

Enhanced multicollector ICP-MS coupled with a desolvating nebulizer system for geochronology

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Abstract

Multicollector ICP-MS instruments are very specialized devices for high precision isotope ratio measurements. For accurate measurement of low abundance isotopes, signal enhancement is often required. In addition, sample preparation and/or sample aerosol desolvation may be necessary to reduce or eliminate mass spectral interferences such as oxides and hydrides.

This paper will examine the coupling of an enhanced multicollector ICP-MS instrument with a desolvating nebulizer system for geochronology. The hardware specification of the ICP-MS will be detailed, including a revised vacuum system and special sampler and skimmer interface cones. Important operating conditions of the desolvating nebulizer system include argon sweep gas and nitrogen addition gas flows.

Application of this coupled system to U-series dating will be described.

Mineralogy and porewater geochemistry of processed kimberlite: implications for acid rock drainage and metal releases

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The development of diamond mines in Canada's North emphasizes the need to assess the environmental implications of storing processed kimberlite tailings (PK) in regions with continuous permafrost. The Diavik Diamond Mine (Diavik) is located in the barren lands on an island in Lac de Gras, 300 km northeast of Yellowknife, NT, Canada. During the life of the mine, up to 42 million tonnes of PK will be produced and disposed on site for permanent storage. In 2009, a study was initiated to understand the mineralogy and evolution of porewater geochemistry in the PK tailings impoundment. Porewater was collected and analyzed from a number of core and drive-point piezometers located across an exposed PK beach and in the central pond. The core samples were analyzed and characterized in detail. The samples collected from the tailings pond are composed of Ni-bearing olivine, calcite, quartz, garnet, lizardite, biotite, albite, saponite and both framboidal and massive pyrite. Olivine and its alteration products made of lizardite, iron oxides and magnesian aluminosilicates are the dominant minerals. Neutralization potentials of the samples are between 39 to 85 kg CaCO₃ eq/t, far exceeding the acid generating potentials in the 5 to 12 kg CaCO₃ eq/t range due to the presence of pyrite. Porewater samples from the unsaturated zone of the impoundment have the lowest pH values and highest concentrations of dissolved SO₄ and metals. With depth, pH values increase and dissolved SO₄ and metals concentrations decrease towards the water table. In the saturated zone, average dissolved concentrations decrease by almost an order of magnitude compared to the unsaturated zone for SO₄, major cations and most metals (e.g SO₄: 3500 to 350 mg/L; Mg: 730 to 80 mg/L, Ni: 0.82 mg/L to 0.038 mg/L). Sulfur isotope ratios measured from the porewater are strongly depleted averaging -17.9 ‰ and show minimal fractionation from the unprocessed kimberlite, suggesting dissolved sulfate concentrations are resulting from sulfide oxidation; however, there are no apparent mineralogical features on pyrite grains indicative of oxidative dissolution. Except for a single grain of BaSO₄, no other sulfate minerals were identified in the PK. Porewaters from the underlying frost zone show further increases in pH and decreases in dissolved SO₄ and metal concentrations. Groundwaters collected from piezometers installed in PK stored below a water cover revealed dissolved concentrations of major ions and metals which are comparable to those measured from the frost zone. Results from this study show that subaqueous disposal and freezing of the PK material would restrict oxidation and dissolution processes and limit the release of dissolved concentrations of metals and SO₄.