Geomicrobiology of a stratified, acidic pit lake in the Iberian Pyrite Belt

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The Iberian Pyrite Belt (IPB) is an extensive massive sulfide deposit rich in gold, silver, and copper. The deposit has been mined continuously since the third millennium BCE, resulting in one of the largest accumulations of mining waste in the world. We examined the geochemistry and microbial communities inhabiting an acidic pit lake at Peña de Hierro in the Huelva region, Spain. We found that the lake contains four distinct redox-clines and a strong oxygen gradient from near saturation at 4 meters depth to less than 1 mg/L by 20 m depth. Despite large vertical shifts in redox potential and dissolved oxygen concentrations, both iron-oxidizing and iron-reducing taxonomic clades are abundant throughout the water column. Planktonic communities could be divided into two distinct types above and below 7 m depth. Although no prokaryotic phototrophs were identified in gene surveys, the community shift is spatially correlated with the disappearance of photosynthetically active radiation (PAR), which is completely attenuated below 8 m depth. Archaeal populations increase in abundance with water depth, parallel with decreasing pH and increasing conductivity in deeper waters. Sequences representing known sulfur cycling taxa were rare in all planktonic communities, suggesting that prokaryotic primary production in the Peña de Hierro pit lake is largely driven by the oxidation and reduction of iron.