How to determine the effectiveness of hydraulic barriers in porphyry Cu tailings dams?

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Porphyry Cu ores are characterized by low Cu grades and high tonnages, resulting in large volume mine tailings, which are accumulated in dams. Commonly, the tailings dams includes pumping wells installed as hydraulic barriers to minimize the seepage towards the aquifers. This work evaluates the potential use of isotope geochemistry as a monitoring tool of the hydraulic barrier effectiveness in a Chilean porphyry Cu tailing dam. The studied tailing waters show a remarkable deviation from local meteoric water line, which is attributed to an evaporation effect. Moreover, isotope values of hydraulic barrier well waters suggests a mixing between meteoric and evaporated tailing waters. Those pumping wells located closer to the dam showed a mine tailing water contribution between 40 and 80%, whereas those pumping wells situated farther has a tailing water proportion lower than 10%. The $\delta^{34}S$ and $\delta^{18}O$ values of SO_4^{2-} showed that: i) water tailings had a high contribution of sulfates from sulfides oxidation; ii) runoff waters had a high influence of sulfate from dissolution of ore sulfates; and iii) pumping wells waters had a mixing between both dissolved sulfate sources. The pumping wells of the hydraulic barrier closer to the dam showed a sulfate contribution from the tailing dam between 70 and 95%, whereas the pumping wells situated farther had a tailing sulfate contribution lower than 35%. Results from a specific mining tailing site, confirmed the usefulness of stable isotopes to determine the origin of water and to calculate the efficiency of the hydraulic barrier.