

WEDNESDAY, AUGUST 24, 2005, A.M.

SESSION 35: INTERNATIONAL SYMPOSIUM ON THE TREATMENT OF GOLD ORES

PLANT PRACTICE AND PROJECT DEVELOPMENT

Sponsor(s): Hydrometallurgy Section, The Metallurgical Society of CIM, Canadian Mineral Processors Division of CIM, CANMET-MMSL

Room: Imperial Ballroom 3

Chair(s): J.S.J. VAN DEVENTER, The University of Melbourne, Australia and D. HODOUIN, Laval University, Quebec, Canada

PAPER 35.1 — 8:30

INSTITUTIONALIZING ADVANCED CONTROL ON NEWMONT'S CARLIN TREND.

A. COLLINS and D. DANNINGER, Newmont Mining Corporation, U.S.A.

Newmont has installed advanced control and online optimization on the dry grinding circuit and both roasters on its Carlin Trend refractory ore treatment plant. Subsequently, Newmont has developed a master plan for institutionalizing advanced control and optimization on all its processing units. Newmont is committed to a program of applying advanced control and optimization from crushing of ore to pouring of gold. This paper describes Newmont's experience with implementing advanced control and optimization and the benefits received. In addition, identification of advanced control and optimization opportunities and their economic justification is discussed.

PAPER 35.2 — 8:55

BARRICK GOLD CORPORATION — LAGUNAS NORTE & VELADERO PROJECTS.

S. HAGGARTY, J. MCMULLEN, Barrick Gold Corporation, Canada and

R. WALTON, SNC-Lavalin, Canada

Barrick's growth and development plan will add three major new mines during 2005 including the Lagunas Norte Project in the La Libertad Province of Peru, the Veladero Project in the San Juan province of Argentina, and the Tulawaka Mine in north-western Tanzania. Lagunas Norte and Veladero are similar in that they are both green-field open pit deposits at elevations over 4,000 meters above sea level, with two stage crushing and heap leaching followed by Merrill Crowe zinc precipitation for precious metal recovery. Operating sites will each generate in excess of 700,000 ozs Au per annum with commissioning and full scale operation planned during the third and fourth quarter of 2005. Details with regards to regional geography, development schedule, production and process specifics for Lagunas Norte and Veladero will be discussed in this presentation providing an overview for the respective properties.

PAPER 35.3 — 9:20

STUDY OF THE KINETICS OF LEACHING GOLD FROM A SOFT SULPHIDE ORE AT THE SADIOLA MINE.

G. DESCHÊNES, H. GUO, M. FULTON, Natural Resources Canada, Canada and

T. MULPETER, SEMOS, Mali

Sadiola Gold Mine is an open pit operation located in Mali and owned by AngloGold Ashanti Ltd, Iamgold Corporation and the State of Mali. A conventional cyanidation process (cyanidation/CIP) treats 15,000 tpd (of a mixture of oxide and sulphide ores) at an average grade of 3 g/t Au. In 2002, the increasing tonnage of sulphides caused an increase in production costs and a decrease in gold extraction (from 95% to 70-76%). Because of the short retention time of the leach circuit (18 hours) and the refractory nature of the sulphides, gold leaching kinetics are critical. A laboratory investigation was initiated to evaluate actual plant practice and identify a means of improving the gold leaching rate. The study was conducted on a "soft" sulphide gold sample containing 4.96 g/t Au, 0.4 g/t Ag, 2.5% pyrite, 1.2% arsenopyrite, and 0.2% pyrrhotite with a P_{80} of 74microns. Pre-leaching significantly influenced the gold leaching rate. A short pre-leach (2 hours) performed at pH 8, a DO of 8 ppm, and with 300 g/t lead nitrate added at the start or the end, produced the preferred conditions. Pre-leaching for more than 2 hours was detrimental to gold extraction. The cyanide concentration had to be maintained at 450 ppm NaCN to reach a maximum gold extraction within the retention time of the circuit. A maximum extraction of 81.3% Au was obtained in 20 hours (leach residue at 0.97 g/t Au). A high level of dissolved oxygen in the pre-leach was not of any benefit. Extension of gold leaching beyond 20 hours indicated that all leachable gold had been extracted by that time. Plant modifications were made to allow leaching of oxides and sulphides in separate circuits. Treatment of oxide ores is now performed at a higher rate. Sulphides are processed at a lower throughput, with 300 g/t lead nitrate, to allow a retention time of 22 hours. Combined throughput remains the same, and total gold recovery has increased from 76% to 80% for an additional gold production of 16,000 ounces per year.

PAPER 35.4 — 9:45

CHLORIDE LEACHING OF GOLD FROM SULFIDE CONCENTRATES.

J. LEPPINEN, M. HÄMÄLÄINEN and O. HYVÄRINEN, Outokumpu Research, Finland

Outokumpu has developed a new chloride leaching process called HydroCopper®. In this process copper sulfide concentrates are leached at atmospheric pressure in concentrated sodium chloride solution using cupric ions as the oxidant. Copper is recovered from the purified leach solution by precipitating cuprous oxide which is then reduced to pure copper and further melted and cast directly to copper products. The key reactants sodium hydroxide, hydrogen and chlorine are generated from the spent sodium chloride using chlor-alkali technology. An important feature in the HydroCopper® process is that the gold contained by copper concentrates is leached as chloride complexes and recovered from solution by activated carbon. Conditions for the leaching of gold-bearing pyrite can also be achieved in the chloride system by optimizing the redox conditions. This paper deals with basic factors affecting gold leaching from copper sulfide concentrates. Opportunities for the recovery of refractory gold associated with arsenopyrite and pyrite will also be discussed.

COFFEE BREAK — 10:10 – 10:30

PAPER 35.5 — 10:30

WHEN HEALTH AND SECURITY MEANS SAVINGS AT THE LARONDE REFINERY.

F. ROBICHAUD, J. FOURNIER and D. FORTIN Agnico-Eagle, Canada

Since milling began in 1988, the Laronde mill has been expanded several times, the most recent, increasing the milling rate from 5 000 to 7 000 mtpd. Laronde uses SAG/ball mill grinding followed by copper and zinc flotation circuits. A cyanidation/Merrill-Crowe process recovers the remaining gold and silver in the flotation tails in order to cope with much higher ratio of silver/gold associated with the discovery of the Penna shaft. Over the last four years, several modification and expansion projects were performed in order to reduce health and safety hazards since the commissioning of the Merrill-Crowe refinery in 2000. Remarkably, several of these improvements have contributed at increasing productivity and Net Smelter Return of the refinery while reducing worker's injuries. In 2004, the refinery was audited to evaluate and quantify the circuit performance. Metallurgical and mechanical operating conditions of the refinery are now understood, and areas for further improvements are well defined. This paper describes some of the factors that have contributed to this improvement and describes how ergonomics and recovery can further be improved.

PAPER 35.6 — 10:55

FROG'S LEG GOLD PROJECT: A NON TRADITIONAL APPROACH TO DEVELOPMENT.

J. P. NICOUD, Mines & Resources Australia, Australia and

D. CONNELLY, Mineral Engineering Technical Services Pty Ltd., Australia

The Frog's Leg project is strategically located in the Kundana mining centre 22 kms west of Kalgoorlie, Australia. The Mines and Resources (MRA) Dioro Exploration joint venturer has had considerable exploration success centred on the high grade Frog's Leg discovery. Gold resources of 749,500 ounces have been defined. At Frog's Leg, there are three discrete resource domains recognised – Supergene, Contact, and Quartz Lode. This paper describes the metallurgical test work undertaken. The selection of the drill core was a joint effort by the MRA Senior Geologist and Mineral Engineering Technical Services (METS) to ensure the samples were representative of the ore body. Optimisation of gold recovery was essential since both contact and quartz have exceptionally high percentages of free gold and significantly higher grade than the typical open pit ores in Western Australia. The Metallurgical scope of work included documenting all of the metallurgical test results., establishing the comminution characteristics, determining the percentage of gravity recoverable gold, the cyanide leach characteristics and the tailings characteristics. This included describing the basis of design for a flow sheet to treat both ores based on test results and the advantages and disadvantages of the alternatives. Investigations also included toll milling options at various plants. Second hand and transportable plants were also considered. A considerable technical effort has been put into ore characterisation by way of test work aimed at managing the process risk at each stage of project development including mitigation. MRA also carried out detailed mineralogical analysis of the ores.

PAPER 35.7 — 11:20

CONTINUOUS EVOLUTION OF PORCUPINE JOINT VENTURE (PJV) DOME MINE'S EFFLUENT TREATMENT PLANT.

J.A. FOLINSBEE and T.Y CHONG, PJV, Canada

Since milling began in 1909, the PJV Dome mill has been expanded several times, to the current throughput of 11,500 tpd. Dome recovers free gold using crushing and grinding followed by gravity concentration. The remaining gold in the gravity tails is recovered by a cyanide leaching followed by a Carbon-In -Pulp circuit. Prior to 1993, cyanide tailing were impounded in the tailing pond where cyanide was allowed to degrade naturally. Effluent was discharged seasonally during the summer and early autumn to maintain the water balance. In 1992, an Effluent Treatment Plant (ETP) was designed and constructed for the purpose of removing dissolved metals and suspended solids. In 1997, an INCO SO₂/Air cyanide destruction process was added to the ETP. Even though the ETP was

successful in meeting the cyanide, metals and TSS discharge limits, often the treated effluent failed to pass toxicity tests. Following successful laboratory and plant scale testing, the addition of the chelant EDTA (ethylene diamine-tetra-acetic-acid) was commenced in the 1999 operating season. To date discharged effluent has passed all toxicity tests. This paper describes the evolution of the ETP from its early conception to the various phases of upgrade needed to meet the MISA discharge limits.