A simple modeling approach for an acid generating, backfilled mine pit

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Abstract Modeling post-closure mine water quality is a key step in mine planning. The Corani project is a silver-lead-zinc mining development project that currently has natural acid rock drainage (ARD) and acid mine drainage (AMD) from abandoned mines. Existing AMD has a pH as low as 2 and acidity as high as 2000 mg/L as $CaCO_3$. The mine will produce approximately 200 million tons of waste rock, some of which will be placed in the mine pit to avoid the formation of an acidic pit lake. The mine pit will be backfilled with acid-generating waste rock over five years. Following closure, the pit backfill will be rapidly flooded to mitigate ARD formation. The acid generating salts (AGS) that accumulate during operations and backfilling will be mobilized when the pit is rapidly flooded (first-flush). After saturation, a modest quantity of water (≈2.5 L/s) will discharge from the backfilled pit and will require treatment.

AGS will create poor water quality in the first-flush, and water flow-through will produce improving water quality over time. To simulate the behavior of the water quality over time, a PHREEQC model was created. On-site kinetic weathering tests have provided over one year of weathering data using a barrel test method. Simulated weathering rates for acid producing waste rocks were calibrated to on-site weathering tests. The backfill is modeled with a Control Volume approach, tracking the quantity of total acidity. Initial AGS is augmented by sulfide weathering under saturated conditions, and transported by groundwater flow-through. Acidity beyond saturation remains in the pit to be dissolved and transported over time. Due to the saturation and encapsulation of the waste, acidity will be transported at a higher rate than continued acid generation in the backfill.

The pit chemistry model accounts for the highly acidic first-flush and the moderately acidic long-term discharge. Since the site has uncommon climatological factors, the on-site kinetic data was key in determining appropriate rates of acid generation. The model results suggest that while the pit discharge may require long-term treatment, if the pit is filled rapidly, the period of first-flush acidity production can be minimized and water with more moderate chemistry can be treated in the long-term.

As mines search for alternative methods of waste disposal, in-pit waste dumps are becoming more common. This approach to water quality prediction applies site kinetic data with widely-accepted modeling software to estimate the discharge from a backfilled pit over time.

Keywords zinc, lead, silver, acid base accounting, PHREEQC