# One-step remediation for mining and industrial wastewater

CSIRO has developed a one-step treatment for removing contaminants from mining and industrial wastewaters, making this previously complex process simpler and more efficient.

Many mining and industrial processes generate wastewater that contains a variety of contaminants, such as metals and metalloids. These contaminants need to be removed to ensure that the wastewater is suitable for reuse or discharge to the environment. However, due to the variety of contaminants that are frequently present in mining and industrial wastewaters, their removal is often difficult, requiring a number of complex steps.

Over the past five years, CSIRO has been developing a treatment that can simultaneously remove a variety of contaminants in a single step. The treatment involves the formation of hydrotalcites.

## Using hydrotalcites to treat wastewater

Hydrotalcites are layered minerals, consisting of aluminium- and magnesium-rich layers separated by interlayers of anions (negatively charged molecules, such as sulphate).

Hydrotalcites form when aluminium and magnesium are present in an ideal ratio and under conditions of approximately pH 6 or greater. Therefore, to produce hydrotalcites in wastewater, concentrations of aluminium and magnesium are adjusted and the pH of the wastewater is increased by adding alkaline compounds.

As hydrotalcites form, the aluminium and magnesium can be partially replaced by a range of other metals, such as copper, lead and cadmium. Also, anions, such as sulphate, chromate and arsenate, can be incorporated into the hydrotalcite interlayers. As the hydrotalcites form, these metals and anions become trapped and are easily removed from the wastewater as a solid. It is this property that makes hydrotalcites so useful in treating wastewaters that contain a variety of contaminants.

Current wastewater treatment processes typically produce lime-based sludges. Large amounts of water often remain in these sludges, which then require additional treatment to effectively extract the water prior to disposal. In comparision, hydrotalcites settle rapidly out of solution and can be easily removed using centrifugation, leaving behind a much cleaner solution (see Figure 1).

**Mining wastewater, such as in these tailing ponds, can contain a variety of contaminants that can be difficult to remove.**

**The use of hydrotalcites to treat wastewater resulted from the recognition that mining and industrial wastewaters often contained substantial magnesium and aluminium and that a simpler process was required that could simultaneously remove a range of contaminants.**

An additional benefit of hydrotalcite treatment is that it means that there are often fewer dissolved salts in the treated wastewater. In many cases, treated wastewaters can then be used to produce sulfuric acid and sodium hydroxide via reverse osmosis/electrodialysis onsite. These chemicals are commonly used in mining processes, so producing them onsite saves on costs of purchasing and transporting them over often large distances to the mine-site.


Figure 1 **Hydrotalcite precipitate (left) and conventional lime-based precipitate (right) at pH 8.5, one hour after neutralisation. Note the substantially smaller hydrotalcite precipitate volume and clear supernatant. At least two phases are present in the lime-based precipitate and the supernatant solution is turbid.**

## Initial applications

Initial applications have focused on the use of hydrotalcites for the removal of contaminants from wastewaters generated from the mining and extraction of uranium. A range of contaminants including uranium, rare earth elements, transition metals, metalloids and anions have been effectively removed from these acidic and often complex wastewaters using the one-step hydrotalcite formation treatment.

Once formed, hydrotalcites form a characteristic hexagonal platy precipitate (Figure 2). Sometimes high uranium and rare earth element concentrations in this precipitate create the possibility of reprocessing to recover valuable commodities and offset remediation costs. It has also been shown that hydrotalcites can be further stabilised to form a stable long-term repository for a range of radionuclides liberated during uranium mining.

## Project outcomes

In light of the very promising results obtained using hydrotalcites to remediate uranium mining wastewaters, provisional patents have been lodged that cover both surface and sub-surface applications. In addition, the hydrotalcite-based technology is currently being commercialised with Virtual Curtain Limited who have an exclusive worldwide licence.

## About Minerals Down Under

The CSIRO Minerals Down Under Flagship works across the minerals value chain to grow Australia's resource base, increase the productivity of the minerals industry and reduce its environmental footprint, both in Australia and globally.

Working with the best research organisations and global industry partners we create links between research, industry and the community to increase the long-term sustainability of the Australian industry and the national economy.

Through targeted research we address the global issues of energy, water, productivity, safety, recycling, environmental performance and social responsibility. We are also working to create better linkages between the minerals and manufacturing sectors.

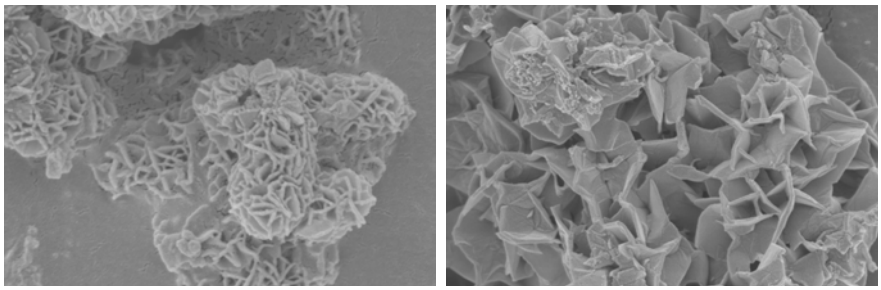

Figure 2 **Grape-like hydrotalcite precipitate showing detail of face to edge and edge to edge hydrotalcite aggregates. Scale bars are 200 nm.**

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