

WEDNESDAY, AUGUST 25, 2004, A.M.

**SESSION 48: FIFTH INTERNATIONAL SYMPOSIUM ON WASTE
PROCESSING AND RECYCLING IN MINERAL AND METALLURGICAL
INDUSTRIES**

TAILINGS TREATMENT: ACID ROCK DRAINAGE

Sponsors: Hydrometallurgy, Non-Ferrous Pyrometallurgy, Iron and Steel Sections and Environment Committee of the Metallurgical Society of CIM and the Environmental Society of CIM

Room: Chedoke B

Chairmen: M. KALIN, Boojum Research, Toronto, Ontario, Canada, and
N. KUYUCAK, Golder Associates, Ottawa, Ontario, Canada

PAPER 48.1 — 9:00

SURFACE REACTIONS OF SULFIDE MINERALS IN ARD ASSESSMENT.

A.R GERSON, R.S. SMART, J.E. THOMAS, Ian Wark Research Institute, University of South Australia, Mawson Lakes, South Australia,

R. SCHUMANN, Levay and Co., University of South Australia, Mawson Lakes, South Australia,

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Single addition and sequential net acid generation (NAG) testing was carried out on single sulfide mineral samples comprising a range of synthetic waste materials prepared using quartz with controlled quantities of the commonly occurring sulfide minerals; pyrite, pyrrhotite, arsenopyrite, chalcopyrite, chalcocite, covellite, bornite, galena and sphalerite. There are significant differences between the acid forming potential of these sulfide minerals. Sequential NAG acid production values for pyrite correspond closely (>90%) to predicted NAPP values, confirming the assumption that pyrite oxidation occurs according to the stoichiometry assumed. For the pyrite sample with 5 wt% S, 2 NAG stages were required for all of the sulphur to be released to solution. The other iron-containing minerals also produce acid but less than predicted NAPP values. For sphalerite, galena, and the Cu-containing sulfides, an estimation of net acid producing potential based on NAPP would lead to a considerable over-estimation of acid production as compared to the sequential NAG tests. Reaction pathways to be proposed, based on surface species found in mineral reactions, provide an explanation for the lower than expected acid production observed for some of the sulfide minerals.

PAPER 48.2 — 9:25

IMPROVEMENTS IN ACID ROCK DRAINAGE TESTING FOR SHORT- AND LONG-TERM NEUTRALISATION KINETICS.

R.S.C SMART, P. WEBER, J.E. THOMAS, W.M. SKINNER, Ian Wark Research Institute, University of South Australia, Mawson Lakes, South Australia,

W. STEWART and S. MILLER, Environmental Geochemistry International, Balmain, North South Western, Australia

Many mine sites already have an existing problem with acid rock drainage (ARD). The prime consideration for these mining operations is not only the classification of different waste rock but also the peak acid (and metal) release rates and expected ARD duration. The peak ARD zone, identified by high sulfide oxidation and acid generation in excess of ANC release rates, is the period where effective ARD management and mitigation procedures are required. Methods for assessment of this additional ANC are unreliable. Corrections for these factors, as refinements for existing Sobek ANC tests, are presented. The measurement of negative ANC values and the release of S to solution (above that which can be accounted for by non-acid generating sulfate salts) indicated that significant sulfide oxidation may occur prior to and during testing in samples containing reactive (particularly framboidal) pyrite. This oxidation may result in serious underestimation of the original ANC in a sample, effectively counting some of the MPA twice. A simple methodology with dissolution in Ar-purged water before ANC testing, removing ferrous salts, and sulfate assay after ANC testing corrects these effects. Results also showed that a significant lag period may be needed (up to 432 h) after standard Sobek-type ANC tests for the complete hydrolysis of Fe associated with the ANC testing of, for instance, siderite. Hence, the ANC of iron carbonates is usually significantly overestimated. A chemical ANC calculation, based on neutralising cations released to solution, provided a method to quantify the short-term ANC of carbonates and alumino-silicates (cation exchange) in simple mixed mineral assemblages and waste rock samples obtained from mining operations. Results showed that alumino-silicate ANC can be more important in short-term neutralisation than carbonate ANC in low carbonate samples.

PAPER 48.3 — 9:50

BIO-REACTOR SYSTEMS FOR TREATING ACID MINE DRAINAGE.

A. KAPOOR and W.D. GOULD, Natural Resources Canada, Ottawa, Ontario, Canada

Acid mine drainage (AMD) is characterized by low pH as low as 1.5 and large concentrations of sulfate and dissolved metals such as iron, manganese, aluminum, zinc and copper. Sulfate reducing bacteria have been used for the removal of sulfate from industrial process wastewaters. The sulfide produced in the biological sulfate reduction process is used to precipitate metals present in AMD as their respective sulfides and the alkalinity generated in the process will result in neutralization of the AMD. This review article will present an overview of sulfate reduction processes using SRB, bioreactor configurations for sulfate reduction systems, AMD treatment studies using SRB, and full-scale sulfate reduction systems in operation for the treatment of acid mine drainage.

COFFEE BREAK — 10:15 -10:40

PAPER 48.4 — 10:40

POTENTIAL USE OF TREATED ACID MINE DRAINAGE AT KINGSMILL TUNNEL, PERU.

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J. CHÁVEZ, Golder Associates, Lima, Peru,

J.R. DEL CASTILLO, CENTROMIN, Lima, Peru, and

J. RUIZ, SEDAPAL, Lima, Peru

Environmental Impact Assessment (EIA) and Feasibility Studies (FS) were carried out to evaluate the potential use of treated acid mine drainage (AMD) occurring at the Kingsmill Tunnel in the Central Andes of Peru. The 11-km long tunnel drains the underground works of the Morococha Mining District and discharges about 1.25 m³/sec of AMD directly into the Yauli River, which is located within the Amazon Basin. The communities living downstream cannot use the Yauli River water due to its low pH and elevated concentrations of metals (e.g., Cu, Zn, Fe, Mn, As, Cd) and sulfate. Studies carried out for this project included technical feasibility, EIA, economic viability and social impact assessment phases. During the "Technical Feasibility" phase, the treated AMD was produced by simulating a high density sludge (HDS) lime neutralization/precipitation process and was evaluated for various potential uses. Mining companies located in Morococha, in particular Centromin Peru S.A., and the Water Works Company of the City of Lima (Sedapal) collaborated with Golder Associates during the studies. The Canadian International Development Agency (CIDA) provided the financial assistance.

The results of the physical, chemical, biological and toxicological analyses demonstrated that the treated AMD could be used for supplementing the drinking water supply of Lima and for agricultural (e.g., irrigation and livestock) and recreational purposes. Process design and scale-up parameters were also determined for the implementation of the full-scale treatment facility to the site. The use of the treated AMD as a drinking water supplement would be economically feasible.

PAPER 48.5 — 11:05

BIOLOGICAL SYSTEM FOR METAL REMOVAL - ANAEROBIC CELL DECONSTRUCTION.

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A. MATTES, Natural Works Remediation Corporation, Ottawa, Ontario, Canada, and,

W.D. GOULD, Natural Resources Canada, Ottawa, Ontario, Canada

A biological treatment system designed to passively remove high concentrations of metals from leachate collected from a landfill near a large integrated zinc lead smelter has been in operation intermittently for the past five years including winter time operations. High metal removal efficiencies in the system were achieved. After 729 days of operation and treating over 8 million L of water the original anaerobic bioreactor constructed in 1997 was taken apart and rebuilt. The deconstruction of the bioreactor allowed systematic sampling at all depths of the biological matrix. Samples were analyzed for metal, S and TOC concentrations; as well bacterial populations were determined. Results of this sampling procedure are examined and compared at various depths within layers and between layers using one-way ANOVA and linear regressions. Metal concentrations were positively correlated with sulphur and negatively with total organic carbon. This is in concurrence with a model of biogenic precipitation of metal sulphides.

PAPER 48.6 — 11:30

PROCESSING AND UTILIZATION OF MINE WASTEWATER SLUDGE FOR UNDERGROUND DISPOSAL WITH PASTE BACKFILL.

H. MADI and L.M. AMARATUNGA, Laurentian University, Sudbury, Ontario, Canada

Final disposal of mine wastewater neutralization (metal hydroxide) sludge continues to be one of more pressing problems in the mining industry. The underground disposal of mining and metallurgical waste products using paste backfill technology reduces the environmental impact and provides the base of a material (Aggregate Composite Material); that can be designed and engineered to give support, and strength properties to improve the safety of the mining operation and the economics of the enterprise. This current research focuses on an investigation of utilization of waste sludge obtained from Kidd Creek Mine site, as a supplementary material for their proposed pastefill system.

Their pastefill consists of combination of rock aggregate in a matrix of imported sand and tailings with binder (Portland Cement + Slag Cement). Pastefill mixes containing various percentages of the waste sludge 0 (control mix), 1, 1.5, 2, 2.5, 3 percent as replacement to the fine sand were prepared and tested with different percentage of binder. Hypothesis behind this approach is to study the behavior of sludge as replacement of sand in matrix as well as its ability to act as a binder. Compressive strength, percentage of sludge, binder dosage, slump, water to cement ratio, percentage of solid, and curing time are being observed. The early results showed that as the amount of the sludge increased the basic strengths of the pastefill mix is increased. The results also revealed that as the percentage of waste sludge increased the water to cement ratio for the mix has also increased, since the waste sludge has a high degree of water absorption, therefore, additional amount water is required for cement hydration.