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Technology Information

Immobilization by *in-situ* $CaCO_3$ crystallization

Fundamentals

Covering of mine tailings with alkalinity generating minerals is a conventional technology to reduce the oxidation of sulfidic minerals. Typical products applied are fly ash, limestone or dolomite. These materials have a high neutralization capacity. Covering results in the reduction of water and oxygen infiltration into the tailings by the formation of secondary minerals such as hydroxides and gypsum.

Carbonate dissolution following the overall reaction

$$CaCO_3 + H_3O^+ \rightleftharpoons Ca^{2+} + HCO_3^- + H_2O$$

increases of the pH value. Reduced sulfide oxidation as well as precipitation of dissolved metals results.

Many field investigations have indicated that covering with alkalinity generating minerals as well as reactions between carbonates and acidic solutions initiate self healing mechanism.

The idea of the newly developed technology is to initiate $CaCO_3$ crystallization within tailings by grouting or penetration with solutions leading to a directed $CaCO_3$ formation. The preparation of such solutions is possible by mixing of $Ca(OH)_2$-solutions with organic compounds, that release carbonate ions in a controlled reaction.

Characteristics of grouts leading to $CaCO_3$ precipitation

The grouts are prepared in two steps. First, $Ca(OH)_2$ solutions are prepared by mixing of $CaCl_2$ and NaOH solutions in the presence of a dissolver. In the second step, an organic

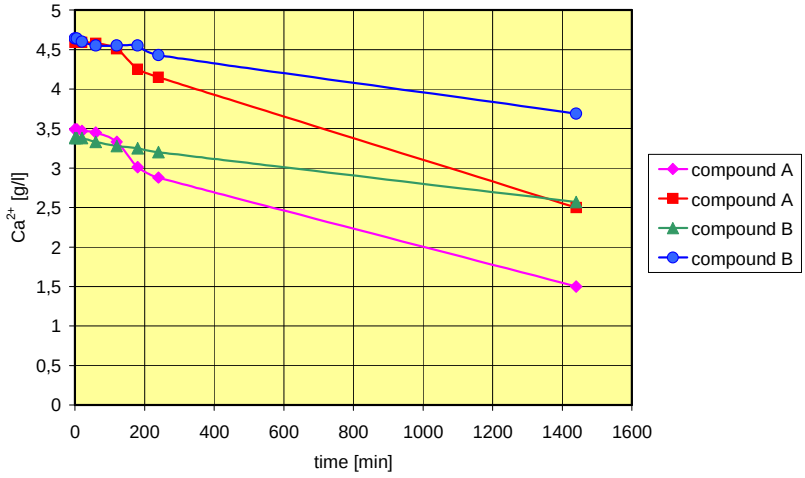

Fig. 1: Course of $CaCO_3$ precipitation depending on the used carbonate releasing compound

compound, decomposing in alkaline solutions in a timely controlled reaction into carbonate ions, is added. Insoluble $CaCO_3$ is precipitated by reaction with the present calcium ions. The carbonate ions generating compound is soluble in aqueous solutions. Thus, a homogeneous self reacting system is created leading to controlled calcium carbonate formation. Many laboratory and field investigations have shown that the course of $CaCO_3$ precipitation can be adjusted by the absolute concentrations, temperature, nature and concentration of the carbonate releasing compound (Fig. 1). Solutions can be prepared leading to the formation of up to 10 g/l $CaCO_3$. Apart from the *in-situ* formation of $CaCO_3$ within tailings, the technology

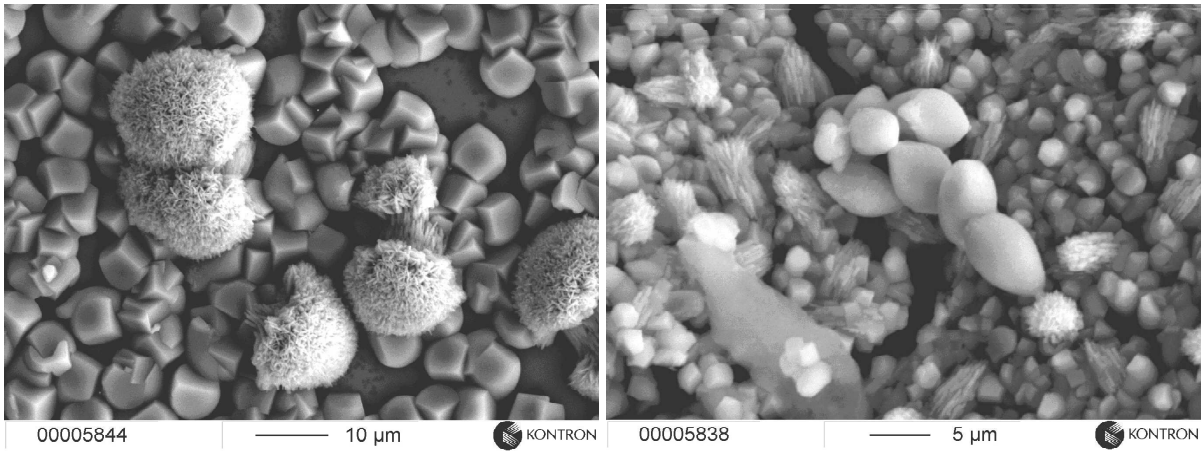

Fig. 2, 3: SEM of different $CaCO_3$ crystals covering a mineral surface

allows the *in-situ* creation of $CaCO_3$ barriers within soil or rock formations and the sealing of flow paths. Typical $CaCO_3$ crystals grown in a porous sandstone formation are shown in Fig. 2 and 3.

The selection of the grout composition depends on the following points:

- The task that is to solve (immobilization, sealing or construction of a reactive barrier).
- The geological and mineralogical conditions of the area.
- The chemistry of the pore water.
- The hydrodynamic conditions.

Different technologies such as spraying, penetration grouting, pressure grouting and infiltration from ponds or reservoirs can be used to transport the mineral forming solutions into the areas that have to be treated. All grouts or penetration agents are pure solutions with a viscosity similar or equal to natural ground water. A good penetration or infiltration even of soils with a low permeability is given.