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Article

Carbon-Assisted Bioleaching of Chalcopyrite and Three Chalcopyrite/Enargite-Bearing Complex Concentrates

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Supplementary Materials

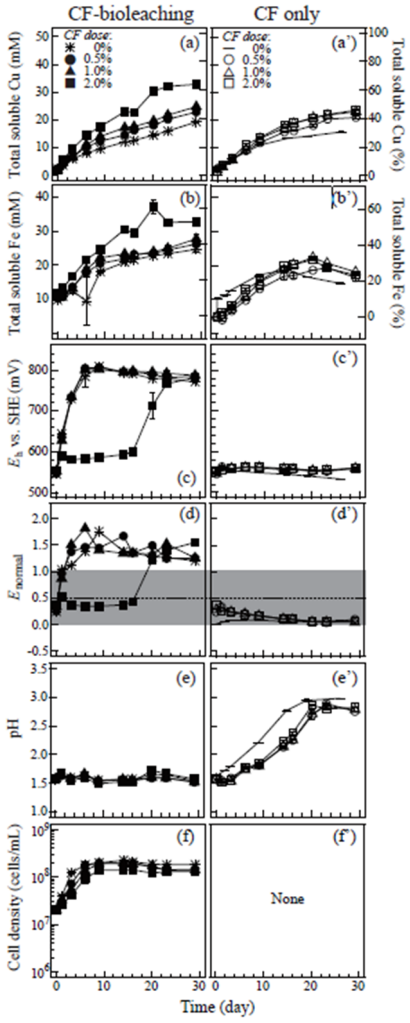

Figure S1. Carbon Fiber (CF)-assisted chalcopyrite leaching with (a-f) or without (a'-f') bioleaching microorganisms. Changes in the total soluble Cu concentration (a, a'), total soluble Fe concentration (b, b'), E_h (c, c'), E_{normal} (d, d'), pH (e, e') and planktonic cell density (f, f') at different CF doses are shown: 0% (*, -), 0.5% (●, ○), 1.0% (▲, △), 2.0% (■, □). Grey shadow in (d) and (d') indicated the "active region" for chalcopyrite dissolution [10, 11]. Error bars depicting averages are not visible in some cases as they are smaller than the data point symbols.

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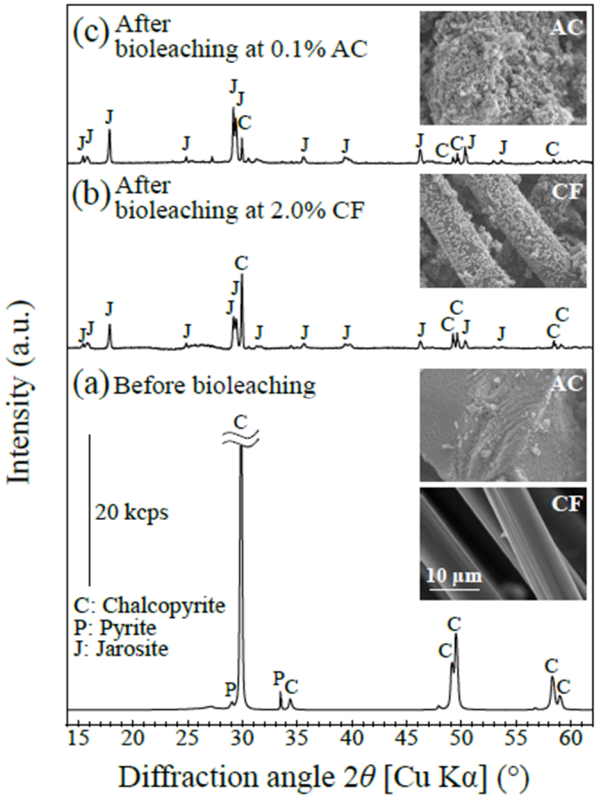

Figure S2. X-ray diffraction patterns of chalcopyrite before bioleaching (a) and after bioleaching with 2.0% CF (b) or with 0.1% AC (c). C: chalcopyrite ($CuFeS_2$; PDF No. 01-075-6866), P: pyrite (FeS_2; PDF No. 00-042-1340), J: jarosite ($K(Fe_3(SO_4)_2(OH)_6)$; PDF No. 01-076-0629). SEM images of the surface of AC and CF are also presented.

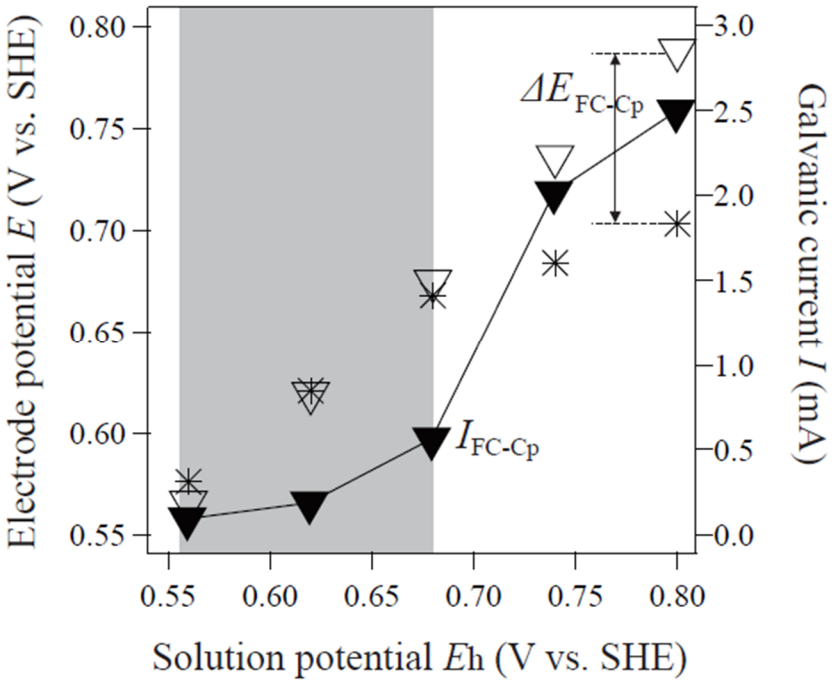

Figure S3. The mineral electrode potential of chalcopyrite (Cp) (*) and carbon fiber (CF) (▽) as the function of E_h: ◿ indicates the amount of galvanic electromotive force created between chalcopyrite and CF. The galvanic current created between chalcopyrite and CF (▼) is also shown as the function of E_h. The grey zone depicts the E_h range wherein galvanic interaction between chalcopyrite and CF is considered minor.

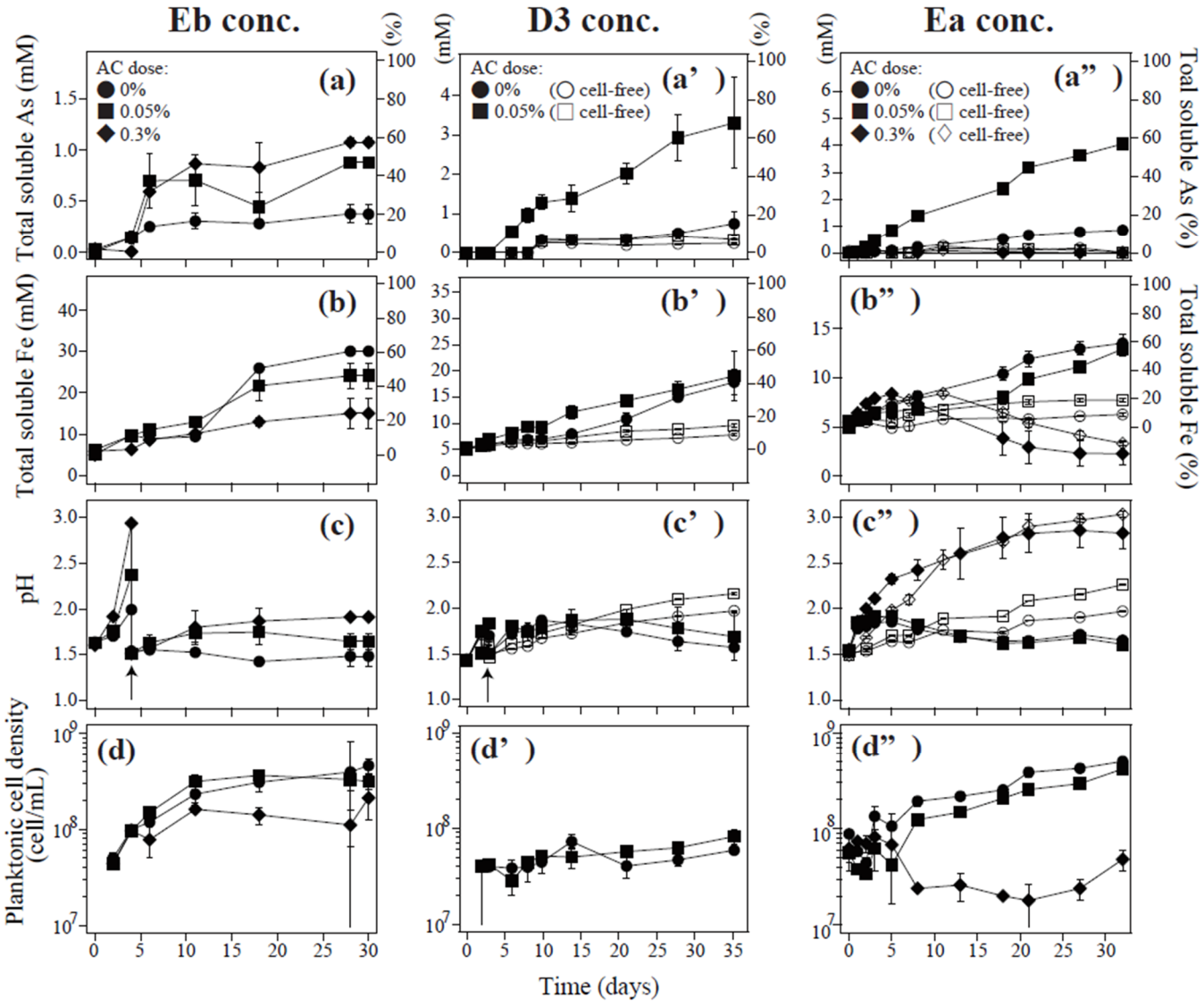

Figure S4. Activated Carbon (AC)-assisted bioleaching of chalcopyrite/enargite-bearing concentrates, Eb (a-d), D3 (a′-d′) and Ea (a″-d″). Changes in the total soluble As concentration (a, a′, a″), total soluble Fe concentration (b, b′, b″), pH (c, c′, c″) and planktonic cell density (d, d′, d″) at different AC doses are shown: 0% (●, ○), 0.05% (■, □), 0.3% (◆, ◇). Error bars depicting averages are not visible in some cases as they are smaller than the data point symbols.