

Mineral transformations in tailings from active mines: Implications for acid neutralization potential and carbon dioxide sequestration

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Secondary sulfate, halide, and carbonate minerals occur in mine tailings as a result of chemical weathering [1-3]. We have measured the extent of secondary minerals in the tailings from two active mining operations: the Diavik Diamond Mine, Northwest Territories, Canada, and the Mount Keith Nickel Mine, Western Australia. The development of secondary minerals, carbonates in particular, has important implications for acid neutralization and carbon dioxide (CO₂) sequestration in mine tailings.

At Diavik and Mount Keith, halide and sulfate minerals on tailings surfaces are readily dissolved and removed from the tailings-containment facilities. Secondary carbonate minerals persist at depth within the tailings, but show signs of having been reworked upon burial. Differences in climate and tailings management practices have resulted in widespread mineralization and preservation of secondary carbonate minerals at Mount Keith, and limited mineralization of carbonates in the tailings at Diavik, where underwater storage of tailings may have restricted mineralization.

We have used quantitative phase analysis with X-ray powder diffraction data and the Rietveld method to estimate the amount of CO₂ bound within secondary carbonate minerals at both sites. In order to evaluate the necessity of the tailings pond at Diavik, acid neutralization potentials have been calculated for the kimberlite mine tailings according to the method of Jambor *et al.* [4]. Our results suggest that it may be possible to engineer tailings-containment facilities such that they favour mineralization of secondary carbonate minerals under diverse climatic conditions.

[1] Jambor & Blowes (1998) *MAC Short Course Series* **27**, 367-401. [2] Al *et al.* (2000) *GCA* **64**, 3933-3948. [3] Dold (2006) *ES&T* **40**, 752-758. [4] Jambor *et al.* (2007) *Environ. Geol.* **52**, 1019-1031.

Development of microanalytical reference material (MACS-3) for LA-ICP-MS analysis of carbonate samples

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The use of carbonate materials such as shells, coral, ear bones, and spelethems to determine the seasonal and long term changes in water chemistry or migratory patterns of fish has led to a dramatic increase in the use of microanalytical techniques such as LA-ICP-MS. Information on the history, chronology and distribution of chemical information recorded in carbonate samples are increasingly important for environmental and climate models. Quantification of trace element compositions has lagged due to the lack of homogenous, readily available reference materials that contain a wide variety of trace elements at concentrations representative of marine conditions. The United States Geological Survey development of MACS-3 is an attempt to fill this quantification void and provide the marine community with a matrix matched calibration material. Using a coprecipitation process and special sample preparation procedures a homogeneous calibration material containing 62 major, minor, and trace elements was developed. Homogeneity testing using LA-ICP-MS spot analyses over multiple pellets indicate that at the 50 micron spot size MACS-3 is homogeneous at the $\pm 3-5\%$ (average %RSD) for the major and minor elements (Mg, Mn, Fe, Sr) and $<10\%$ for many of the trace elements. Preliminary total element concentrations based on USGS bulk analysis using a variety of total element procedures including INAA, ICP-MS, ICP-OES and selected single element methods will be reported.