The occurrence of As, Hg, Sb and Tl in pyritic waste rock and the ability to prevent their release

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Pyrite contains varying content of trace elements. Upon oxidation, these elements can be released having a great impact on water quality. Therefore, it is crucial to identify trace elements occurrence in minerals, and their overall leachability to ensure that suitable measures are taken to protect the environment. Sulfide-rich waste rock was mineralogically investigated, screened and quantified using QEMSCAN and LA-ICP-MS. The water quality was determined by leaching the waste rock in small scale test cells for more than two years. Arsenic, Hg, Sb, and Tl were elevated and the dominating trace elements in the waste rock with a content of 217, 17, 38, and 26 ppm respectively. Results show that pyrite was the most abundant mineral (66%) with traces of other sulfides such as arsenopyrite, chalcopyrite, and sphalerite. The abundance of pyrite along with the scarcity of any buffering minerals resulted in high concentrations of Fe^{3+} which subsequently generated acidic leachate pH (<1.3) with extremely high concentrations of As (21 mg/L), Hg (13 µg/L), Sb (967 µg/L), and Tl (317 µg/L). The leachability of elements varied substantially. The highest leachability was observed for As (18%) due to the presence in pyrite preferentially to arsenopyrite or as a sulfosalt. Conversely, Sb was primarily identified in various sulfosalts such as Bournonite, found in cracks between pyrite grains, which can explain the lower leachability (5%). Results from LA-ICP-MS show that Hg was distributed in the more porous parts of the pyrite and displayed a partial correlation with Tl. However, Hg had low leachability compared to Tl implying at least two sources of Hg in the pyrite.

Additional leaching tests with pyritic waste rock treated with lime kiln dust (5wt.%) to inhibit the sulfide oxidation are ongoing. The treatment has limited oxidation and leaching of As and Tl but has not prevented the release of Hg and Sb indicating restricted ability to prevent the oxidation of sulfide minerals such as sulfosalts. The overall results from LA-ICP-MS and leaching of the waste rock indicate that mineral association of trace elements profoundly influences the possibility to prevent their release during sulfide oxidation and the overall effectiveness of inhibition. Moreover, this suggests that the ability to prevent sulfide oxidation in more complex mine wastes could prove difficult.