Nickel leaching for metal recovery from Titania Tailings, Norway

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Titania AS has been extracting ilmenite from deposits within the Aana-Sire anothosite masif for almost 100 years. The Telnes operation was opened in 1964. Tailings were deposited in the Jossing fjord and the Dungadjup until 1994; they have since been placed in a landbased tailings pond (45 Mton). The tailings pond is an upstream flow through. Since emplacement, the mining company has struggled to control the nickel discharge from the tailings to below permit limits. Nickel leaching rates vary with the spigoting point.

Eight small upsteam column tests (200 gr samples) and two larger humidity cell tests (6 kg samples) were run to evaluate nickel leaching from tailings under a controlled setting. Upstream columns were run for 20-40 days (100-400 ml/day flow rate) with either sulfuric acid discharge water (SADW; waste water in the ilmenite processing) or deionized water (DIW). The larger columns ran for approximately 7 months, one liter SADW or DIW added every 7 days. Analysis included mineralogy by SEM, Surface area analysis, sequential chemical extraction (SCE), acid base accounting, pH dependents tests and water analysis of the leachate.

Soil pH is above 9, neutralizing potential around 18-22 $CaCO_3$t/kt and acid potential around 2.5 $CaCO_3$t/kt eq. Plagioclase $An_{60-70,}$ the main mineral, constitutes 50 wt.%, ilmentite 20 wt.%, Mg-biotite 11 wt.%; cummingtonite, chlorite, and anthopylite, approx. 4 wt.% each. Nickel content is 250 ppm; pentlandite and millerite are the main nickle sulfide minerals. SCE indicates some nickel may be bound in olivine. There is a steady release of nickel using DIW; however, SADW leaches 10-100 times more nickel. Approximately 60% of nickel was extracted within 60 days of the humidity cell leaching. Upstream flow was far less effective in leaching nickel. High oxygen content is needed for the nickel leaching.

SADW has a pH of 1.6 with 1.3 mg/l Ni, 0.3 mg/l Cu, 0.1 mg/l Co, and 1.3 mg/l Cr. Plagioclase is efficient in increasing pH to about 3, resulting in chromium being retained; copper has relatively low concentration; nickel and cobalt leaches well and is available in concentrations suitable for solvent extraction/electrowinning extraction.