Supplementary Materials: Biosynthesis of schwertmannite and goethite in a bioreactor with acidophilic Fe(II)-oxidizing betaproteobacterium strain GJ-E10

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Table S1. Kinetics of biotic and abiotic Fe(II) oxidation at different temperatures and pH levels.

Conditions	Eq. 2 Parameters (± SD)		Eq. 1 Parameters (± SD)		
	k (h^{-1})	R^2	X_0 (mM) [b]	μ_{max} (h^{-1})	R^2
25°C /GJ-E10 /pH 2.2	- [a]	-	1.35×10^{-1}	$(8.82 \pm 0.06) \times 10^{-2}$	0.9891
pH 2.5	-	-	1.35×10^{-1}	$(1.02 \pm 0.01) \times 10^{-1}$	0.9907
pH 3.0	-	-	$(1.35 \pm 0.51) \times 10^{-1}$	$(1.05 \pm 0.08) \times 10^{-1}$	0.9900
pH 3.5	-	-	1.35×10^{-1}	$(1.01 \pm 0.01) \times 10^{-1}$	0.9842
pH 3.8	-	-	1.35×10^{-1}	$(9.16 \pm 0.05) \times 10^{-2}$	0.9907
pH 4.2	-	-	-	-	-
25°C/abiotic/ pH 3.0	NO [c]	NO	-	-	-
pH 3.5	$(4.81 \pm 0.73) \times 10^{-4}$	0.6465	-	-	-
pH 3.8	$(7.96 \pm 1.18) \times 10^{-4}$	0.7716	-	-	-
pH 4.2	$(2.41 \pm 0.11) \times 10^{-3}$	0.9415	-	-	-
37°C/GJ-E10/pH 2.5	-	-	3.84×10^{-1}	$(1.71 \pm 0.03) \times 10^{-1}$	0.9430
pH 3.0	-	-	$(3.84 \pm 1.30) \times 10^{-1}$	$(1.88 \pm 0.16) \times 10^{-1}$	0.9937
pH 3.5	-	-	3.84×10^{-1}	$(1.61 \pm 0.01) \times 10^{-1}$	0.9951
37°C/abiotic/pH 2.5	NO	NO	-	-	-
pH 3.0	$(1.22 \pm 0.17) \times 10^{-3}$	0.5643	-	-	-
pH 3.5	$(1.57 \pm 0.08) \times 10^{-3}$	0.9620	-	-	-

[a] Not applicable. [b] X_0 that was determined for the cultures at pH 3.0 served as a fixed value in analysis at other pH levels. [c] Fe(II) oxidation was not observed under these conditions.

Table S2. A comparison of biotic and abiotic oxidation of Fe(II) under different pH and temperature conditions.

Conditions	Term (h) Calculated [a]		Ratio [c]
	Biotic Oxidation	Abiotic Oxidation	
25°C, pH 2.5	51	-[b]	-
25°C, pH 3.0	49	-	-
25°C, pH 3.5	52	4800	1/92
25°C, pH 3.8	57	2900	1/51
25°C, pH 4.2	-	960	-
37°C, pH 2.5	24	-	-
37°C, pH 3.0	22	1900	1/86
37°C, pH 3.5	26	1500	1/58

[a] Incubation time needed for oxidation of 90% of the Fe(II) amount initially added (i.e. $S/S_0 = 0.1$). The calculations for biotic and abiotic Fe(II) oxidation were conducted via Eqs. 1 and 2, respectively, with parameters shown in Table S1. [b] Not calculated. [c] Biotic versus abiotic oxidation.

Table S3. Sorption capacity values of metal oxyanions in schwertmannite and goethite phases formed in cultures of strain GJ-E10 [a].

Metal	Schwertmannite			Goethite		
	Maximum sorption (Γ_{max}), mg g^{-1}	K (L mg^{-1})	R^2	Maximum sorption (Γ_{max}), mg g^{-1}	K (L mg^{-1})	R^2
As(V)	123 ± 5	3.9 ± 0.8	0.9554	51.0 ± 3.1	2.6 ± 1.0	0.8209
As(III)	70.1 ± 5.9	0.087 ± 0.022	0.9409	81.2 ± 12.2	0.041 ± 0.014	0.9272
Cr(VI)	20.1 ± 1.1	0.32 ± 0.06	0.9663	15.8 ± 0.9	2.3 ± 0.7	0.9208
Se(VI)	53.2 ± 5.4	0.052 ± 0.011	0.9739	26.2 ± 1.7	0.073 ± 0.014	0.9738

[a] The data on sorption isotherms were fitted to the Langmuir equation to estimate sorption capacity: $\Gamma = \Gamma_{max} \cdot \frac{K \cdot [Metal]}{1 + K \cdot [Metal]}$, where Γ is the amount of metal adsorbed on the solid, Γ_{max} is the maximum metal sorption, K is the Langmuir constant, and [*Metal*] is the metal concentration in the aqueous phase.

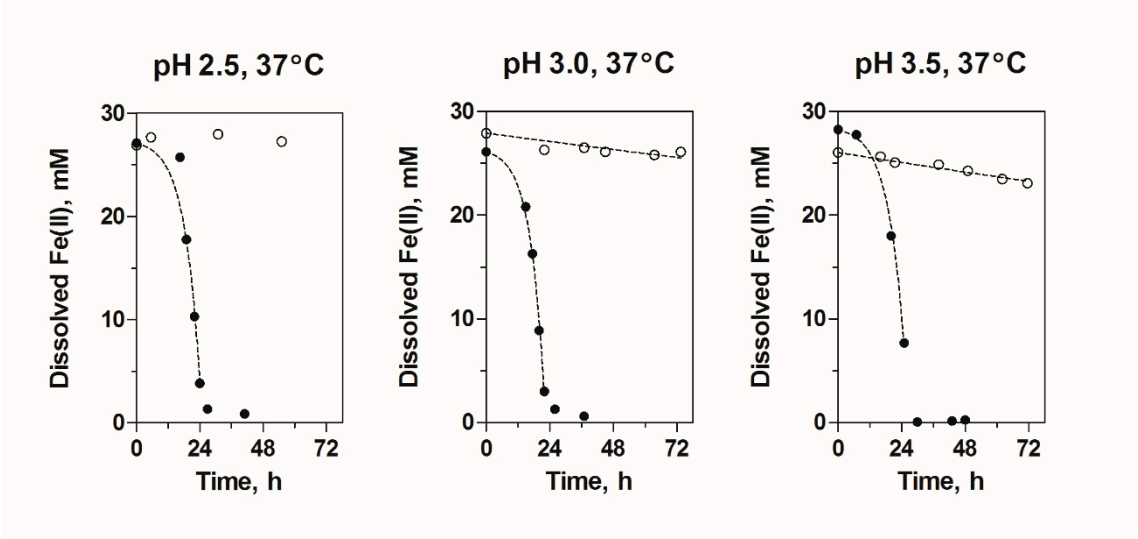

Figure S1. Fe(II) oxidation kinetics in cultures of strain GJ-E10 (filled circles) and in an abiotic medium (open circles) at different pH levels at 37°C. The dashed lines show nonlinear regression of the data from biotic cultures and the abiotic medium to Equations (1) and (2), respectively.

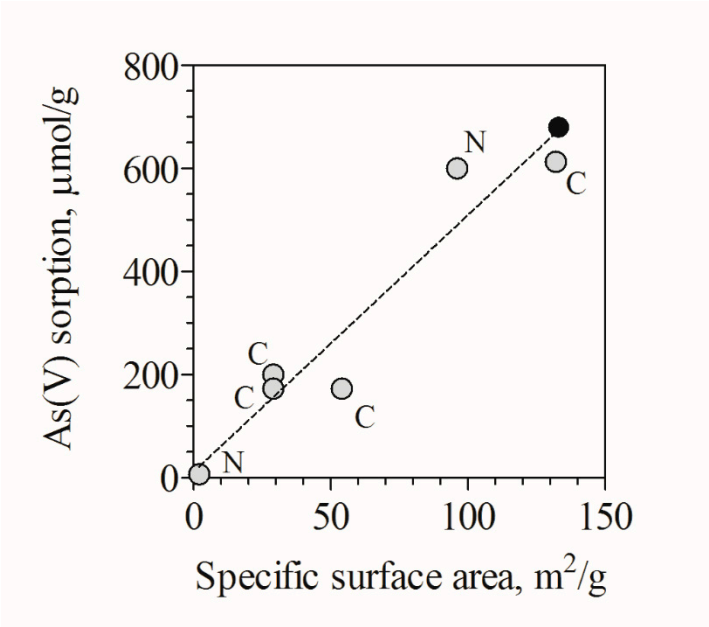

Figure S2. The relation between As(V) sorption capacity and specific surface area in goethite phases. The plotted data (grey circles) are from Asta et al. [39]: naturally occurring and chemically synthesized phases are indicated by 'N' and 'C', respectively. The black circle represents the value for goethite produced by strain GJ-E10. The dashed line shows linear regression of the data with a slope of 5.1 (µmol m^{-2}; $r > 0.966$).