Supplementary materials

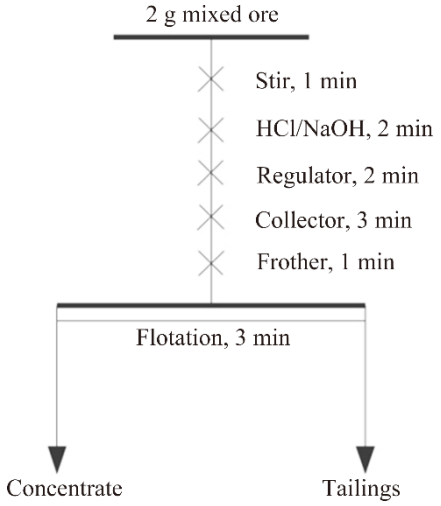

Figure S1 Micro-flotation test flowchart

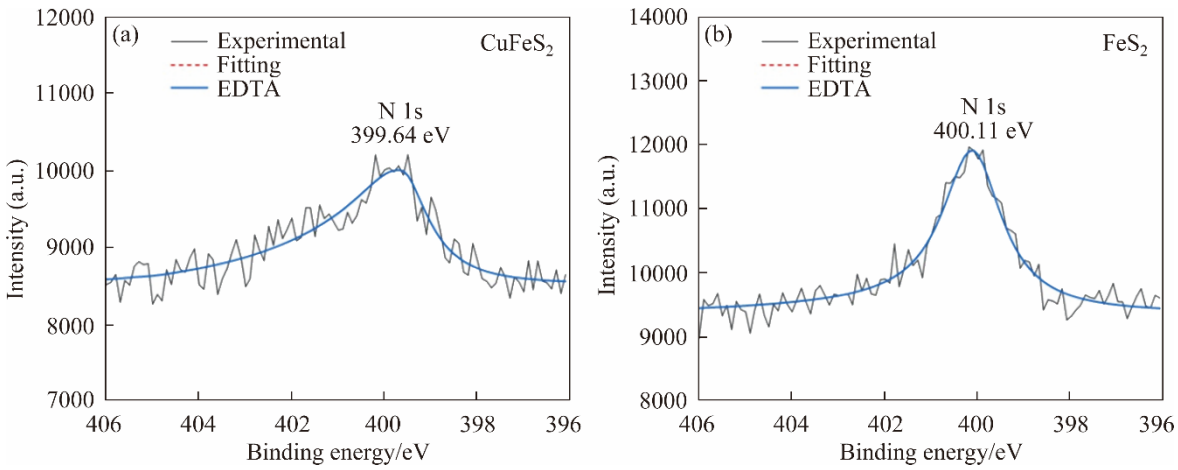

Figure S2 N 1s peaks of chalcopyrite (a) and pyrite (b) after interaction with excessive EDTA

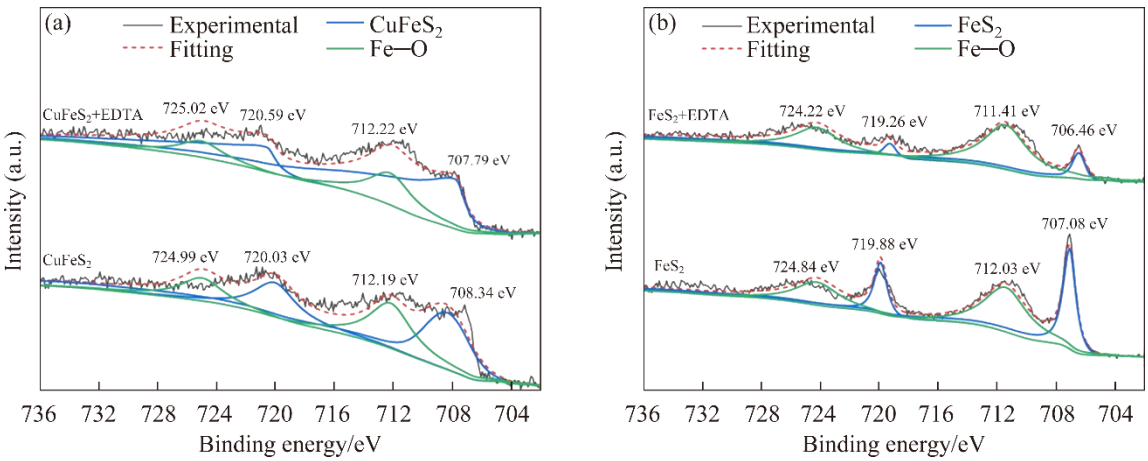

Figure S3 Fe 2p peaks of chalcopyrite (a) and pyrite (b) after interaction with excessive EDTA

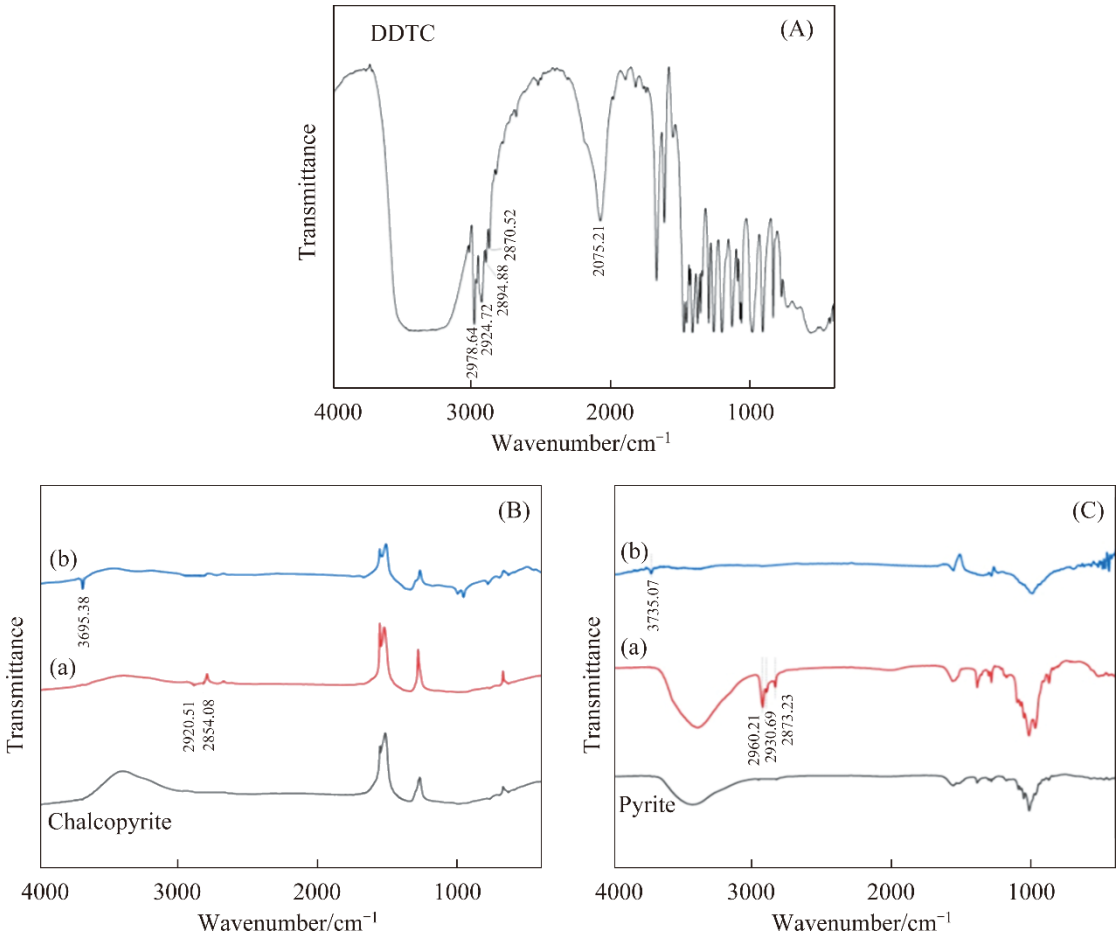

Figure S4 FT-IR spectra of DDTC (A), chalcopyrite (B) and pyrite (C) in deionized water (a) and seawater (b)

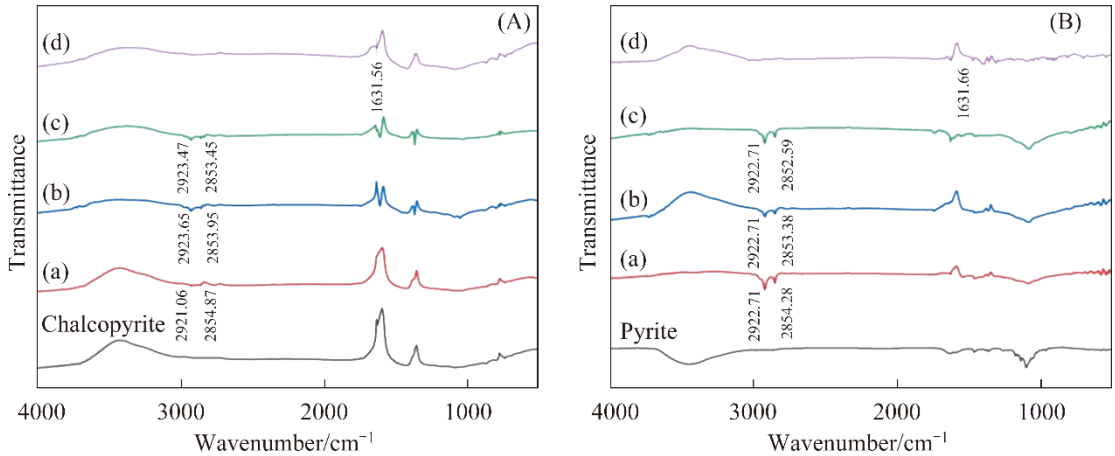

Figure S5 FT-IR spectra of chalcopyrite (A) and pyrite (B) after interaction with 30 mg/L EDTA (a), SHMP (b), SS (c) and 90 mg/L EDTA (d)

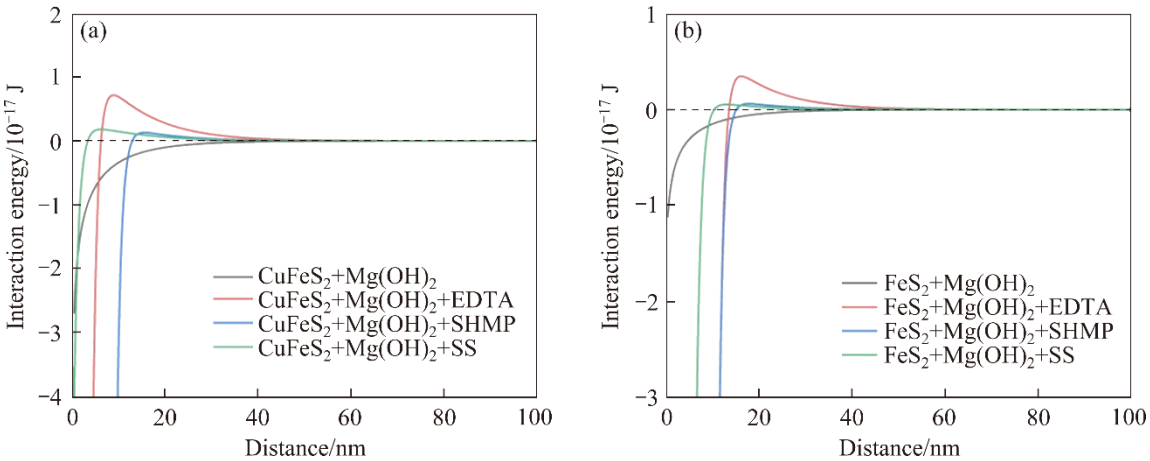

Figure S6 E-DLVO interaction energy between sulfide mineral particles and $Mg(OH)_2$ particles

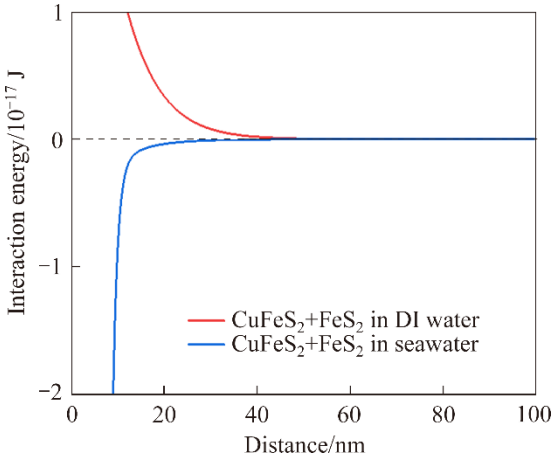

Figure S7 E-DLVO interaction energy between chalcopyrite and pyrite in deionized water and seawater

Table S1 Chemical compositions of the pure chalcopyrite and pyrite wt.%

Sample	Cu	Fe	S	Else
Chalcopyrite	33.60	29.02	33.57	3.81
Pyrite	—	45.91	53.00	1.09

Table S2 Main ion contents in artificial seawater g/L

Ca^{2+}	Mg^{2+}	K^+	Na^+	HCO_3^-	SO_4^{2-}	Cl^-	Total dissolved solids
0.41	1.31	0.50	11.60	0.15	2.62	19.58	36.17

Table S3 Parameters of flotation reagents used in the study

Reagent	Molecular formula	Manufacturer	Purity
DDTC	$C_5H_{10}NNaS_2$	Shanghai Aladdin	>95.0%
MIBC	$C_6H_{14}O$	Shanghai Aladdin	99%
EDTA	$C_{10}H_{12}N_2Na_4O_8{\cdot}xH_2O$	Shanghai Aladdin	≥95.0%
SHMP	$Na_6O_{18}P_6$	Shanghai Aladdin	AR
SS	$Na_2O(SiO_2)_x \cdot yH_2O$	Shanghai Aladdin	AR, Molar ratio x=2.30−2.50

Table S4 The interaction energy of sulfide mineral with reagents

Mineral	Condition	$E_{mineral}$/(kJ·mol^{-1})	$E_{reagents}$/(kJ·mol^{-1})	E_{total}/(kJ·mol^{-1})	ΔE/(kJ·mol^{-1})
Chalcopyrite (112)	+PBX	−6964.61	−1916.32	−9559.9	−678.97
	+Mg(OH)$^+$	−6964.61	−2140.05	−9786.19	−681.53
	+Mg(OH)$^+$+PBX	−9786.19	−1916.32	−11748.48	−45.97
Pyrite (100)	+PBX	−6832.23	−1916.32	−9167.94	−419.39
	+Mg(OH)$^+$	−6832.23	−2140.05	−9781.87	−809.59
	+Mg(OH)$^+$+PBX	−9781.87	−1916.32	−11630.27	67.92

Table S5 E-DLVO theoretical calculation parameter

Mineral	d_{50}/μm	Hamaker constant/10^{-20} J	Relative dielectric constant	Zeta potential/mV				
				+DI water	+Seawater	+EDTA	+SHMP	+SS
Chalcopyrite	60.3	28.4	81	−26.55	−8.83	−31.75	−20.07	−21.29
Pyrite	62.2	12	33.7	−12.43	1.61	−30.08	−11.69	−10.46
Mg(OH)$^+$	6	7.99	—	11.60	—	−31.22	−16.57	−10.24