -5.5 cm soil layer; B: As/Fe molar ratio=0.05, -12.5 — -14.5 cm soil layer; C: As/Fe molar ratio=0.005, -2.5 — -5.5 cm soil layer; D: As/Fe molar ratio=0.005, -12.5 — -14.5 cm soil layer).

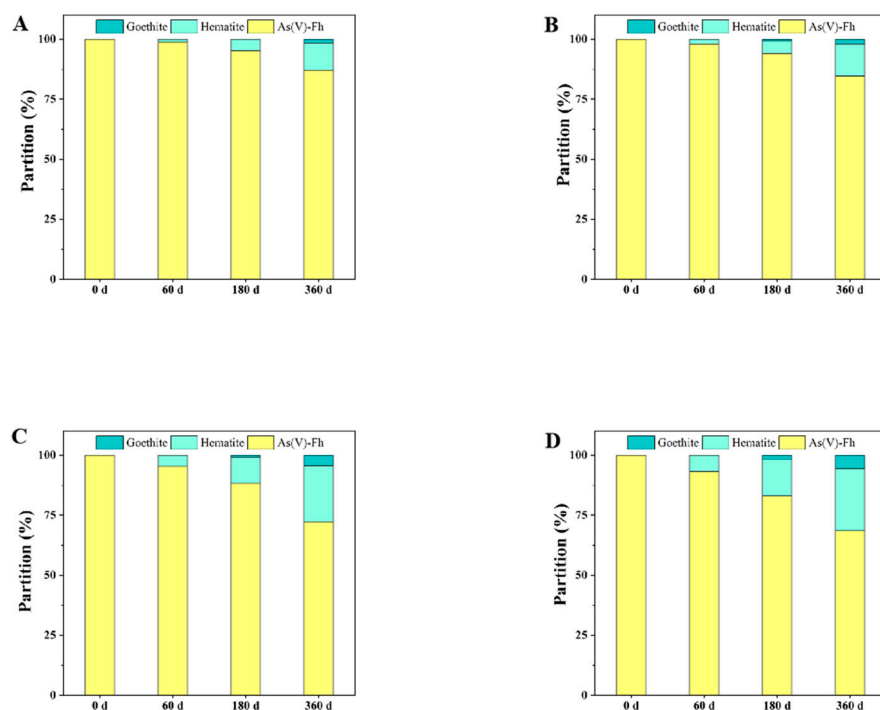


Figure S5. Composition of As(V)-Fh under 120% SWHC moisture conditions after incubation for 360 days (A: As/Fe molar ratio=0.05, -2.5—5.5 cm soil layer burial depth; B: As/Fe molar ratio=0.05, -12.5—14.5 cm soil layer burial depth; C: As/Fe molar ratio=0.005, -2.5—5.5 cm soil layer burial depth; D: As/Fe molar ratio=0.005, -12.5—14.5 cm soil layer burial depth).

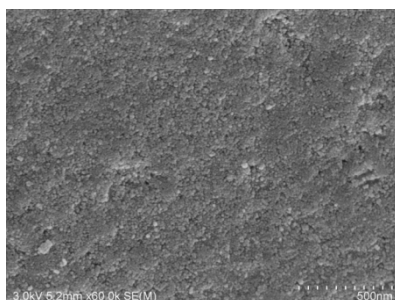


Figure S6. Morphological characteristics of original arsenic-bearing ferrihydrite in unadded soil under scanning electron microscopy.

Table S1. Basic physical and chemical properties of tested soil.

Test index	
Soil type	Quaternary red soil
Soil particle size composition	sandy clay loam
pH	5.78
Total organic matter (g/kg)	33.2
Cation exchange capacity (coml+ /kg)	20.4
Available iron (g/kg)	26.7
Available aluminum (g/kg)	0.87
Weakly crystallized iron (g/kg)	0.80
Weakly crystallized aluminum (g/kg)	0.49
Total arsenic (mg/kg)	4.93
Available arsenic (μg/kg)	34.16

Table S2. Change of specific surface area of arsenic-bearing ferrihydrite with incubation time under different moisture conditions.

Soil moisture (%)	As/Fe molar ratio	Soil depth (cm)	Incubation time (d)	Specific surface area (m ² /g)
70%	0.05	-2.5—-5.5	0	321.42
			60	308.15
			180	293.21
			360	270.17
		-11.5—-14.5	0	321.85
			60	311.19
			180	287.56
			360	258.33
	0.005	-2.5—-5.5	0	324.41
			60	315.08
			180	289.44
			360	262.23
		-11.5—-14.5	0	324.71
			60	306.42
			180	277.03
			360	245.86
120%	0.05	-2.5—-5.5	0	321.35
			60	298.84
			180	263.26
			360	229.58
		-11.5—-14.5	0	321.12
			60	278.32
			180	241.11
			360	186.77
	0.005	-2.5—-5.5	0	324.38
			60	274.49
			180	227.53
			360	145.71
		-11.5—-14.5	0	324.31
			60	259.88
			180	204.35
			360	110.21