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Long Term Acid Generation Studies: Cinola Project British Columbia

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EXECUTIVE SUMMARY

In 1987, City Resources (Canada) Limited initiated a program of acid generation testing as part of feasibility studies for the Cinola Gold Project located on the Queen Charlotte Islands, off the north coast of British Columbia. The program was designed to quantify acid generation potential and evaluate waste rock management options for the proposed open pit gold mine. In 1990, the Mine Environment Neutral Drainage (MEND) Program and the BC Acid Mine Drainage Task Force began funding further monitoring of tests to evaluate long term weathering conditions in five humidity cells, five leach columns and four on-site waste rock pads. The study was concluded in 1993.

The project area experiences mild damp maritime conditions. Most precipitation occurs in the winter, primarily as rain. Bedrock in the area is mantled by thin till deposits. The Cinola deposit was formed by localization of relatively low temperature hydrothermal fluids along a fault system. During mineralization, the surrounding conglomerates, sandstones, siltstones and mudstones were altered to clay minerals (kaolinite and illite, a low temperature form of muscovite) and pyrite was disseminated throughout the rock mass at concentrations typically in the range of 1 to 2%. Calcite occurs at similar or lower concentrations. Several rock types were classified as potentially acid generating based on conventional acid-base accounting.

The study yielded important data on long term weathering trends for tests conducted at different scales. Five humidity cells (four of which contained acid generating waste rock) were continued for 140 weeks and showed three distinctive stages in pH and sulphate production rate. In Stage 1, leachate pH was near 7.0 and sulphate production was slow (less than 20 mg SO_4/kg/week). As readily available neutralizing minerals were removed, leachate pH decreased to less than 3 and sulphate production increased rapidly (to greater than 1000 mg SO_4/kg/week). In Stage 3, sulphate production slowly decreased and leachate pH slowly increased to

between 3 and 4. After more than 100 weeks of leaching, sulphate production decreased by one or two orders of magnitude and leachate continued to be acidic (leachate pH<4). Trends in waste rock pad leachate were less apparent due to annual flushing events related to late summer and fall rainfall. However, a qualitatively similar long term decrease in sulphate production and increase in leachate pH was observed. After five years, the waste pad leachate continued to be strongly acidic for three test piles and concentrations of iron, copper, zinc and arsenic were indicative of acidic weathering conditions.

The leach column study evaluated the delay in release of heavy metals and acid drainage achieved by addition of varying concentrations of crushed limestone to waste rock. Long term trends were very similar to humidity cells. Two simple relationships were defined relating limestone content (ie. neutralization potential) to (1) time elapsed until the first indications of net acid generation were observed; and (2) time elapsed until peak acid generation was observed. Release of zinc followed the first type of relationship whereas release of iron and copper followed the second relationship. The study showed that although limestone addition delayed full acid generation and release of copper and iron according to an exponential relationship, significant zinc loads may be released in pH-neutral drainage several years before acid drainage is produced.

When comparing different types of weathering tests, the study demonstrated that the small- and large-scale tests produced similar results for qualitative long term trends, sulphide oxidation reaction kinetics, and average sulphate release rates expressed as estimates of exposed particle surface areas. The test results were dissimilar for metal release rates probably due to complex mineral precipitation controls operating under widely varying solid-to-liquid ratios. These conclusions apply to the Cinola epithermal deposit where sulphide mineralogy is simple relative to complex deposits containing two or more different types of iron sulphide in a variety of forms.

It was concluded that further research is needed to address a number of issues. These include: evaluation of solid weathering products; long term kinetics of weathering in mineralogically complex materials; long term kinetics of weathering in marginally-acid generating materials; long term leachate quality for sulphide-depleted weathered waste rock; application of small-scale test results to large scale waste rock piles; and evaluation of the effect of heterogeneities in mixing of calcareous and potentially acid generating waste rock.