The importance of mineralogy and geochemistry in biomining

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Low and very-low ore-grade ores become more and more a target for exploitation, especially for the copper sulfide ores. Due to low operational costs of bioleaching or more general biomining operations, they find increasing applications in the industrial process. However, the efficiency of biomining operations is strongly dependent on mineralogy and geochemistry of the system, i.e., the substrate, which defines the conditions in which a certain microbial community can develop and catalyze the biogeochemical processes, leading to solubilization of the target elements. But, many of the so-called biomining operations lack a thorough mineralogical, geochemical, and microbial characterization before and during the process. Thus, many of these biomining operations show very low recoveries (5-40 %). In order to improve the recovery, strategies have to be developed for proper ore characterization taking into account the needs of the biomining operations. For example, nowadays the selection for the explotation process choise is mainly the cut-off grade. This selction criteria ignores the mineralogy to which the target elemente is associated. But, most of the recovery processes respond to the mineralogy and not to the target element. In porphyry copper systems, where most industrial bioleaching operations are operating today (mainly for ore grades between 0.1 wt.% Cu to cutt-off), mineralogy is crucial for the recovery. For example chalcopyrite, the main ore mineral, is not acid leachable and shows slow oxidation kinetics at mesophile temperature ranges. Only if a supergene Cu-sulfides like covellite or chalcocite-digenite are present in the ore, reasonable recoveries can be reached, like in the case of Escondida, Chile. But this is mainly due to the acid leachability of the supergene Cu-sulfides and in a lesser extent to microbialogically catalyzed sulfide oxidation. Only with a thorough mineralogical characterization (e.g. by QEMSCAN® or MLA and sequential extractions) the necessary data is obtained to select the appropriate exploitation process and optimize the recovery for the specific ore mineralogy. An other often ignored key issue in such operations is the geochemistry of the pregnant leach solutions (PLS). Increased element concentrations, due to recycling and evaporation, can trigger the precipitation of secondary minerals, like jarosite, goethite, schwertmannite in the biomining operation, leading to inhibition of the sulfide surfaces and therfore lowering the recovery of the process.