B.5 Relationships Between Flow-Paths and Weathering in a Waste Rock Pile

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Research Objective

An investigation is underway studying the relationships between flow-paths and weathering in waste rock. The relationships between hydrologic and chemical properties within waste rock likely control weathering of primary minerals and the formation, retention, and release of secondary minerals.

Research Site

Cameco Inc.'s Key Lake Operation built a 12 m high waste rock lysimeter in 1994. Lysimeter deconstruction during the summer of 2000 investigates weathering effects over the six year period since the pile was built. Waste rock was removed in six two meter lifts. Each lift was dissected with three trenches along the lysimeter length. Trenching enabled in-situ sampling of fresh, undisturbed waste rock.

Sample Methodology

Physical and chemical properties were identified at each sample location. Physical properties include the following: grain-size distribution, soil suction, and volumetric water content. Soil-water-characteristic curves developed from these properties define relative hydraulic conductivities and flow-paths. Chemical properties analysed include the following: paste pH, pore-water chemistry, and sequential sulphate extraction. Pore-water results may provide insight toward sources of weathering, buffering, and mixing. Sequential sulphate extraction results may identify

spatial patterns in weathering and the formation and retention of secondary minerals. Correlations between physical and chemical properties may provide insight toward waste rock weathering and secondary mineral behavior.

Large-Scale Sampling Strategies

Sampling strategies include a variety of scales and spatial approaches. The sampling plan includes random, composite, target, grid, and bulk methods, with approximately 200 total sample locations. Samples represent sub-meter, meter, trench, and lift scales within the pile.

Results to Date

Lysimeter deconstruction revealed heterogeneity and structure at a variety of scales. Soil-water-characteristic curves developed through analysis of grain-size distributions, soil suctions, and water contents show flow-path variability on the sub-meter scale. Rubble zones from end dumping during lysimeter construction created structure at the pile base. This large-scale structure was 3-4 meters thick. Frozen zones and ice lenses within the waste rock pile developed above and below the basal rubble zone. Sampled water represents fluid that had previously traveled through the entire pile and then subsequently froze at the pile's base.

Future Work

-Pore-water extractions
-Sequential sulphate extractions
blah blah blah

*use this as a guide for Cameco

Future work will identify the waste rock's chemical characteristics. Pore-water extraction by centrifuge and sequential sulphate extraction will characterise the waste rock chemical properties. Pore-water will be analysed for sulphate and metals. Results may identify sources of weathering, buffering, and mixing. Sequential sulphate extractions will target sulphate and metals associated with mineral phases. The extraction sequence targets the following three groups of phases: (1) water soluble +/- exchangeable fractions and carbonates; (2) secondary sulphates and oxides; and (3) primary sulphides and silicates. The proposed extractions will identify relationships between spatial patterns in the formation and retention of secondary minerals and physical properties previously identified. Identifying fundamental relationships between physical and chemical properties in waste rock is essential in making predictive estimates for waste rock weathering.