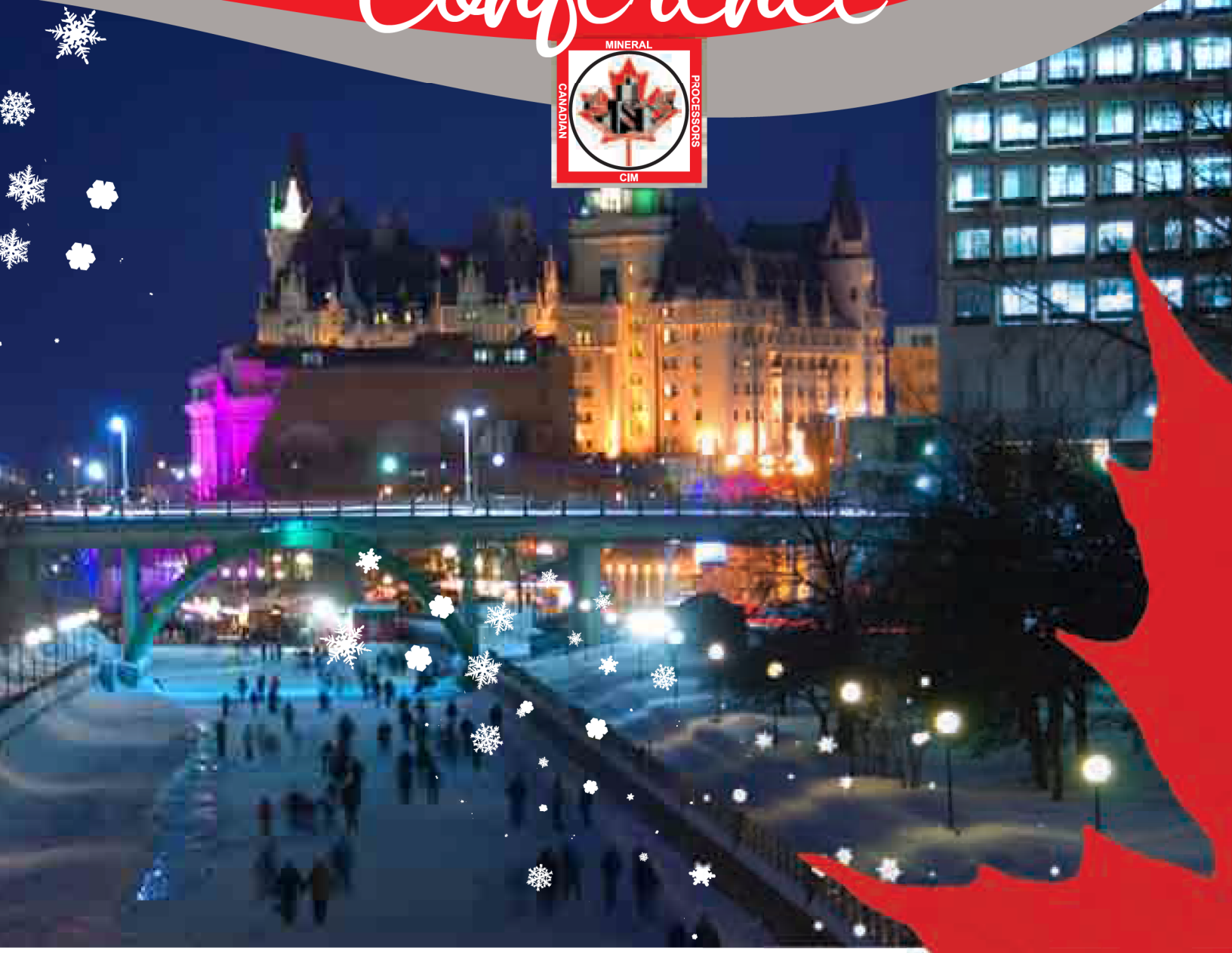
CANADIAN MINERAL PROCESSORS

2017 Conference

CANADA 150



www.cmpsoc.ca

January 17-19, 2017
The Westin Hotel
Ottawa, Canada

Technical Program at a Glance

TUESDAY

8:30

OPENING REMARKS
Scott Martin

PLENARY PRESENTATION

8:45

The Need to Innovate: Celebrate the Past.... Look to the Future
Dominic Fragomeni

COMMINUTION

9:30

Fine Grinding, A Refresher
Alex Doll

9:55

Two-Mass Vibrating Screens for High Tonnage Applications
Eddie Wipf

Break

10:50

Breaking Down Energy Consumption in Industrial Grinding Mills
Jocelyn Bouchard

11:15

Rubber Liners in the Service of Large Diameter Ball Mill at Hudbay, Constancia Mine, Peru
Raj Rajamani

11:40

Honeywell Multivariable Predictive Control Implementation in the Goldex Grinding Circuit
Sarah Simard and Michel Dion

Networking Luncheon (provided)

COMMINUTION

13:35

Grinding Circuit Final Grind Control at Agnico Eagle Meadowbank Mine
Irma Gabric

14:00

Comminution Circuit Design Considerations
Paul Staples

14:25

Use of Functional Performance Models to Increase Plant Grinding Efficiency
Rob McIvor

Break

15:20

Technical Review and Evaluation of Ore Sorting Technology Incorporating Results from Four Properties
Brent Hilscher

15:45

Spiral Surface Property Investigation
Wynand Erasmus

16:10

Flash Flotation Circuit Design Considerations
Ben Murphy

Day 1 Concludes 16:35

WEDNESDAY

OPERATIONS

8:30

Design, Construction and Commissioning of Gold Tailings Plant at Mazowe Mine, Zimbabwe
Alain Bantshi

8:55

An Update on Reaching Nameplate Throughput and Continuous Improvements at Mt Milligan
Joel Yue

9:20

Processing Plant Expansion at Kittila Mine Affords Opportunity for Significant Material Handling Improvement
Tracy Holmes

Break

10:15

Goldcorp's Peñasquito Pyrite Leach Project
Simon Hille

10:40

The Effect of Choke Feeding a Gyratory Crusher on Throughput and Product Size
Jean-Francois Dupont

11:05

Investigating the Potential of HydroFloatTM Coarse Particle Flotation Techniques on Copper Sulphide Ores
Peter Mehrfert

CMP AGM and Luncheon (provided)

FLOTATION

13:00

Improving Concentrate Grade through Smart Design and Piloting
Virginia Lawson

13:25

Online Elemental Analysis of Slurry using Laser Induced Breakdown Spectroscopy
Lauri Koresaar

13:50

The Removal of Iron-bearing Silicate Minerals from a Hard Rock Lithium Ore
Charlotte Gibson

Break

FLOTATION

14:45

Improvement of Valuable Mineral Transport and Gangue Drainage in Froth Flotation

15:10

Linking Flotation Efficiency to Bubble Size
Jose R. Hernandez-Aguilar

15:35

Rejection of Uranium from Copper Gold Ore by Flotation
Manqui Xu

16:00

Economic Recovery and Upgrade of Metals from Middling and Tailing Streams
Paul Voigt

Day 2 Concludes 16:25

THURSDAY

GOLD

Anaconda Mining Inc.'s Point Rousse Project Cyanide Destruction System Development Study
Neri Roux

8:55

Demonstration Campaign Results on a Cyanide-Free Process for Gold Extraction from a Refractory Pyrite Concentrate
Andre Drouin

9:20

Red Lake Gold Mine Autoclave Optimization Project
Kevin Murray

Break 9:45

10:15

A New Method for the Stabilization of Arsenic from Enargite Concentrates
Gabriel Garcia Curiel

10:40

Economic Evaluation of Activated Carbon for Gold Milling Circuits
Mark Somppi

11:05

Selecting the Correct Cyanide Destruction Process for Your Operation
Anca Nacu

Lunch 11:30

GOLD

13:00

Selecting the number of increments for daily metallurgical samples: Application to Goldcorp Eleonore Gold Ore Concentrator, Quebec, Canada

13:25

Assessing the Total Cost of Representativity in Flotation Plants
Luc Lachance

13:50

Evaluating the Applicability of Gold Pre-Concentration by Sensor Based Sorting of Quartz Ore
Jorn Rohleder

Break 14:15

14:45

Enhanced Gravity Recovery of Base Metal and Industrial Minerals
Ish Grewal

15:10

Update of Canadian Rare Earths Projects and Technological Trends
Maziar Sauber

15:35

Design, Commissioning and Operation of an Heavy Rare Earth Separation Pilot Plant
Jack Zhang

Conference Concludes 16:00

CHAIRMAN'S WELCOME

Welcome to Ottawa and the 49th Annual Meeting of the Canadian Mineral Processors! On behalf of the CMP Executive it is my pleasure to welcome all delegates to the conference. This conference provides an opportunity for members of our mineral processing community to exchange and engage in a balanced technical and social program covering all aspects of mineral processing.

Johnna Muinonen, this year's first Vice Chair, has put together an excellent technical program with 36 delegate presentations plus a plenary presentation called The Need to Innovate: Celebrate the Past and Look to the Future. The sessions for this year are Flotation, Gold Processing, Process Control, Ore Sorting, Operations and Comminution. This year we have continued the tradition of a Short Course Program, with a variety of courses covering a range of subjects led by industry experts.

I would also like to invite you to participate in this year's social program which includes the student mixer on Monday evening open to all registered delegates, the networking lunch Tuesday, the Chairman's Reception Tuesday evening (I can tell you will be an eye opener), the business meeting lunch on Wednesday, and finally the banquet and reception on Wednesday evening. As well, the CMP hosts the annual East vs. West *Ray MacDonald Memorial Hockey Game* to whom the famed Kilborn Cup will be hoisted in triumph.

The entire CMP community has continued to be very active in the mining community throughout 2016. The CMP pulled together and donated over $14,000 in response to the Fort McMurray Wildfires. This amount was matched by the Red Cross. This collective effort went a long way to support those in our community who are in need.

This year, the CMP also came together to remember two pillars of our industry. Dr. Laxman "Lucky" Amaratunga and Mr. Ludwig "Lud" Strah passed away. Both Lucky and Lud were pioneers in our industry and played a very important part in bringing the CMP to where it is today. We will come together to honour and pay tribute to both Lud and Lucky at this year's event.

For those feeling up to it, or needing some fresh air on Wednesday morning you are welcome to join Stephanie Vo, Paul Blatter and Johnna Muinonen for a short jog in and around Ottawa (rain-snow-cold, it's a go!).

Enjoy the Conference!

Scott Martin
CMP 2017, Chairman

IN REMEMBRANCE

Ludwig (Lud) M. Strah (1933-2016)

The Canadian Mineral Processors lost a Founding and Life Time Member on Wednesday October 26, 2016.

Lud was born on September 23, 1933 in Noranda, Quebec to Ludvik and Mary Strah. He attended school in Noranda, graduating from Noranda High School and entered St. Patrick's College in Ottawa followed by the Haileybury School of Mines, graduating in 1955. On September 17, 1955 he married Patricia Anne Leng at St. Paul's United Church in New Liskeard. They then moved to Noranda, Quebec where Lud was employed by the Quemont Mine.

In 1958, they moved to Elliott Lake, Ontario where Lud had accepted a position in the engineering office of Denison Mines. Positions with Siscoe Metals in Gowganda, Ontario and Sorel Steel, as a Sales Engineer in Montreal followed.

Lud traveled extensively with Sorel Steel and later joined the Mine Equipment Company, first in Montreal, next with the western division in Winnipeg, then the Ontario division in Toronto.

In 1968 he purchased the assets of Lecky Machinery and NorLecky Manufacturing and formed his new business, Continental Mine Equipment Limited in Haileybury, Ontario. He worked worldwide and continued to be active in the mining industry as a founding partner of ASK Consulting and completed two tours with Canadian Executive Services Overseas in Ghana and Romania.

From the early 1990's until early 2000 Lud, affectionately known as "Dad" to many of the young fellows in the industry, worked as a consultant with the Norcast Casting companies and as well as, MPSI during the '90's. During these years he became known as the outspoken 'God Father of Mineral Processing' who was never lost for words and could tell stories, never the same one twice, until the sun came up. During the annual CMP conference Lud would be found holding court with a band of brothers around him and coaching the East Hockey Team during the annual hockey game. He was a big supporter of the CMP Student Program and Haileybury School of Mines where in he helped organize a 50th Anniversary for the 1954-56 graduating classes.

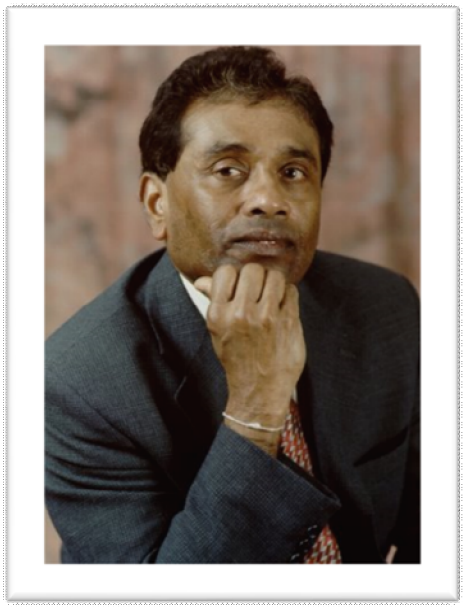
He was a life member of the Canadian Mineral Processors, and contributed significantly to many improvements in comminution technology, particularly design and development of grinding media. A fellow of the Canadian Institute of Mining and Metallurgy, a member of The American Institute of Mining, Metallurgical and Petroleum Engineers, the Engineering Institute of Canada and the Association of Professional Engineers of Ontario.

He was awarded a Paul Harris Fellow by Rotary International and a proud Mason as a member of Silver Lodge #486.

Lud is survived by his loving wife of 61 years, Patricia, daughter Nancy (Tia) Gorman and granddaughter Rachel Anne Sillers, son Michael and wife Alma Gonzalez and granddaughter Alma Patricia and brother-in-law Bob Leng and nieces.

IN REMEMBRANCE

Dr. "Lucky" Laxman Mahendra Amaratunga (1943-2016)



The Canadian Mineral Processors lost one of its Life Time Achievement Award recipients on May16th 2016. Dr "Lucky" Amaratunga was a dedicated member of the CMP and the CIM with a special interest in the students. He chaired the CMP Education Committee as a member of the Board of Directors from 1992 to 2016 and chaired the annual Student Essay Competition for over 10 years.

Lucky came to Canada as a research associate at the University of Toronto in 1980 after graduating from University of Ceylon (1969), Camborne School of Mines (1974), and University of Birmingham where he received his PhD in 1978. From 1981 to 1984 he was a Process Engineer at the Iron Ore Company of Canada. He joined Laurentian University in 1984 and achieved full professorship in 1993. Professor Amaratunga's research activities were in the areas of: environmental aspects of the minerals industry, waste processing and utilization, application of nanomaterials in waste processing, solid-liquid separation, interfacial phenomena, mineral processing, and sulphide dust explosions. He authored or co-authored a number of papers on these subjects.

Lucky has been the recipient of many awards including CIM Fellowship (1997), Laurentian Teaching Excellence (2003), Teck Cominco Environmental Award (2007), and the CMP Life Time Achievement Award in 2012. In addition he was a CMP Distinguished Lecturer in 1999-2000 and in 2011, a MetSoc / CMP Luncheon was held in his honour at the Conference of Metallurgists.

Lucky was devoted to the CMP and the mineral processing students. He worked tirelessly in promoting the Student Essay Competition and in evaluating the submissions. There was a lot of satisfaction in his face when he awarded the winners at the annual CMP Student Mixer held at the conference in January. The students also showed a lot of respect for Lucky as they recognized his strong support of them. In recognition of Lucky's dedication to the Student Essay Competition, the competition was renamed the "Lucky Amaratunga Technical Report Competition" in 2016.

Even as his ALS advanced, Lucky made every effort to attend the CMP Conference in Ottawa. As this is always held in January, and he lived in Sudbury, it was a major challenge for him and his wife Nan to make the trip, but for him, and for his many friends and colleagues at the CMP Conference who enjoyed his warm personality and lively sense of humour, the trip was very worthwhile.

Lucky will be greatly missed by his students and by us, his CMP Family.

CONFERENCE OVERVIEW

Monday, January 16th

8:00 - 17:00 Short Courses, Westin Hotel, 4th Floor

8:00 – Registration and breakfast

9:00 – Full day courses start

- Geometallurgical Approach to Plant Design and Optimization
  - SGS - Doug Hatfield, David Hatton
  - Room: New Brunswick
- Get it Sorted: An Introduction to Sensor Based Ore Sorting
  - Outotec - Jorn Rohleder and UBC – Bern Klein
  - Room: Nova Scotia
- Thickened Tailings Management – Dewatering to Stacking
  - Outotec – Jason Palmer
  - Room: Newfoundland
- 12:00 – 1:00 Short course luncheon
  - Daly's 3rd floor
  - *Open to all short course participants and instructors*
- 1:00 to 5:00 - Activated Carbon in gold recovery utilising the Carbon-in-Pulp and Carbon-in-leach processes
  - KEMIX – John Rogans
  - Room - Quebec

8:30 - 16:00 Board of Directors Meeting
Colonel By Suite, 23rd Floor

19:00 - 22:00 Early Conference Registration
4th Floor Westin Hotel

19:30 - 21:30 Student Round Table
Governor General I, 4th Floor
Invitation Only

21:30 - 23:30 Student Mixer
Governor General I, 4th Floor
All Welcome

Tuesday, January 17th

7:00 - 8:15 Authors' Breakfast
Quebec Room, 4th Floor

7:00 - 15:15 Registration
4th Floor Westin Hotel

8:30 - 16:35 Technical Program
Confederation Ballroom

12:05 - 13:35 Tuesday Networking Luncheon
Governor General Ballroom

17:30 – 19:30 IMPC 2016 Celebratory Reception
Saskatchewan, 3rd Floor Westin
Invitation Only

19:00 - 21:00 Ray MacDonald Hockey Challenge
Carleton University

21:00 - 24:00 Chairman's Reception
Governor General Ballroom I

Wednesday, January 18th

7:00 - 8:15 Authors' Breakfast
Quebec Room, 4th Floor

7:30 - 15:15 Registration
4th Floor Westin Hotel

8:30 - 16:25 Technical Program
Confederation Ballroom

11:30 - 13:00 Wednesday Luncheon and Annual Business Meeting
Governor General Ballroom

18:00 - 19:30 Executive Reception
Colonel By Suite, 23rd Floor
Invitation only

18:30 - 19:30 Banquet Reception
4th Floor, Ballroom Foyer

19:30 - 22:00 Annual Banquet
Confederation Ballroom, 4th Floor

22:00 - 24:00 Post Banquet Reception
Governor General I, 4th Floor

Thursday, January 19th

7:00 - 8:15 Authors' Breakfast
Quebec Room, 4th Floor

:45 - 15:15 Registration
4th Floor Westin Hotel

8:30 - 16:00 Technical Program
Confederation Ballroom

11:30 – 13:00 Student Luncheon
Governor General I, 4th Floor
Invitation Only

17:00 - 20:00 Board of Directors Meeting
Colonel By Suite, 23rd Floor

20:00 – 23:00 Board of Directors Dinner
Daly's, 3rd Floor

TUESDAY, JANUARY 17th
Morning Session

07:30 - CONTINENTAL BREAKFAST – PROVINCES BALLROOM

08:30 – Opening Remarks
Scott Martin, Chair CMP 2017

PLENARY PRESENTATION

08:45 - PAPER 1
The Need to Innovate: Celebrate the Past....Look to the Future
Dominic Fragomeni, XPS

The mineral processing industry has had a long history of innovation that is recognized but not often celebrated. These include significant advances in mineral measurement, testing, comminution, mineral separation and process control technologies that have transformed mineral assemblages into ore.

This presentation presents some of the major mineral processing innovations and the impact they have had on our industry. As we look to the future, it is critical that we innovate and change. We will explore some examples of the next developments and how they can be catalyzed in the face of risk management, lower metal price cycles, resource constraints, inertia and the challenge of short term value delivery.

NOTES:

COMMINUTION

09:30 - PAPER 2
Fine Grinding, A Refresher
Alex Doll, SAGmilling.com

Many power-based grinding models exist, and most operators are familiar with Fred Bond's "third theory". Bond's model is most commonly used to describe primary and secondary grinding to product sizes above, for example, 100 µm. Operators sometimes use Bond's equation to describe grinding in situations where it is not appropriate, such as fine grinding below 50 µm. Using an alternative model would be a better choice in this situation.

Bond's equation is one in a large family of models. Related equations better suited to fine grinding include the “signature plot”, Von Rittinger's model and Charles' equation. These models have a similar form to Bond's and can be fit to industrial regrind mills and laboratory tests using the simple regression tools in the charts of computer spreadsheets. Operators will find that fine grinding calculations are both easier and more accurate when using the alternative equations to fit their regrind milling surveys or when performing laboratory regrind mill scale-up for plant design.

None of these models are new: Charles' equation was published in 1957 and Von Rittinger's model was proposed in 1867. A quick refresh how to apply these equations can turn these oddities from the undergraduate curriculum into useful tools for plant optimization. They can be fit to any type of mill including stirred and tumbling ball mills.

NOTES:

09:55 – PAPER 3

Two-Mass Vibrating Screens for High Tonnage Applications

Edward Wipf - EdRockMan IV LLC, Steve Massman - General Kinematics, Gary Beerkircher - PE, LLC

As mine size and tonnage continues to increase, material handling/processing equipment has also increased in size with 400 MT haul trucks, 2000 KW crushers, 12 M SAG/AG mills, 8.5 M ball mills, 3000 M3 flotation cells and 12.5 MW HPGR's all with planned designs to increase in size further. Related equipment including vibrating screens have also increased in size with screens seeing feed rates of 3000 MTPH. Open circuit SAG Pre-Crush and closed circuit HPGR flowsheets are becoming more common with large screening requirements. Large multi-slope (banana) or horizontal screens are commonly used for these applications, however as the size of these screens has increased, the number and size of the brute force/overhead exciters has increased but with limitations. An example is a SAG discharge screen that will see surges of material from the SAG mill which overload the screen, reducing the screen stroke or throw causing a large reduction in screen efficiency with excessive fines & moisture in the screen oversize feed to the pebble crushing circuit. This paper will present some actual examples of the use of Two-Mass screens as a solution to these overloading problems and the advantages of Two-Mass screens in other high tonnage applications.

NOTES:

10:20 BREAK – PROVINCES BALLROOM

10:50 – Paper 4

Breaking Down Energy Consumption in Industrial Grinding Mills

Jocelyn Bouchard - Université Laval, Gilles LeBlanc, Michelle Levesque, CanmetMINING, Peter Radziszewski – Metso Minerals, and David Georges-Filteau-Université Laval

Grinding mills are infamous for their extremely low energy efficiency. It is generally accepted that the energy required to produce new mineral surfaces is less than 1% of the electricity consumed to operate ball mills. The remaining 99% is assumed to be dissipated as noise, vibration, and heat, but there is no clear picture on how much is lost in the air or serves to heat the slurry. This paper reports the results of an investigation targeting two objectives: (1) characterising energy outputs in industrial grinding mill circuits, and (2) identifying the potential for recovering energy from grinding circuits. Agnico-Eagle Goldex Division, Mine Canadian Malartic, and New Gold New Afton Mine participated in the study by providing operating data for 3 semi-autogenous grinding (SAG) mills and 4 ball mills. Results show on average that 79% of the supplied electrical energy converts to heat absorbed by the slurry, 8% is lost through the drive system, and about 2% of the energy is transmitted to ambient air. The analysis reveals that 91 % of the input energy, currently wasted as heat, could potentially be recovered using suitable technologies or integrated energy management systems, but this topic remains to be further investigated.

NOTES:

11:15 – PAPER 5

Rubber Liners in the Service of Large Diameter Ball Mill at Hudbay, Constancia Mine, Peru

Raj Rajamani - University of Utah, Jose A. Delgadillo - Universidad Autónoma de San Luis Potosí, Pramod Kumar, Matt Hurley - Polycorp Limited, Hugo Granados, Manuel Sanchez, Marcial Medina - Hudbay Minerals, Constancia Mine

Large-diameter ball mills have traditionally used steel liners—steel being a highly durable material that can be shaped into any desired geometry, among which the double-wave has been the preferred design. Such a design produces a purely cascading charge motion, which is ideal for the shearing action needed to produce a finer product. Today, however, rubber liners, which have been in existence for over forty years, are now preferred over traditional steel, largely because they weigh less and are easier to maintain. In this paper, we show the operating data from the Hudbay Minerals' Constancia Mine, wherein the liners on a 26-by-40-foot mill were changed from conventional steel liners to PolyStl™ liners. It is then shown that this change reduced the amount of energy consumed whilst being able to maintain previous grind and throughput levels. The design is verified via discrete element simulations.

NOTES:

11:40 – PAPER 6

Honeywell Multivariable Predictive Control Implementation in the Goldex Grinding Circuit

K. Frenette - Agnico Eagle Mines Limited, R.K. Jonas - Honeywell, S. Simard - Agnico Eagle Mines Limited, F. Robichaud - Agnico Eagle Mines Limited, and M.R. Dion - Honeywell

In 2011, a site study indicated that the application of Honeywell's Multivariable Predictive Control Technology (MPC) to the Goldex processing facility would provide significant opportunities for improvement. Grinding MPC was implemented in the SAG Mill in June 2015. This pilot application, called Phase 1, featured one of the first Multivariable Predictive Controllers to be installed in a Canadian mineral processing plant. Since the implementation of MPC, gold recovery from the gravity circuit has increased. MPC contributed to a decrease in flotation feed particle size (120 to 112 µm) and an increase in the SAG feed tonnage (8.5% increase). MPC also increased and stabilized the % solids of the SAG feed, which can have an impact on cost reduction (mechanical maintenance). Additionally, MPC increased productivity, providing grinding operators with more time to perform other tasks. Further anticipated benefits include the standardization of the grinding circuit operation from one team to the next, thereby minimizing circuit disturbances resulting from different operating philosophies. This paper will discuss the advanced control project development and justification, the technology and rapid implementation process, the performance results and the benefits obtained.

NOTES:

12:05 – NETWORKING LUNCH – GOVERNOR GENERAL BALLROOM

TUESDAY, JANUARY 17h
Afternoon Session

PROJECTS

13:35 - PAPER 7

Grinding Circuit Final Grind Control at Agnico Eagle Meadowbank Mine

Pathies Nawej Muteb, Karl Leetmaa - Agnico Eagle Mines Limited, Irma Gabric, Keith Darby, Tom Strombotne – Thermo Fisher Scientific

Continuous control of the final grinding product size is important to optimize gold liberation for Gold Milling operations. At Meadowbank Mine an on-line Particle Size Monitor has been employed successfully to achieve the targeted final grind which leads to optimizing the gold recovery at maximum grinding circuit throughput. The live monitoring of the final product particle size leads to a maximum grinding circuit throughput every minute during the process. This paper discusses the optimal utilization of the Particle Size Monitor to assist the Mill operator to maximize the grinding circuit throughput as the milling conditions change due to variable ore processed at Meadowbank Mine. Also the paper includes the usage of the Particle Size Monitor to guarantee the final grind target at each instant of the process.

NOTES:

14:00 - PAPER 8

Comminution Circuit Design Considerations

G. Lane, B. Foggiatto, R. Braun, M. P. Bueno, P. Staples and S. Rivard - Ausenco

This paper demonstrates the selection of grinding circuit technology for a number of recent projects including discussion of the key drivers and the role of energy efficiency. Decreasing head grades combined with a strong and sustained increase in operating costs has forced miners to examine increased project size, increased equipment capacity and efficiency improvements in order to reduce their unit operating costs and improve overall project economics. Comminution energy consumption, safety and capital cost considerations play a critical role in the success of projects. This paper presents some key guidelines for a successful and cost effective comminution circuit design and includes a case study on three projects, outlining the issues and the drivers which led to the ultimate circuit selection and the critical role that energy efficiency played.

NOTES:

14:25 - PAPER 9

Use of Functional Performance Models to Increase Plant Grinding Efficiency

R.E. McIvor, K.M. Bartholomew and O.M. Arafat – Metcom Technologies, J.A. Finch – McGill University

The Functional Performance Equation calculated from a plant grinding survey defines two distinct ball mill circuit efficiencies and how they relate to total production rate through the target grind size. The survey data are also used to calculate a complete ball mill size distribution model, represented by the energy specific grinding rates, not just through the target grind size, but through all the size classes. Cyclone separation performance is represented by individual size recoveries to underflow. When these two unit operation performances are entered into the circuit modelling program (Streamline™), along with the circuit feed rate and size distribution, all the circuit survey size distributions and mass flows are perfectly regenerated by the program. The many issues associated with the historical Epstein (breakage-selection) models are eliminated. Once the circuit program is populated, pump and cyclone performance changes can be evaluated using a step-by-step procedure in order to maximize Classification System Efficiency. Mill water use and media sizing opportunities are also diagnosed in order to maximize Mill Grinding Efficiency at the size of interest. An example is provided. This circuit analysis and modelling system, and related training, is provided through a web-based application.

NOTES:

14:50 BREAK – PROVINCES BALLROOM

15:20 - PAPER 10

Technical Review and Evaluation of Ore Sorting Technology Incorporating Results from Four Properties

B. Hilscher, P. Nayak and N. Yoon-Sacré-Davey Engineering

The mining industry is currently facing challenges with declining feed grades and is struggling to find solutions to improve the project's economic value. By means of pre-concentration, ore sorting aims to separate the barren material from the valuable ore to reduce energy consumption and tailings generation, while increasing the feed grade, concentrate grade, mill recovery, and revenue. In addition, ore sorting allows the modification of deposit geometallurgy in order to allow the creation of an optimal mill feed.

This paper evaluates the applicability and challenges of ore sorting by utilizing the results from four different mines, and reviews them in detail. The mines include two underground and two open pit mines that are base metal and precious metal operations. In order to understand the applicability of ore sorting in these operations, initial rock-by-rock test results and different types of assays (atomic adsorption [AA], inductively coupled plasma [ICP], and fire assay) are utilized. Using the assay results, the grade recovery curves for ore sorting are generated and they are further improved by using and developing an ore sorting algorithm, which is discussed in this paper. The application and evaluation of ore sorting in greenfield and brownfield properties will also be discussed.

The state of the art ore sorting technologies for both rock-by-rock and bulk sorting are reviewed in this paper. The future technologies on the horizon, including different combinations of sensors, are explained. The sorting technologies include, X-ray transmission (XRT), X-ray fluorescence (XRF), colour, infrared, electromagnetic, and laser induced breakdown spectroscopy (LIBS).

NOTES:

15:45 - PAPER 11

SPIRAL SURFACE PROPERTY INVESTIGATION

F. Bornman, W Erasmus, X. Louw - Multotec Process Equipment

This paper examines the change in surface properties of the Polyurea used on spirals at different operational times: unused spiral, 28 months in operation and 58 months in operation. This is being done to investigate the alleged statement that spirals have a decrease in spiral separation efficiency after a certain period of operational time. Observing the surface characteristics under 1.5x and 36x magnification it can be concluded that the surface roughness decreases with increased operational time. This may be explained by a decrease in air inclusions and streak lines as the spiral surface wears. Decreased surface roughness should in theory have a beneficial effect on spiral separation performance. This leads to the conclusion that if a decrease in spiral separation performance is observed after a certain period of operation, it can't be attributed to the change in surface properties. Uneven wear of the spiral surface, material creep or application of force to the spiral will change the profile of the spiral and could cause an adverse effect on spiral separation performance. The metallurgical test work showed that the best results are obtained at 30 - 35% solids by mass in the spiral feed. The iron recovery was significantly higher in the new spiral in comparison to the 2012 and 2010 spirals. The mass yield to concentrate in the new spiral was approximately three times more than for the older spirals. In conclusion, the yield combined with the grade, which equals the recovery was the best for the new spiral.

NOTES:

16:10 – PAPER 12

Flash Flotation Circuit Design Considerations

J.L. Heath, B Murphy - Outotec

The first SkimAir flash flotation cell was installed in Outokumpu's Hammaslahti Copper Concentrator in 1982 to prevent overgrinding of soft sulphides in the milling circuit. Since this first installation the popularity of the flash flotation has fluctuated depending on metal market conditions and regional preferences. Units have been installed in many commodities including copper, lead, gold, PGMs, silver and nickel. Though it has been successfully employed in many operations around the world, flash flotation technology is still not well understood by many in the mining industry. This paper will discuss aspects of flash flotation flowsheet development along with some of the metallurgical and engineering considerations required to successfully incorporate flash flotation into new or existing milling circuits. This paper will also try and debunk some of the myths that exist around flash flotation cells and their operation. Case studies of flash flotation implementation will be discussed.

NOTES:

WEDNESDAY, JANUARY 18th
Morning Session

07:30 - CONTINENTAL BREAKFAST – PROVINCES BALLROOM

OPERATIONS

08:30 – PAPER 13

Design, Construction and Commissioning of Gold Tailings Plant at Mazowe Mine, Zimbabwe

Alain M. Bantshi, Peter Makuvise - Baldmin

The Mazowe Gold Mine is managed by Metallon Gold (Zimbabwe) and is situated in the west-central part of the Harare greenstone belt. Orebodies here generally comprise shear zones which are in-filled with gold-bearing sulphides and quartz. The mineralised zones are up to 1 m in width, have average grades of 4 to 5 g/t, and mostly dip between 10º and 60º to the north.

Mazowe Mine is one of the oldest mines in Zimbabwe, and exploration and development in this region dates back to 1890, with over 1.4 million ounces of gold produced to date. Mazowe mine comprises two underground operations, Mazowe and the BSV sections. Ore is processed in a single plant which consists of conventional crushing and milling and carbon-in-leach facility.

Baldmin Projects was awarded the contract for the design, construction and commissioning of the 60,000 tonnes per month plant at Mazowe mine in 2014 for the processing of sand and slimes tailings from previous operations at Mazowe mine. The average grade of the tailings is 1.1 g/t. The plant consists of feed preparation, grinding, flotation, thickening of flotation concentrate, and carbon in leach (CIL). A pump station for hydraulic mining of the slimes tailings dam also part of the plant.

Key features of the Mazowe sands Plant are described and include:

- Hydraulic mining of gold tailings dump.
- Feed preparation section that includes a (W x L) 2.4 m wide x 4.8 m trash screen, 250 m^3 surge tank, a cluster cyclones with 2 x 500 mm diam. Cyclone.
- Comminution circuit designed for a bond work index range of 10-12 kwh/tonne. Comminution circuit is constituted with 3 ball mills, 1.83 m diam. X 6.71 m Long, 280 kW.
- Flotation circuit comprising rougher bank, scavenger bank and cleaner bank.
  Rougher Scavenger bank is constituted of 6 x 6m^3 flotation cells and 3 x 30 m^3 flotation cells and the cleaner is constituted of 3 x 6 m3 flotation cells.
- Concentrate thickening with 6 m diam. thickener.
- Concentrate CIL (carbon in leaching): CIL circuit is comprised of 7 tanks with 2 leach tanks and 5 Carbon in leach.

The commissioning plan is presented and the results and lessons from the first six months of operation are discussed.

8:55 – PAPER 14

An Update on Reaching Nameplate Throughput and Continuous Improvement at Mount Milligan

J. Yue, Mount Milligan Operation

Mount Milligan mine is located in northern British Columbia. The concentrator employs conventional SABC grinding circuit with bulk sulphide flotation processes. Commissioning started in September of 2013 and nameplate production of 60,000 TPD was reached in the fourth quarter of 2015. As is typical with many mill ramp ups, bottlenecks developed as throughput increased. Since then, plant modifications and new control philosophies in the comminution and flotation circuits have been implemented and evaluated. The mine-to-mill collaboration played a key role in reaching target throughput rates by improving blast fragmentation and implementing temporary pre-crushing. Results of the projects as well as ongoing challenges/bottlenecks and solutions will be discussed.

NOTES:

9:20 - PAPER 15

Processing Plant Expansion at Kittila Mine Affords Opportunity for Significant Material Handling Improvement

T. Holmes - Jenike & Johanson Ltd., J. Middlemiss - Agnico Eagle Mines Limited

Agnico-Eagle (AE) has been operating their Kittila Mine in Northern Finland since 2008. The mine has experienced considerable ore flow problems with ratholing, bridging and freezing in their mill feed bin since start up. In the first winter of operation, the entire central portion of the contents of the cylindrical flat-bottomed 2000 tonne mill feed bin froze. Flow was erratic and could only be achieved through small diameter ratholes. To maintain a reasonable, albeit limited, feed to the mill, the bin had to be kept less than ½ full and a portable steam generator was brought in to melt the frozen agglomerates that frequently blocked the outlets. The combination of limited surge capacity and frequent outages required the crushing plant to operate 24/7 and resulted in inconsistent production levels and high operating costs.

AE had planned to expand the processing plant to increase throughput by about 30% when they transitioned from open pit to underground ore. These plans presented an opportunity to improve the material handling.

To avoid the problems experienced with the original mill feed bin, AE enlisted Jenike & Johanson Ltd. (J&J) to test samples of the ore, and based on the measured flow properties to provide design recommendations to ensure that the new mill feed bin would operate reliably. The new 2000 tonne expanded flow mill feed bin and apron feeder were installed in 2014 and are now supplying almost 93% of the total mill feed with the remaining coming from the original bin.

NOTES:

09:45 BREAK – PROVINCES BALLROOM

10:15 - PAPER 16

Goldcorp's Peñasquito Pyrite Leach Project

S.Hille - Goldcorp

Peñasquito is Mexico's largest gold producer, consisting of two open pits - Peñasco and Chile Colorado - containing gold, silver, lead and zinc. Over the next three years, mining activities in the pit are expected to be focused on lower grade ore in the upper parts of the Peñasco pit while stripping is emphasized to ensure an economically optimal pit shell design to maximize the net asset value of the operation. By 2019, Peñasquito's gold production is expected to benefit from an improvement in mined grades as it recommences mining higher grades at the bottom of the Peñasco pit and significantly enhanced metallurgical recoveries with the planned completion of the Pyrite Leach Project ("PLP").

NOTES:

10:40 – PAPER 17

The Effect of Choke Feeding a Gyratory Crusher on Throughput and Product Size

J.-F. Dupont, Jacques McMullen - Detour Gold Corporation, Dave Rose - FLSmidth

The Detour Lake mine is located 200 km northeast of Timmins, Ontario, Canada.

The mill processes a free milling gold ore using both a gravity circuit and leaching with a state-of-the-art carbon-in-pulp circuit. The grinding circuit is a conventional SABC circuit with a tonnage of 55,000 tpd at 95 microns with the addition of pre-crushing upstream of the SAG mill.

The Detour Lake mine has one of the largest gyratory crusher in the world (60" x 113") and over the years, many improvements have been made to this crusher with the result of improving plant throughput. This paper will present how choke feeding the gyratory crusher has been found to be one of the main influences on crusher product particle size and plant throughput. It will explain how the effect of choke feeding the gyratory was measured and from that, the various changes made to improve choke feeding of the gyratory crusher.

NOTES:

11:05 – PAPER 18

Investigating the Potential of HydroFloatTM Coarse Particle Flotation Techniques On Copper Sulphide Ores

P.J. Mehrfert - ALS Metallurgy

Recovery of mineralized coarse particles is notoriously low in conventional concentrators that treat copper porphyry ores. The application of coarse particle flotation techniques has the potential to achieve comparable metallurgical performance at significantly coarser primary grind sizings. ALS Metallurgy has been conducting both internal research and commercial test programs to investigate the potential of Eriez HydroFloatTM technology on copper sulphide ores. Test data indicates that significant improvements in the recovery of copper sulphide bearing particles between 200µm to 850µm can be achieved using Hydrofloat technology compared to conventional flotation techniques. This paper summarizes the results from a selection of test programs that includes recovery by size data from both conventional flotation and HydroFloatTM tests. An explanation of the apparatus and test procedure will be given. Mineralogical analyses of the test products and characteristics that limit metallurgical performance will be discussed.

NOTES:

11:30 – LUNCH – GOVERNOR GENERAL BALLROOM

WEDNESDAY, JANUARY 18th
Afternoon Session

FLOTATION

13:00 – PAPER 19

Improving Concentrate Grade through Smart Design and Piloting

V. Lawson, G. Anderson - Glencore Technology, T. Strong - Panoramic Resources Limited

Selectively recovering pentlandite from high levels of pyrrhotite presents a technical and operational challenge. The liberation characteristics and also the chemical environment are critical to performing a successful separation. Reviewing the mineralogy to understand the characteristics of the ore and the plant flotation behavior is fundamental to designing a successful improvement program.

At Savannah Nickel the challenges presented by a falling nickel price required a rethink of the flowsheet to improve the project economics through improving the concentrate grade and recoveries. Glencore Technology reviewed the plant performance and proposed and tested solutions to improve the grade performance of the concentrator with the support of the plant team. A pilot plant comprising a M20 IsamillTM followed by an L500/1 Jameson Cell was operated on various plant streams. In addition to the pilot plant, flotation surveys and a plant based laboratory program was used to supplement the plant understanding and within two weeks significant improvements were identified and demonstrated. The combination of the pilot operation and the plant based laboratory program was able to quickly demonstrate the improvements and test with equipment that is fully scaleable from pilot plant to full scale.

NOTES:

13:25 – PAPER 20

Online Elemental Analysis of Slurry Using Laser-Induced Breakdown Spectroscopy

Lauri Koresaar, Juha Timperi, Tano Balbin, and Valery Astakhov - Outotec

Online elemental analysis is the basis of optimal flotation control in mineral concentrator plants. Traditionally XRF analyzers have been used as the online analysis method. However, online XRF analyzers struggle to measure elements below calcium in atomic number (Z=20). For many processes lighter element assays would be beneficial to improve control of grade and recovery. Processes where elements below Ca are required include P, Mg and Si in phosphate concentrators, Si, Mg and Al in iron concentrators, and S and C in gold concentrators. Laser-Induced Breakdown Spectroscopy (LIBS) based elemental analysis can readily be applied to these processes. LIBS is based on generating plasma in the slurry sample by a high energy laser and analysis of the plasma by optical emission spectroscopy. Capabilities of a new Courier® 8 analyzer based in LIBS technology are demonstrated for elemental analysis starting from lithium (Z=3). Results of a plant installation in a sulfide gold concentrator provide a good agreement with the analyzer and laboratory assays.

NOTES:

13:50 – PAPER 21

The Removal of Iron-Bearing Silicate Minerals from a Hard Rock Lithium Ore

C. Gibson, M. Aghamirian, and T. Gammatikopoulos
SGS Canada Inc.

Lithium is an alkali metal found in brine deposits in the United States, Chile and Argentina, as well as in hard rock deposits in Australia and North America. In hard rock deposits, spodumene ($LiAl(Si_2O_6)$) is the major economic lithium bearing mineral. Spodumene is typically upgraded through a combination of dense media separation, flotation and magnetic separation. One of the major spodumene concentrate quality specifications is the iron oxide content because it will help determine if the concentrate is considered ceramic grade for use in ceramics and glass or chemical grade for use in lithium ion batteries. The rejection of iron bearing silicate minerals from artificial ore composites (high amphibole and low amphibole, high quartz/feldspar) from a hard-rock spodumene deposit was investigated using magnetic separation and flotation. The efficacy of Wet High Intensity Magnetic Separation (WHIMS) in iron rejection was found to be dependent on the mineralogy of the iron-bearing silicate minerals including modal distribution, liberation and association. When magnetic separation was conducted prior to flotation, the Fe_2O_3 grade in the final flotation spodumene concentrate was reduced from ~3% to ~1% Fe_2O_3, and improved lithium recovery in flotation was observed. It was determined that it was most effective to conduct WHIMS on the flotation feed after scrubbing and de-sliming because this reduced the required magnetic field to recover iron-bearing minerals, likely because slime coating was greatly reduced. Flotation collector screening of four different collectors with varying rosin acid content demonstrated a potential increase in selective flotation of spodumene over some iron silicate minerals with decreasing rosin acid content in the fatty acid collector. However, due to marginal difference in flotation results with the various collectors tested, further testing is required to confirm the observations made and establish a hypothesis regarding the effect of rosin acid content.

NOTES:

14:15 BREAK – PROVINCES BALLROOM

FLOTATION

14:45 – PAPER 22

Improvement of Valuable Mineral Transport And Gangue Drainage in Froth Flotation

B. Levasseur, N. Ouellet, A. Lockhart - COREM, G. Couture, D. Nathan – Mine Raglan and G. Bartolacci - COREM

Pulp and froth zone characterization in a flotation circuit to improve transport of valuable minerals remains a challenge. Even though some significant breakthroughs have been made in the development of collectors in terms of selectivity, the control of gangue drainage is still the main bottleneck to achieve the production of a clean concentrate.

Over the last decade, COREM's team has been working on technologies to improve the selectivity of flotation circuits by tuning their hydrodynamic conditions using online instruments such as the bubble viewer, Jg sensor and gas hold-up. As part of its research program, COREM also developed the half-life column that establishes the relationship between the collection zone (bubble-particle attachment) and the cleaning zone (foam) of a flotation machine. In recent years, COREM has continued the development of the prototypes to make them more robust and improve the accuracy of their measurements.

Recently, these hydrodynamic instruments were installed in an industrial process at Raglan Mine in order to diagnose and control the impact of hydrodynamic parameters versus the recovery and the quality of the Ni concentrate produced. Sampling campaigns of hydrodynamic parameters demonstrated that froth height could be optimized in order to increase recovery and quality of the concentrate at the same time. The specific effect of the froth height impacts both the pulp and the froth zones. Along with the impact on the drainage of the concentrate, it was observed that froth height also contributes to enhance the collection of particles in the pulp leading to an increase in metallic units.

NOTES:

15:10 – PAPER 23

Linking Flotation Efficiency to Bubble Size

Jose R. Hernandez-Aguilar - First Majestic Silver Corp.

This paper revisits data from previous studies (Hernandez-Aguilar, 2010, 2011) to better understand the link between metallurgical performance and pulp-zone bubble size (Db) in full-scale flotation systems. To obtain conclusive evidence exclusively related to the pulp (collection) zone, the experiments were designed in those studies to control both the bubble generation method and the influence of the froth zone on the overall metallurgical performance in industrial and pilot-scale flotation columns. The results showed that Db had a significantly larger effect on the recovery of coarse (> 75 µm) particles compared to the effect on fine (< 16 µm) particles. It was observed that, under certain practical conditions, the recovery of coarse particles was close to zero, but dramatically increased by reducing Db. The evidence revealed an inconsistency of the so-called "k–PSb" model: at constant froth recovery, increasing Sb (i.e., the rate of production of bubble surface area) did not always result in higher recovery, as the model predicts. Furthermore, the evidence showed that it was not the Sb but the bubble size that proved to be a more reliable link to metallurgical performance. Only in the presence of suboptimal-sized bubbles (Db > 2 mm) did the froth zone seem to play a role, possibly reflecting an effect of pulp-zone bubble size on froth stability. However, the role of the froth was negligible for Db < 1 mm.

High-resolution mineralogical measurements performed on process samples revealed that, regardless of the degree of liberation, Db had a profound effect on the shape of the recovery-by-size curve, particularly the coarse particle size fraction. This observation is key as it implies that the loss in efficiency associated with floating the coarse particles was not the result of neither particle hydrophobicity nor particle detachment issues: even in the absence of mechanical agitation, liberated and highly hydrophobic coarse particles did not seem to attach to the bubbles in the first place, an inefficiency that was corrected by reducing bubble size. The data analysis suggests that poor attachment efficiency can practically affect both fine and coarse particles but via different mechanisms which are discussed here.

NOTES:

15:35 – PAPER 24

Rejection of Uranium from a Copper Gold Ore by Flotation

M. Xu, J. Dong, F. Ford - Vale Base Metals Technical Excellence Center

Laboratory and miniplant testwork was carried out to reject uranium from an Iron Oxide Copper Gold (IOCG) deposit that contains an average of 60-70 ppm uranium with high variability. The dominate copper bearing mineral is chalcopyrite with minor bornite and trace covellite. The main gangue minerals are iron-rich chlorite, quartz and magnetite. The main uranium-containing mineral is uraninite (UO_2). Downstream processes require the maximum uranium level of no more than 80 ppm in final copper concentrate.

Mineralogical examination reveals that uraninite particles are finely disseminated with grain size of less than a few microns in the deposit requiring fine regrind in order to liberate uraninite from chalcopyrite particles. A lab flowsheet was developed to include ultrafine regrind of the rougher concentrate to the particle size of 80% passing 11-13 µm with up to four stages of recleaning in flotation columns. Finer regrind to 80% passing 5-6 µm may continue to improve liberation but does not decrease uranium level in the final concentrate. In each of the successive recleaning stages by flotation column after fine regrind, uraninite is rejected into the column tailings, with the final copper gold concentrate containing less than 70 ppm uranium from a feed containing 83 ppm uranium. The conceptual flowsheet was further tested in an integrated, continuous miniplant showing average 94% copper recovery with average 74 ppm uranium. The uraninite particles that report to the final concentrate are either locked with chalcopyrite or entrained as liberated particles of less than 5 µm in size.

NOTES:

16:00 – PAPER 25

Economic Recovery and Upgrade of Metals from Middling and Tailing Streams

P. Voigt, M. Hourn, V. Lawson, G. Anderson, D. Mallah - Glencore

As mine head grades decline and orebodies become more complex, traditional mineral processing techniques and flowsheets to achieve saleable concentrate become more difficult to design and construct. Mines with lower quality concentrates or concentrates with penalty elements are particular under threat. The economics of these operations are far more susceptible to metal price, concentrate treatment terms and the availability of other, cleaner concentrates. Additional value may be realised for these orebodies through improved recovery by producing a low grade middling concentrate for further processing, in conjunction with a saleable concentrate.

The most cost effective way to reduce impurity levels is to do so as early as possible in the mining value chain. Technologies such as fine grinding and fine particle flotation are well established as effective methods for impurity rejection in mineral processing. What is normally overlooked is how a hydrometallurgical process could also be integrated in the overall flowsheet to achieve higher overall recovery at the mill. In the base metals environment, this is mainly because hydrometallurgical processes are associated with production of metal or use of expensive and toxic precipitating agents once the minerals of interest are solubilised. These processes can be very expensive, particularly with rising power costs and poor economies of scale in capital costs associated with low production rates from middling streams.

Glencore Technology (GT) has recent experience in the treatment of middling and low grade concentrate streams as well as tailings streams to compliment a concentrator flowsheet in a refractory gold and base metals setting. The value proposition is the isolation of a low grade middlings concentrate from the primary circuit or the tailings stream for upgrading to an intermediate product with an equal or higher grade than the primary concentrate to allow blending for sale. This allows plants to operate on a more favourable part grade-recovery curve while avoiding the expense of metal production. For existing operations this is particularly attractive since it can be added on with no process interruptions.

Two case studies are examined showing flowsheets and costings to arrive at the value proposition of the GT low grade treatment flowsheet.

6:30 BANQUET RECEPTION, BALLROOM FOYER

7:30 BANQUET CONFEDERATION BALLROOM

THURSDAY, JANUARY 19th
Morning Session

07:30 - CONTINENTAL BREAKFAST – PROVINCES BALLROOM

GOLD

8:30 - PAPER 26

Anaconda Mining Inc.'s Point Rousse Project Cyanide Destruction System Development Study

Allan Cramm, Chris Budgell - Anaconda Mining Inc., and Leo Cheung and Neri Roux - Research & Productivity Council

Anaconda Mining Inc. is investigating potential improvements and expansions to their operating plant located on the Baie Verte Peninsula in Newfoundland. An extensive batch and continuous bench scale testing program was launched to investigate the efficiency of cyanide destruction under different conditions in order to improve tailings handling. The primary objective of the cyanide destruction study was to apply new technologies to develop a novel cyanide destruction system.

Effluent and slurry from Anaconda Mining Inc.'s Point Rousse Project was received at RPC where test work was conducted. Various sodium metabisulfite (MBS) dosages were evaluated and the use of utilizing ozone and ultra violet (UV) light to oxidize cyanide was investigated. All the data was evaluated and mass balances were compiled to develop several flowsheets. Overall encouraging results were found using a combination of ozone and MBS.

NOTES:

08:55 – PAPER 27

Demonstration Campaign Results on a Cyanide-Free Process for Gold Extraction from a Refractory Pyrite Concentrate

D. Lemieux, A. Drouin, J.-M. Lalancette and C. Chouinard - Dundee Sustainable Technologies Inc.

A gold bearing pyrite concentrate was treated at the demonstration scale (15 t/d) for the extraction of gold using a cyanide-free process. The pyrite was depressed in the flotation circuit in order to promote the flotation of copper and to achieve a sufficient copper grade to meet the copper smelter criteria. However, the recoveries of copper were 80% and only about 50% for the gold was found in the copper concentrate. The balance of the gold (50%) and copper (20%) contained in the pyrite concentrate as a reject from an overall flotation circuit. The gold grade in the pyrite concentrate is 5.40 g Au/t and copper about 0.77%. About 170 tons of pyrite concentrate were processed in the DST demonstration plant. The concentrate was first oxidized using a fluid bed to produce a calcine. Copper was then extracted as copper sulphate using diluted sulphuric acid. The residual solid was submitted to the DST chlorination process for gold extraction. Thereafter, the gold was recovered from the pregnant brine by precipitation over silica using DST proprietary process. The maximum gold recovery by chlorination was 90%. The average gold recovery by cyanidation of these calcines was 71%.

NOTES:

09:20 – PAPER 28

Red Lake Gold Mine Autoclave Optimization Project

K.K. Murray - Goldcorp Technical Services and D.G. - Goldcorp Red Lake Gold Mines

The pressure oxidation autoclave at the Goldcorp's Red Lake Gold Mines (RLGM) was commissioned in 1991. Since commissioning, the circuit has been well maintained and its capacity increased to mechanical and gaseous oxygen limitations. With advances in available technology, opportunities to produce more sulphide concentrate and a changing business environment, an optimization project has been initiated at RLGM. A multi-phase approach has been developed to optimize both the operations and economics of the circuit. This paper describes the history and future of the autoclave circuit at RLGM.

NOTES:

09:45 BREAK – PROVINCES BALLROOM

10:15 – PAPER 29

A New Method for the Stabilization of Arsenic from Enargite Concentrates

G. Garcia Curiel, R. Barbaroux, K. Nasrallah, J.-M. Lalancette, D. Lemieux, B. Dubreuil - Dundee Sustainable Technologies

As conventional, base or precious metal ores are being depleted worldwide, the mining industry is being faced with an increasing exploitation of arsenical sulfidic ores. Enargite is a common example. The downstream processing of these ores poses several problems ranging from high smelter penalties to finding economical and environmentally acceptable means of disposing of the arsenic. Several hydrometallurgical processes have been proposed for extracting arsenic from enargite concentrates, notably using alkaline sulphide leaching (ASL). However, few alternatives exist for removing the arsenic from solution and stabilizing it in an approach that is both economical and environmentally acceptable.

Dundee Sustainable Technologies ("DST") has developed a technology for the sequestration of arsenic by vitrification. Originally optimized to cost-effectively stabilize arsenic trioxide (As_2O_3), DST has shown that vitrification could be successfully extended to the stabilization of other arsenical products, such as calcium arsenate ($Ca_3(AsO_4)_2$) and sodium arsenate (Na_3AsO_4). In this paper, the vitrification of arsenic in the context of an enargite leaching was newly explored and demonstrated successfully.

Two processing routes are being proposed by DST for the removal of arsenic from enargite concentrates and their stabilization by vitrification. In one route, arsenic is extracted by ASL and is then precipitated under atmospheric conditions and with minimal use of reagents and time. The resulting precipitate is an unstable hydrated ferric arsenate ($FeAsO_4 \cdot 2H_2O$) that is then vitrified in a non-dilutive method, significantly increasing the stability of arsenic and meeting the TCLP guideline. Unlike is required for scorodite, stabilization was successfully achieved without concern for the crystallinity of the precipitate.

NOTES:

10:40 – PAPER 30

ECONOMIC EVALUATION OF ACTIVATED CARBON FOR GOLD MILLING CIRCUITS

Z. Yamak, M. Somppi - Goldcorp Inc. – Musselwhite Mine and M. Drozd - Scotia International of Nevada

Granular activated carbon is widely used in the gold mining industry for gold extraction from aurocyanide-containing slurry. The extraction process can employ carbon as part of the gold recovery operation for various circuit designs including carbon-in-pulp (CIP), carbon-in-column (CIC), and carbon-in-leach (CIL) circuits. However, various qualities of activated carbon exist and the durability of the material can change significantly from source to source. Handling this expensive reagent can pose challenges when fine carbon losses occur in the CIP, CIC, and CIL circuits. Additionally, any gold that is adsorbed to these carbon fines can also be lost by various mechanisms including carbon attrition and fracturing, inefficient coarse-fine separation, and poor carbon fines capture. With the above in mind, a series of tests were conducted to investigate standardizing simple laboratory methods for testing carbon quality. A standard procedure beyond or enhancing ASTM methods can serve as additional starting points for evaluating carbon specific to the gold industry. The investigation focused on size distribution, flatness, wet attrition resistance, surface area, gold kinetics, and gold loading. The final results provided information to generate an equation for ranking carbon samples to plant performance.

NOTES:

11:05 – PAPER 31

Selecting the Correct Cyanide Destruction Process for Your Operation

A. Nacu - Kemetco Research Inc. and R. Agius - R&C Environmental Consulting Company Inc.

Adoption of the International Cyanide Management Code, regulatory requirements and community concerns have increased the need to implement suitable cyanide destruction processes at gold operations to meet ever more stringent discharge limits. As standards set for the allowable concentrations of cyanide, cyanide compounds and other contaminants may vary from country to country, jurisdiction to jurisdiction, and even from site to site, there is no "one size fits all" technological solution. Currently the most common cyanide destruction processes used in industry are sulfur dioxide/oxygen, hydrogen peroxide and Caro's acid. Regardless of the process used, cyanide destruction plants must be reliable and achieve permit guidelines at all times. The selection of the most appropriate cyanide destruction process for an operation depends on several factors, including permit discharge requirements, tailings chemistry, location, site-specific climatic conditions and size of the operation. Only after considering all these factors together can the most effective approach be selected to achieve the permit guidelines economically and technically feasible. Finally performing the correct test work program is the most important step to ensure that the correct process design criteria can be determined to accurately calculate capital and operating costs.

NOTES:

11:30 – LUNCH BREAK

THURSDAY, JANUARY 19th
Afternoon Session

GOLD AND OTHER METALS

13:00 – PAPER 32

Selecting the Number of Increments for Daily Metallurgical Samples: Application to Goldcorp Eleonore Gold Ore Concentrator, Quebec, Canada

Claude Bazin - Laval University and Jalna Lamontagne - Goldcorp Eleonore Mines

The operators of mineral processing plants collect daily samples from strategic process streams with a view to prepare production balances to assess plant performances. The rules to minimize the risk of systematic sampling errors are known and applied in many mineral processing plants. The mass of the sample to be collected is calculated to yield a target measurement reproducibility considering the fundamental error associated to the sampling of heterogeneous material. This paper demonstrates that this practice is partly valid if one does not account for the time variation of the ore composition during the day. The concept is demonstrated using samples collected on a 30 minute basis from different streams of a gold ore concentrator. Results show that depending of the natural variability of the stream characteristics the mass of the daily samples may not be the critical variable to obtain reproducible measurements. On the other hand the number of cuts taken during the day could impact on the variance of the measurements obtained from daily samples.

NOTES:

13:25 – PAPER 33

Assessing the Total Cost of Representativity in Flotation Plants

L. Lachance - Algosys, and D. Brand - Heath & Sherwood (1964) Limited

The risk management objective of the AMIRA Code of Practice for Metal Accounting has seldom been systematically investigated in the literature up to the authors' knowledge. Risk is defined in the Australian Standard on Risk Management (AS/NZS 4360:2004), as "the chance of something happening that will have an impact on objectives". The simplified economic analysis performed in this paper has led to define "something happening" as measurement non-representativity and "impact on objectives" as NSR loss from the optimal NSR. This has pinpointed a missing link being the establishment of a relation between NSR in flotation plants and measurement representativity. The proposed framework, referred to as the total cost of representativity, answers the previously unanswered question of how much accuracy/reproducibility is fit for purpose in a given flotation plant. Authors readily acknowledge that it is way easier to assess the cost of accuracy/reproducibility than the cost of inaccuracy/irreproducibility. However, this exercise not only answers previously unanswered questions but also establishes an essential link with operational excellence. This paper exposes why such operational excellence could neither be attained nor proved without a state of the art metal accounting system. This should impact not only how metal accounting systems are audited/designed/refactored, but also how flotation plants are designed.

NOTES:

13:50 – PAPER 34

Evaluating the Applicability of Gold Pre-Concentration by Sensor Based Sorting of Quartz Ore

J. Rohleder, B Nielson, H. Lehto, A. Takala – Outotec Oyj and J. Schunicht – TOMRA Sorting GmBH

Pre-concentration in minerals processing presents clear advantages in energy efficiency, water efficiency, reduction of consumables and minimization of capital and operating costs. Outotec's sorting solutions are powered by Tomra Sorting in order to achieve pre-concentration of concentrator feed in a variety of mineral processing applications. Sensor based sorting combines advanced sensors with rapid computational evaluation and mechanical separation of valuable material from waste and/or gangue. Modern sensor based sorting machines typically use fine air jets to propel individual rocks, thus optimizing recovery and minimizing "mis-sorting".

Gold is generally present in such low concentrations that sensors suitable for ore sorting cannot directly detect it. Therefore, in order to sort gold ore, properties of associated host rock are used. Free and sulphidic gold is often hosted on the quartz-host rock contact zone. Laser scattering effect can be used to detect the surfaces of quartz and composite quartz-host rock particles for subsequent sorting with very high recovery of 95 to 99%. In addition, ore often preferentially fractures along the quartz-host rock contact zone in the crushing circuit. This behavior helps because it liberates more quartz for detection.

The feasibility of sorting is investigated for four gold projects in Northern Europe with similar mineralogy. This includes geometallurgical evaluation; amenability testing, small scale "mini-bulk" factory testing in full scale sensor based sorting. The results of the various tests are presented and basic feasibility demonstrated with information on flow sheet development. In addition, the amenability process is evaluated and recommendations made for future projects.

NOTES:

14:15 BREAK – PROVINCES BALLROOM

14:45 – PAPER 35

Enhanced Gravity Recovery of Base Metal and Industrial Minerals

I. Grewal - Met-Solve Laboratories Inc. and A. Neale - Sepro Mineral Systems Representative

Mineral separation by exploiting the differences in mineral or metal specific gravities (sg) has been used since antiquity. In the modern era, this is most commonly seen in the recovery of gold by the use of centrifugal concentrators and the separation of coal (low sg) from waste rock (high sg) using heavy media cyclones and jigs. Other metals, notably oxides of tin and tungsten, are successfully recovered using some combination of jigs, spirals and shaking tables. However, many conventional gravity separation systems are limited to fairly coarse (>1 mm) to medium (>100 micron) particle separations due to the limitations of the gravitational separation forces in conventional equipment.

Many of the high specific gravity minerals of interest are friable (e.g. cassiterite, wolframite, etc.) and excessive fines are generated in the grinding/comminution circuits which cannot be recovered with conventional equipment and may be lost directly to the tailings stream. Recent developments in centrifugal gravity separation equipment specifically designed for fine or ultra-fine particle separation and recovery have resulted in heavy mineral particle recoveries as fine as 10-20 microns. Ongoing research work has also identified the benefit of closed-circuit, multi-stage gravity recovery circuits using some combination of centrifugal concentrators and conventional equipment (tables, spirals, flotation, etc.) which can substantially increase overall plant recovery and final concentrate grade.

This paper will provide details of the evolution of non-fluidized bed gravity concentrators for high sg mineral recoveries, correlate laboratory scale development work with plant results to confirm scale-up, and show how recent flowsheet developments have contributed to significantly improved plant performance.

NOTES:

15:10 – PAPER 36

Update of Canadian Rare Earths Projects and Technological Trends

Maziar E. Sauber, Janice Zinck - CanmetMINING, Natural Resources Canada

Canadian companies have initiated the development of several new rare earth deposits to reduce the uncertainty in the global rare earths market by diversifying source of supply to help meet the future demand. In the past few years, various studies on rare earths plant design have taken place mainly covering process development, process selection, and flowsheet design. This paper provides an overview of known domestic and potential resources and reserves of rare earths and their status with a focus on the metallurgical processes using the information available in the public domain. A high-level overview of process designs currently under consideration is reviewed. An outline of the areas of opportunity for selective innovation and technology development in the rare earths flowsheet development and the associated risks and rewards is provided.

NOTES:

15:35 – PAPER 37

Design, Commissioning, and Operation of A Heavy Rare Earth Separation Pilot Plant

Jack Zhang, Baodong Zhao, Yunguo Tang - Saskatchewan Research Council

Rare earth elements (REEs) have numerous key applications in both traditional and advanced technologies. A shortage of some critical REEs is expected due to the discrepancy between the REE abundance in REE deposits and the REE demand from the market. For example, Neodymium, Europium, Terbium, Dysprosium, Erbium and Yttrium are expected to be in short supply. REE recovery and separation from secondary resources such as uranium wastes, heavy mineral sands, and recycled materials can balance the shortfall in a cost effective way.

The Saskatchewan Research Council (SRC) is engaged in the development and commercialization of complete REE recovery and separation technologies in Canada. One of SRC's newest developments is the design and commissioning of a heavy rare earth (HREE) separation pilot plant. The pilot plant uses hundreds of stages of solvent extraction (SX) to produce high purity individual HREEs from both primary and secondary resources.

This paper presents the design of an HREE recovery process for the particular case of uranium processing wastes. The separation results of a group separation are reported and discussed, as well as the issues and the challenges of the development, commissioning and operation of the continuous SX pilot plant.

NOTES:

16:00 CONFERENCE CONCLUDES

CALL FOR PAPERS

50th Annual Canadian Mineral Processors Operators Conference
Past, Present and Future: Celebrating 50 Years of Innovation

January 23 to 25, 2018
Westin Hotel, Ottawa, Canada

Please submit technical papers from the full spectrum of subjects in mineral processing for all commodities. To celebrate the **50th anniversary** of the Canadian Mineral Processors Conference we are specifically requesting papers that support the theme of the Past, Present and Future. We are specifically soliciting papers from new and operating plants describing plant design, start-ups and improvements, application of new technologies, ore characterization and process mineralogy in optimization and design, precious metals recovery, tailings handling and management. This format for this year will be slightly different with each day focussed on one of the past, present and future. We will be looking for papers that specifically celebrate successes of our past, achievements of today and innovations for the future.

Please do not hesitate to contact me for any additional information. Authors selected will be required to produce a written paper by Oct 6, 2017 and present a 20 minute technical presentation to the conference.

Please submit a ~200 word abstract for consideration before **June 15th, 2017** to:

Brian Danyliw, 1st Vice Chair CMP2018
briand@chemtreat.com
705-618-6729

Your notice of acceptance will be granted on or before August 1st, 2017.

AUTHORS AND SESSION CHAIRS

Authors and session chairs must register as conference delegates. A speaker's breakfast will be provided starting at 7:00 am on the day of their presentation/session in the in the **Quebec Room**. Authors, please contact John Chaulk john.chaulk@canada.ca for presentation information**.**

CMP PUBLICATIONS

Past proceedings, compilation proceedings on CD, and other mineral processing related books are available for purchase at the registration desk. In the near future, all CMP publications (past and present) will be available on OneMine (www.OneMine.org).

CMP 2017 SPONSORED STUDENTS* AND STUDENT AWARD WINNERS

School/Award	Student(s)
CEGEP de L'Abitibi-Temiscamingue	Lysianne Charron
	Elvin Javier Basto Guio
U of A	Mikkel Holt
	Ryley Elkjer
BCIT	Layne Kaufmann
	Reid Simpson
UBC	Veronica Knott
	Ian Hengemuhle
Cambrian	Jean-Claude Carriere
	Alyssa Huard
Dalhousie University	Mark Webb
	Mike Forsyth
Haileybury School of Mines, Northern College	Tim Sanford
	Olivier Renson
Lakehead University	Liam Kelly
	Janet Martin
Laurentian	Miranda Gauthier
	Kaella Earle
Laval	Sarah Lamontagne
	Léa Ebacher
McGill	Catherine Amyot
	Hillary Williams
Memorial University	Henley Munn
	Sonja Hanna-Quinn
Queens	Thomas Mills
	James Cruikshanks
University of Saskatchewan	Jessica Wilson
	Zenon Kripki
CEGEP Sept-Iles	Jimmy Morin
	Marika Arseneault
CEGEP deThetford	Pierre-Alexandre Ouellet
	Sébastien Lord
U. of Toronto	Sydney Page
	Zichen (Mark) Li
Yukon College	Elliott Merkley
Technical Report Winner	Eric Bernabé Nzokem Jeuatsa
Andre Laplante Scholarship Winner	David Georges-Filteau
Byron Knelson Scholarship Winner	Jonathan Ladyman

* Our gracious sponsors (see back cover) provide the funding necessary to send two students from each of the Canadian mineral processing colleges and universities to the annual Canadian Mineral Processors conference all expenses paid.

CMP 2016/17 – EXECUTIVE, REGIONAL and COMMITTEE REPRESENTATIVES

CMP EXECUTIVE

Chair	Scott Martin, Progressive Rubber Industries, scott@progressiverubber.com
1st Vice-Chair	Johnna Muinonen, Royal Nickel Corporation, jmuinonen@royalnickel.com
2nd Vice-Chair	Brian Danyliw, ChemTreat, briand@chemtreat.com
Past Chair	Paul Blatter, Agnico Eagle Mines Limited, paul.blatter@agnicoeagle.com
Secretary	Janice Zinck, CanmetMINING, janice.zinck@canada.ca
Secretary (elect)	Rory Cameron, CanmetMINING, rory.cameron@canada.ca
Treasurer	Wesley Griffith, CanmetMINING, wesley.griffith@canada.ca

REGIONAL REPRESENTATIVES

Atlantic – Vacant
Côte Nord-Labrador - François Lavoie, BBA, Francois.Lavoie@bba.ca
Nord-Ouest Québécois – Mark Furlotte, Mine Matagami, mark.furlotte@glencore-ca.com
Quebec-Montreal-Ottawa – Stéfanie Vo, Hatch, svo@hatch.ca
North Eastern Ontario – Daphne Walsh, Goldcorp, daphne.walsh@goldcorp.com
Southern Ontario - Yves Breau, Kinross, yves.breau@Kinross.com
North Western Ontario - Matt Martin, mmartin.mats@gmail.com
Central Ontario - Andrew Taylor, Vale, andrew.taylor@vale.com
Manitoba / Saskatchewan - Lorne Schwartz, Amec Foster Wheeler, lorne.schwartz@amecfw.com
Alberta/NWT/Nunavut - Benjamin Xie, Suncor, bxie@suncor.com
British Columbia/Yukon - Berge Simonian, Metso, berge.simonian@metso.com
Regional Coordinator - Donald Leroux, Woodgrove Technologies, donleroux@woodgrovetech.com

DIRECTORS

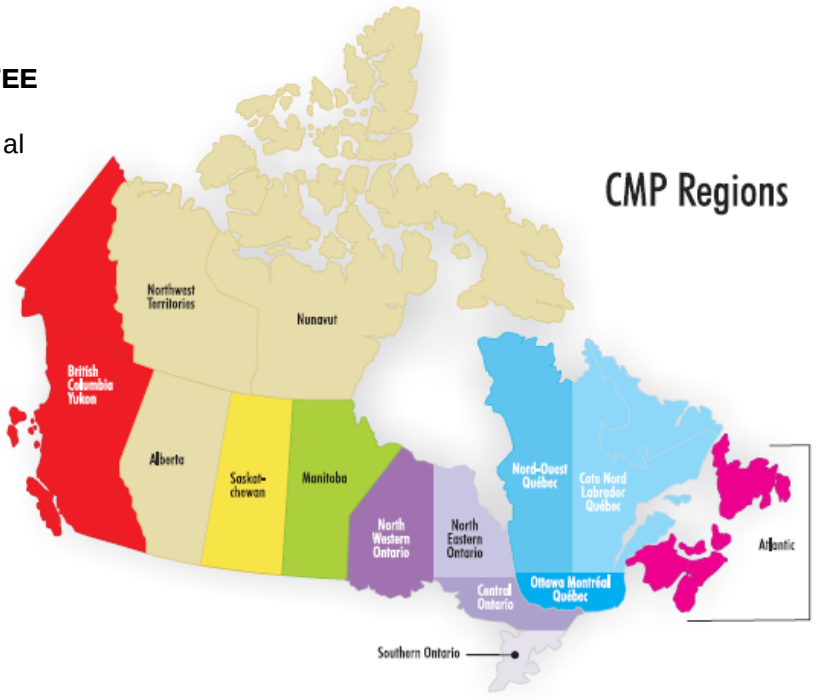
John Starkey, Stuart McTavish, Ernie Marcotte

REPRESENTATION ON CIM and CMP COMMITTEES

CIM Council Representative	Pierre Julien, Outotec, pierre.julien@outotec.com
Publications/Technical Journal	Michael Sue, Outotec, michael.sue@outotec.com
Education	René del Villar, Laval, Rene.DelVillar@gmn.ulaval.ca
International Relations	Pramod (PK) Kumar, Polycorp Ltd., pkumar@poly-corp.com
IMPC 2016	Donald Leroux and Jan Nesset, Jan Nesset nessetech@bell.net

LOCAL ORGANIZING COMMITTEE

Janice Zinck, Planner
John Chaulk, Registrar/Audio-Visual
Dave Hardy, Students
Al Kuiper, Photography
Louise Madaire
Wesley Griffith
Rory Cameron



CMP HOCKEY PLAYERS AND SPECTATORS!!!!

The Southern Ontario Branch of the Canadian Mineral Processors (CMP) is pleased to once again organize the CMP East versus West Hockey Game as a part of the social program of the annual CMP meeting in Ottawa.

To honour the late Ray MacDonald, who was instrumental in getting this annual event started, the game has been renamed the **'Ray MacDonald Memorial Hockey Game'**. The winning team will be awarded the 'Kilborn Cup'.

The 2017 game will be played on **Tuesday January 17th, 2017 at 7:00 pm at Carleton University**. Bus transportation to/from the Ottawa Westin Hotel will be provided for all players and spectators. The bus for players and spectators will depart the Westin hotel at 5:30 pm.

The hockey game is open to all registered members of the conference. Players (men and women) of all ages and skill levels are encouraged to participate in this great event of networking, recreation, and fun. Full hockey equipment including a helmet is required. Participants will also be required to sign a waiver form. Slap shots and body contact are not permitted. If interested in participating in this game, please contact Mark Griffiths at mark_griffiths@quadra.ca (289-321-1814).

CMP SQUASH AND RUNNING CLUBS

In addition to the 'Ray MacDonald Memorial Hockey Game' CMP delegates can also remain physically active by participating in the CMP squash club by contacting Berge Simonian berge.simonian@metso.com , or take part in the Wednesday morning Rideau Canal run - contact Stéfanie Vo SVo@hatch.ca.

FEEDBACK

We welcome your feedback. Please contact us at janice.zinck@canada.ca. Thanks.

CMP 2018 AWARDS NOMINATION INVITATION

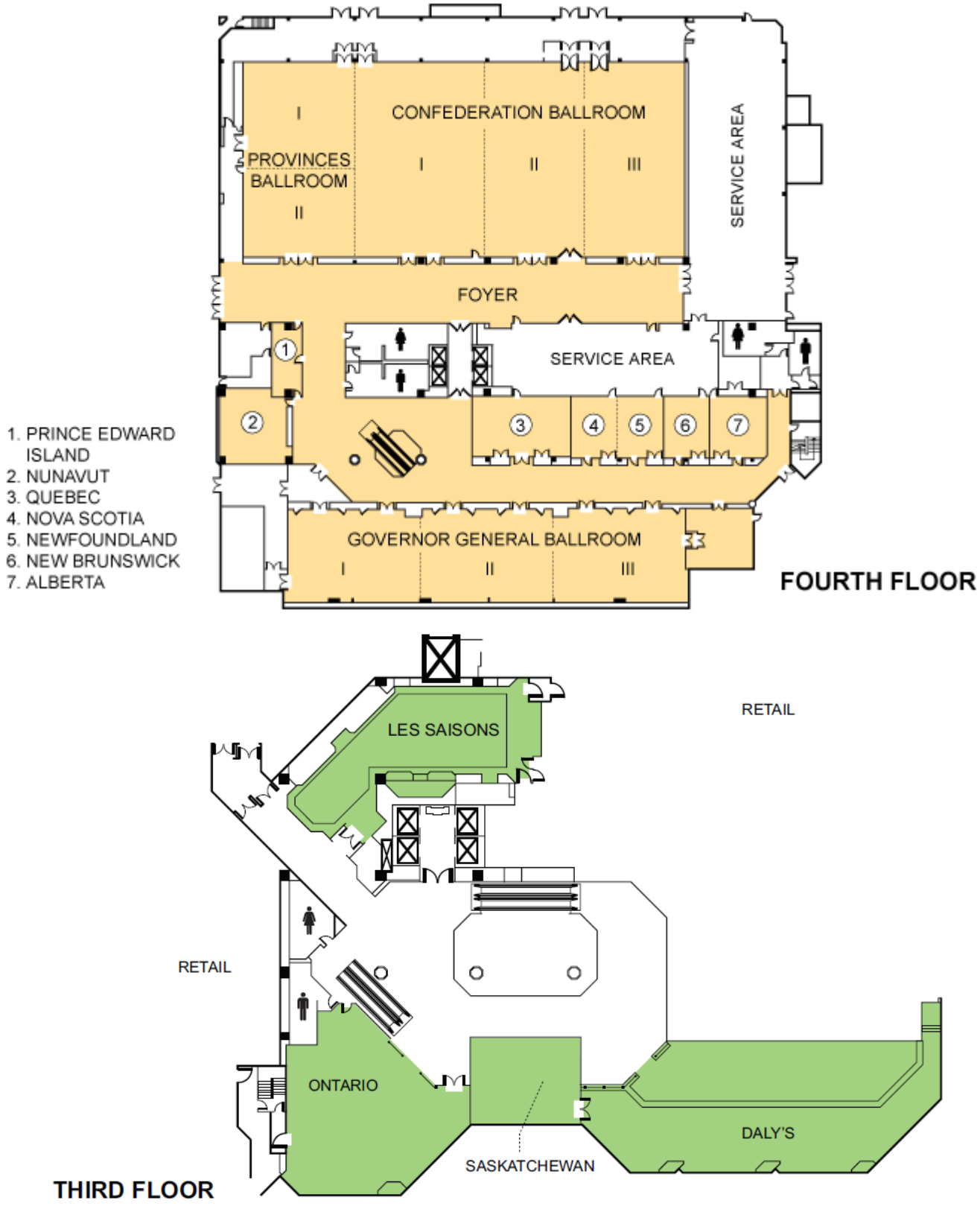
The Executive of the Canadian Mineral Processors Society invites nominations from the membership for the CMP 2018 Awards under the following five categories.

CMP Award	Recognizing ...
Mineral Processor of the Year	Outstanding results recently achieved by an active CMP member while *tackling significant mineral processing challenges.*
Lifetime Achievement	Outstanding results/influence achieved by a retired CMP member *throughout his/her career* in mineral processing.
Bill Moore Special Achievement	Outstanding results achieved by an active CMP member throughout *the early part of his/her career* in mineral processing.
A.R. MacPherson Comminution	Outstanding results recently achieved by an active CMP member *while tackling comminution challenges* in mineral processing plants.
Ray MacDonald Volunteer	*Exceptional volunteer contribution* to the Canadian Mineral Processors Society

Awards are in the form of an engraved medallion and a framed certificate and will be presented during the Awards Banquet to be held at the 2018 Annual CMP Meeting in Ottawa. Nominations for the 2018 CMP awards open on **January 19, 2017**. Nomination applications should be sent to Scott Martin, scott@progressiverubber.com CMP Past Chairman (2018) **by November 15, 2017**.

Guidelines for nominations, award categories, selection criteria, and information on past awards are available at www.cmpsoc.ca. Please take the time to recognize your mineral processing colleagues and peers.

WESTIN FLOOR PLAN



ADDITIONAL NOTES

CMP gratefully acknowledges the contributions and financial support

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SGS
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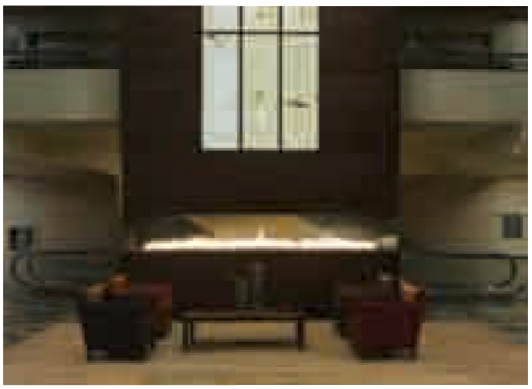

Photos: Courtesy of The Westin, Ottawa Tourism, and the City of Ottawa

Canadian Institute of Mining, Metallurgy and Petroleum

L'Institut canadien des mines, de la métallurgie et du pétrole