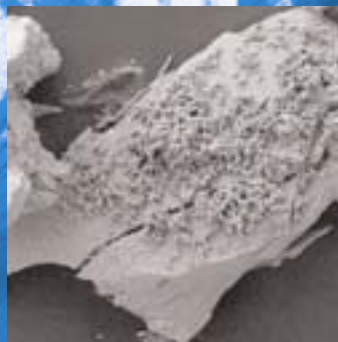


# ***Annual Report*** ***2004***





## **Message From the Director**

It is my pleasure to introduce the 2004 Annual Report of the CANMET Mining and Mineral Sciences Laboratories (MMSL). CANMET-MMSL has established itself as a team of problem solvers, and is not an organization focused on theoretical science. CANMET-MMSL develops new science and adapts existing science, to provide the technology needed to address specific problems in the mining and metals sector.

During the past year, scientists and technical staff worked on 180 projects for external government or industrial clients, and 90 internal projects to develop the science needed to address developing needs. In 2004, projects in 11 provinces and territories were undertaken to provide R&D assistance to more than 50 Canadian mining operations. CANMET-MMSL has provided policy support to major initiatives both within Natural Resources Canada (NRCan) and six other government departments (such as Environment Canada's smelter regulations) and has worked with officials of most provinces on concerns of mutual interest. CANMET-MMSL scientists have internationally recognized expertise, and are often called upon to provide advice to the governments of other countries, especially in the developing world, having had collaborations with 14 countries in 2004.

With roots tracing back to 1907 with the founding of the Mines Branch, CANMET-MMSL is part of the Minerals and Metals Sector of NRCan. CANMET-MMSL science activities have evolved over the years, but its mandate has largely remained the same, which is to support:

- The people and government of Canada, by providing science relevant to decision making regarding Canada's mining industry, and metals and minerals issues; and
- The Canadian mining industry and the supporting service industry, by using S&T to solve problems and assist the industry in remaining competitive, which contributes to the Canadian economy and provides benefits to Canadians.

CANMET-MMSL also supports the governments of a number of developing countries, by providing expertise and technical advice on mining-related concerns.

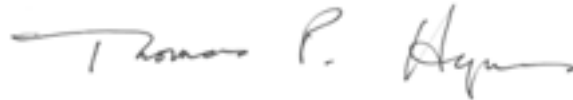
Mining is a key component of the Canadian economy and provides economic benefits to many thousands of Canadians, directly, and through spin-off activities. These benefits accrue in all provinces and territories, but are most pronounced in rural and northern Canada, where other economic opportunities are often limited. CANMET-MMSL's role is to help keep these economic benefits flowing to Canadians, while providing the science and technology needed to address concerns regarding environmental protection, and the health and safety of employees and the public. Internationally, CANMET-MMSL's contributions bring mutual benefits to the client countries and to Canada.



*“With roots tracing back to 1907 with the founding of the Mines Branch, CANMET-MMSL is part of the Minerals and Metals Sector of Natural Resources Canada.”*

In the following pages I hope you will find things that spark your interest - if you do, please feel free to contact us through our Business Office, at the address below.

Best regards,



Thomas P. Hynes  
Director, CANMET Mining and Mineral Sciences Laboratories

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The Annual Report 2004 is available on the CANMET-MMSL web page at:  
[www.nrcan.gc.ca/canmet-mmsl](http://www.nrcan.gc.ca/canmet-mmsl)

The organizational structure of CANMET-MMSL changed this year, with the naming of two deputy directors. Louise Laverdure is Deputy Director - Mining, and Jim Vance is Deputy Director - Processing and Environment.



*Dr. Louise Laverdure,  
Deputy Director, Mining.*



*Mr. Jim Vance, Deputy  
Director, Processing and  
Environment.*

## Introduction

CANMET Mining and Mineral Sciences Laboratories (MMSL) are federal government research facilities within Natural Resources Canada (NRCan). CANMET-MMSL conducts R&D on the economic, safe and environmentally responsible recovery of Canada's mineral resources. CANMET-MMSL provides technical leadership to assist in government policy and regulatory initiatives. CANMET-MMSL also works under contract with individual companies, and organizes consortia with multiple partners on topics of common interest.

Current activities are focused in three principal directions to promote sustainable development:

- Improving health and safety in the mining environment
- Finding technically-sound solutions to environmental problems
- Improving industry competitiveness through enhanced productivity

CANMET-MMSL has established teams of experts in the following fields:

- Mine mechanization and automation
- Mine air quality and ventilation
- Ground control
- Mineralogy and metallurgical processing
- Mining effluent technologies
- Mine waste management
- Metal behaviour in the environment
- Certified reference materials

Mine mechanization and automation R&D centres on explosive and non-explosive rock fragmentation, transportation equipment for ore and personnel (including energy alternatives to diesel), communication systems, and hoisting systems for underground mines. Specifically, considerable effort is being directed toward the increased use of fuel cells in underground applications, as well as the safety of hoisting equipment and narrow-vein extraction activities.

Mine air quality and ventilation activities focus on mine worker health and safety, as well as underground environment issues. Efficient mine ventilation and airborne contamination reduction are at the core of every project undertaken by this research and engineering team. The emphasis remains on deep mining and greenhouse gas (GHG) reduction issues. Diesel engine performance, efficient ventilation and heat-stress mitigation are also at the forefront.

Ground control specialists provide applied research services to the Canadian mining industry on issues related to ground stability. Advanced R&D work on geomechanics, geodynamics, modeling, support and instrumentation continues to be undertaken by our scientists in cooperation with industry. Ground control scientists

CANMET-MMSL continues to remain certified to ISO 9001:2000 for all its activities, as part of its commitment to excellence and continual improvement. In addition, CANMET-MMSL laboratories located in Bells Corners (Ottawa) and Sudbury are accredited by the Standards Council of Canada to ISO/IEC 17025 for specific tests.



are involved in projects with an emphasis the dynamic response of ground support, and geodynamical aspects of production of oil from tar sands.

Mineralogy and metallurgical processing activities advance mineral sciences through improved understanding of metallurgical processing and technology development. The technical team is very active in the areas of mineral processing, applied mineralogy and hydrometallurgy, in close collaboration with industry and academia.

Mine effluents activities focus on developing and adapting effluent management strategies, including prevention and remediation technologies. In order to assist the industry in meeting these challenges, the scientists develop reliable and cost effective technologies that are capable of effectively removing contaminants from effluents. These technologies involve the use of traditional chemical processes as well as biological or natural processes, such as engineered wetlands. CANMET-MMSL is also extensively involved in technology transfer activities in the areas of metal leaching and acid rock drainage. The team has expertise in chemistry, chemical and biochemical engineering, microbiology, biochemistry and soil science.

Mine waste management R&D develops long-term, scientifically-sound, cost-effective options for mine waste disposal, management, and rehabilitation. Current research activities include acidic drainage prediction, prevention and treatment technologies, development and evaluation of alternative waste disposal and stabilization technologies, revegetation and phytoremediation options for mine waste, and application of advanced techniques to characterize mine wastes. In addition, CANMET-MMSL provides independent reviews and technical advice on decommissioning and rehabilitation-related studies, and also participates in environmental capacity-building projects in developing countries.

Metal behaviour in the environment is a field of research undertaken by CANMET-MMSL to ensure that environmental policy, regulations and decision-making pertaining to metals and metal compounds are based on sound scientific information. The research activities link key scientific information on the fate and effect of metal emissions to environmental impact assessment policies at national and international levels.

Certified reference materials are prepared by CANMET-MMSL's Canadian Certified Reference Materials Project (CCRMP) team, who also co-ordinate the operation of the Proficiency Testing Program for Mineral Analysis Laboratories (PTP-MAL). For over thirty years, CCRMP has prepared and certified reference materials. These are finely powdered Canadian ores, rocks, concentrates, tailings, exploration-grade materials, soils, sediments and radioactive materials for which the concentrations of specific elements have been accurately determined. Analytical laboratories in the mining industry assess the accuracy and precision of their own results by using these reference materials.

Within the framework of these fields of expertise, CANMET-MMSL provides R&D services, not only to support government initiatives, but also to meet the needs of individual mining stakeholders. Collaborative activities with industry ensure the relevance of CANMET-MMSL current projects and future directions. During 2004, major technical investigations carried out on behalf of client companies resulted in 81 confidential client reports, in addition to those listed as publications at the end of this document. We appreciated the opportunity to work directly with those organizations and we look forward to continuing collaborations. Highlights of our 2004 activities follow.



Dr. John E. Dutrizac is well known nationally and internationally for his contributions to the metallurgical industry in the area of process understanding and optimization, and for his continuing leadership in the Canadian metallurgical profession.

## Awards

Dr. Guy Deschênes, Mr. Jean Cloutier and Mr. Mike Fulton won the 2004 Federal Partners in Technology Transfer (FPTT) Award for their work in the dissolution of gold and sulphide minerals in gold processing. In 1994, CANMET-MMSL established a consortium with several Canadian gold companies to improve gold leaching using a more efficient reagent management strategy. Results have led to increased gold plant recoveries by optimizing dosages of cyanide, oxygen and lead nitrate.



*Dr. Guy Deschênes, Mr. Jean Cloutier (absent) and Mr. Mike Fulton*

Dr. John E. Dutrizac was selected as one of the six CIM Distinguished Lecturers for 2004-2005. His presentation was titled: "Recent Developments in the Hydrometallurgical Processing of Base Metal Ores and Concentrates", a topic of relevance, not only to the broad metallurgical community, but also to NRCan's on-going efforts to sustain the Canadian base metals smelting and refining industry.

## Highlights

### Action Plan in Mining R&D

In 2004 CANMET-MMSL completed a roadmap for research and development for the mining sector, available now in both English and French. The authors made several presentations on the content of the report to various industry stakeholders and decision-makers. The proposed organizational structure for mining research was of particular interest to the mining community. A committee was formed in December 2004 to distribute the report and coordinate follow-up to this study.

### Meeting of Chief Inspectors of Mines with CANMET-MMSL

At the annual meeting of Canada's Chief Inspectors of Mines in 2004, CANMET-MMSL was asked to compare provincial legislation on three specific items: standards governing the underground storage of explosives, engine evaluation standards, and the allowable level of diesel particulates in the underground mining environment. This work will enable the provinces to compare their respective regulations and could lead to modifications in certain provinces or territories, if necessary. The report will be submitted at the next meeting, to be held in conjunction with the annual CIM conference in Toronto in April 2005.

### Narrow-Vein Mining

NRCan's special initiative on narrow-vein mining techniques, launched in 1999, concluded in October 2004 with a second symposium on the subject. Organized by CANMET-MMSL in collaboration with the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) and Canada Economic Development, the event focused on best practices in mining and included two workshops. A total of 192 delegates from eight countries met in Val-d'Or to discuss the challenges associated with narrow-vein mining. Papers presented are available on the CIM Web site.

### The Deep Mining Research Consortium (DMRC)

In 2004, the first four projects were identified for funding by DMRC, two of which will be led by CANMET-MMSL. The DMRC is founded on the premise that the safe exploitation of deep mineral ore bodies is important for the Canadian mining industry. Mining ore at depth in an existing operation is potentially more cost effective and environmentally friendlier than opening a new mine, but current deep operations in Ontario and Quebec are already experiencing problems related to depth. Key themes being addressed by the DMRC are health, safety and productivity issues, which include such specific topics as heat, ground control, hoisting and backfill.



### **Deep Mining and Heat Control**

One of the challenges of deep mining is to control the heat from both the rock and machinery which can cause workers to be less productive or even overcome by heat stress. CANMET-MMSL, through its involvement in the Deep Mining Research Consortium, was selected to lead a project that investigates heat issues in deep mechanized mines. While much can be learned from deep hot mines elsewhere in the world, this work focuses on issues specific to the Canadian mining industry. This will eventually lead to better and more protective regulations for workers in deep mines.

### **Diesel Contamination Control**

Reducing exposure of mine workers to diesel exhaust contaminants is an important health and safety concern. CANMET-MMSL research investigated reducing the dependency on diesel production equipment. Laboratory simulations in 2004 showed that emissions and fuel consumption can be reduced by 40% if a diesel-electric hybrid load-haul-dump (H-LHD) vehicle is used instead of the alternative diesel vehicle. In order to evaluate performance and overall impact on air quality, a new initiative is underway to design and build a 1.5 cubic meter H-LDH prototype.

### **Application of Fuel Cell Power to Underground Mining**

Several projects are being carried out under the general direction of the Fuelcell Propulsion Institute (U.S.A.) and CANMET-MMSL, with the aim of providing underground mining operations with a clean energy alternative to hydrocarbons, particularly diesel, and hence with an improved work environment. For example, underground reliability testing was conducted using a four-ton fuel cell locomotive. Work done to optimize the engine resulted in improved performance and reduced operational constraints. In addition, the project to develop a load-haul-dump vehicle equipped with fuel cells is at the component fabrication stage. The first industrial field trials are scheduled for late 2005. As well, an agreement in principle has been reached on the development of a light underground service vehicle and a water electrolysis unit for hydrogen production.



Dr. Mahe Gangal, Diesel Emissions Specialist and Chief of the Canadian Program for Diesel Engine Certification, organizes and co-chairs the annual Mining Diesel Emissions Conference (MDEC).







Dr. Shahriar Talebi developed a seismic technology which helps oil extraction from tar sands to be environmentally safer, and can extend the production life of individual wells.



### **Modeling Underground Ventilation**

Efficient use of ventilation is expected to grow as a priority, due to rising fuel costs in addition to concerns over greenhouse gas (GHG) emissions. One aspect investigated at CANMET-MMSL this year was the modeling of ventilation needs as a function of the life of the mine, in order to assess potential cost, energy requirements and GHG reduction strategies. The objective was to enable mine management to select the level of ventilation that is appropriate to support production and to dilute contamination, on an on-demand basis.

### **Dynamic Response of Ground Support**

Understanding ground support characteristics and predicting how support systems will react to rock mass conditions are critical to safely mining in weak rock masses or under high tectonic stress regimes. In 2004, CANMET-MMSL undertook research projects to better understand the yielding capacity of tendons such as rock bolts and cables, and their response to dynamic loading. A novel approach is being developed to improve the standard method for testing, analysis and interpretation of the static and dynamic loading response of commonly used types of ground support.

### **Best Practices for Ground Control**

This year, CANMET-MMSL personnel provided advice and training to members of industry working in the field of ground control. Training covered precise techniques such as numerical modeling and interpretation of results. Best practices advice was also provided, such as on the load capacity of ground support. At the same time, CANMET-MMSL had an opportunity to transfer some of the ground control expertise developed in Canada to international clients, enhancing the safety of workers in other countries.

### **Underground Wireless Communications**

In autumn 2004, construction was completed on an annex to CANMET-MMSL's Experimental Mine in Val-d'Or. The annex is now home to a five-year, \$3.2M project dedicated to wireless underground telecommunications research. CANMET-MMSL collaborated with Canadian universities, telecommunications companies and other government departments to advance research in the field of underground telecommunications. The knowledge, expertise and skills gained will enable Canadian mining companies to improve telecommunications efficiency, as well as enhance the safety of underground mine workers.

### **Mine Hoist Safety**

In 2004, the safe operation of mine hoists continued to be a priority for CANMET-MMSL. With its leading-edge expertise in the field, CANMET-MMSL inspected many hoists in Canada and abroad, and was also an active participant on working committees on the sinking and operation of deep mine shafts. The increased use of programmable electronic systems (PES) for mine hoists poses a significant challenge to ensure safe operation. For this reason, CANMET-MMSL has been working for a number of years to develop a technical guide on the use of PES-controlled mine hoists.

### **Underground Training Site for Miners**

The CANMET-MMSL Experimental Mine in Val-d'Or, Quebec, is often described as an ideal site for the underground training of mine personnel, whether at the professional, technical or university level. In 2004, more than 150 mining industry workers received health and safety training in the underground environment of the CANMET-MMSL Experimental Mine.

### **Collaborator in the "Canadian Light Source" (CLS) Synchrotron Technology**

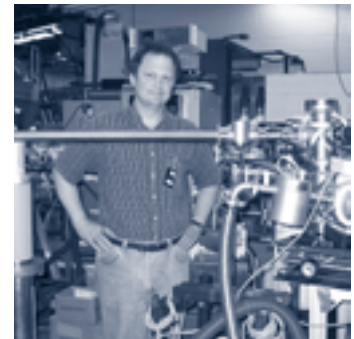
In addition to NRCan's key financial contributions to the CLS synchrotron in Saskatoon, Saskatchewan, CANMET-MMSL has also contributed to the CLS's technological capacity. Early in 2004, CANMET-MMSL was invited by the Canadian Synchrotron Radiation Institute to design and build an apparatus to prepare fresh surfaces on brittle material for ultra-surface sensitive chemical analysis. The apparatus uses two independent, remote controlled chisels for the fracturing operation. After testing, the apparatus was moved in August 2004 to the Canadian Light Source in Saskatoon, where it is now available to all users.

### **Metallurgical Applications for Synchrotron Technology**

CANMET-MMSL researchers pursued potential applications of synchrotron technology in mineralogical, metallurgical and environmental research. One such project focused on the treatment of mine wastes in order to prevent contaminants such as copper, zinc and arsenic from ending up in ground water and plants, where they might also pose an environmental hazard. The synchrotron technology enables researchers to develop new mineralogical applications such as three-dimensional imaging of multi-phase particles typical of mineral processing circuits, and molecular-scale characterization of contaminants in metallurgical wastes, having economic, environmental and sustainable development implications.



Dr. Suzanne Beauchemin specializes in molecular-scale characterization of mine wastes and soils. She applies sophisticated tools such as synchrotron-based analyses to better understand metal speciation and behaviour.





Ms. Yvonne Boucher is part of the team that provides high quality chemical analytical support for a wide range of research projects.

CANMET-MMSL depends on its highly qualified chemists and analytical services staff to provide laboratory analyses to support its metallurgical processing and environmental research projects. In addition, new laboratory methods are developed by CANMET-MMSL's chemists to keep pace with changing needs, as industry encounters different mineralogies, impurities or concentrations.

### **Molecular-scale Characterization of Arsenic**

Mineralogical and synchrotron studies were conducted to determine the speciation and molecular-scale characterization of arsenic in gold mine tailings and metallurgical wastes. In addition, a series of ferric arsenate and arsenical ferrihydrites were synthesized to better understand the stability of arsenic minerals and compounds. The aim was to better predict the potential of arsenic in processing effluents to adversely affect the quality of the receiving waters.

### **Gold Processing**

CANMET-MMSL research has helped improve the understanding of how elements and mineral impurities interfere with gold dissolution. This led to an increase in gold extraction by adjusting gold leaching strategies. An on-line lead nitrate control strategy was developed and implemented successfully at an operating mine, resulting in a 30% reduction in consumption of the reagent with no decrease in gold extraction or plant throughput.

### **Treatment of Gold Mill Effluents**

One of the primary causes of effluent toxicity in gold milling effluents is the presence of cyanide, thiocyanate and ammonia. In collaboration with Canadian companies, CANMET-MMSL continued research into the application of biological systems, such as rotating biological contactors and sulphate reducing bacteria, for the mitigation of cyanide and nitrogen species in mine effluents. The technology has been successfully applied to treat gold mill effluents.

### **Passive Wetlands Treatment for Mine Effluents**

CANMET-MMSL performed a number of studies in the area of passive treatment for a variety of metal and metalloid contaminants. The objective of the work was to understand the key chemical and microbial mechanisms in nature that facilitate the treatment of mine contaminants, and use them to maximize performance and minimize land usage in an engineered system. The work is leading to the technology's implementation at Canadian contaminated sites.

### **Mine Reclamation**

CANMET-MMSL investigated novel methods to reclaim mine waste. Research on the use of lignin and lignin derivatives to promote increased vegetative growth and metal uptake (phytoremediation) in metal contaminated soils such as tailings and treatment sludges was undertaken. Investigations into the challenges of revegetating alkaline sludge and residue ponds were undertaken to examine metal uptake in vegetation, both from a phytotoxicity and phytomining perspective, and to improve phosphate availability, which would result in reduced fertilizer use.

### **Life Cycle Assessment**

CANMET-MMSL scientists continued to develop Life Cycle Assessment (LCA) approaches for metals. These activities included representing Canada at the United Nations Environment Program/Society of Environmental Toxicology and Chemistry Life Cycle Initiative and organizing one of the largest-ever symposia on LCA in North America. Another highlight was the participation in the development of the "Declaration of Apeldoorn", a critical step in ensuring metals are considered properly within LCA.

### **Aquatic Chemistry and Toxicology**

Aquatic chemistry and toxicology research continued in 2004 with a focus on the development of toxicity prediction models for metals and their application to complex effluents, natural waters and chronic impacts. These efforts involved significant collaborations with industry, academia and other government departments. CANMET-MMSL's expertise was requested to ensure integration of sound science into environmental policies at the provincial, national, as well as international levels, including the US Environmental Protection Agency's Metals Action Plan and Forum on Metals Risk Assessment.

### **Mine Environment Neutral Drainage (MEND)**

Many key issues in acidic drainage were examined during 2004, such as use of permafrost in mitigation, sludge management, neutral pH drainage, and assessment of metal-leaching acid rock drainage strategies. In addition studies were initiated to investigate performance of dry covers, waste-rock scale-up and the terrestrial effects of selenium and molybdenum. Technology transfer activities, an important element of MEND, were carried out through newsletters, reports and presentations, in addition to the hosting of two successful workshops, the 2004 Ontario-MEND Workshop in Sudbury, and the 11th Annual British Columbia ML/ARD Workshop in Vancouver.



Dr. Jim Skeaff specializes in research on national and international issues related to the impact of metals in the environment and in linking good science to environmental protection measures.

CANMET-MMSL is well known for leading multi-stakeholder initiatives to address issues of national importance such as acidic drainage and abandoned mines. The model of co-operation among industry, various levels of government, non-government organizations and First Nations is being applied both nationally and internationally.



#### **National Orphaned/Abandoned Mines Initiative (NOAMI)**

The legacy of orphaned/abandoned mines, with the associated environmental liability, health and safety concerns and financial costs, is a serious issue facing Canada. NOAMI was established to examine these issues, with CANMET-MMSL acting as Secretariat. A multi-year Action Framework approved by the Mines Ministers outlined two key activities which were developed in 2004. The first was the report on capacity building, that sets the stage for a national database on inactive mineral sites. The second activity was the drafting of the Guidelines for Legislative and Jurisdictional Review, which have been provided to various jurisdictions to assist in the development of a legislative framework for management of orphaned and abandoned mine sites.

#### **Environmental Management in the Mining Sector (EMMS) of Zambia**

CANMET-MMSL wrapped up its CIDA funded EMMS project in Zambia, having made significant strides towards improving the operating capacity of the Zambian Mines Safety Department (MSD). The outcome reduced duplication of mine inspections and produced recommendations for the creation of a restructured MSD. Another important accomplishment was the establishment of an educational trust program for training in the Zambian mining sector.

#### **Seven New CCRMP Materials**

Some one hundred and thirty reference materials have been produced over the years by CCRMP. In 2004, seven new products were released for sale. These included a gold ore, a copper-molybdenum ore, an iron sulphide concentrate, and a base-metal tailings material. Three geochemical materials with trace concentrations of gold and the platinum group elements were re-released, with certified and provisional values for other elements.

#### **Proficiency Testing of Laboratories - Mineral Analysis Laboratories (PTP-MAL)**

Every year CANMET-MMSL prepares exploration grade samples and sends them to participating laboratories worldwide for analysis. Laboratories receive a certificate that indicates their proficiency. In its seventh year of operation, 45 laboratories participated with several of the participants using their successful results as part of the requirements to gain accreditation from the Standards Council of Canada under ISO/IEC 17025 and CAN-P-1579. The certificate and the accreditation are typically used by the laboratories as marketing tools.

## ***Future Directions***

Looking ahead to 2005, CANMET-MMSL will remain focused on health, safety and productivity in the Canadian mining industry, and will continue to work on priorities such as greenhouse gas reduction and sustainable development.

Deep mining, ventilation, safe and effective rock breaking, extraction methods, and rock mass stability will be important issues for CANMET-MMSL mining programs and our industrial partners. In concert with mining operators, regulators and organized labour, CANMET-MMSL will remain committed to delivering the research and development required to cost-effectively enhance safety and well-being in underground mines.

CANMET-MMSL's clean processing efforts will focus on the development of tools for early identification of environmental problems including the integration of chemical and microbial expertise, and management of acid generating wastes. The development of better mineralogical and surface characterization techniques to improve metal recovery in an environmentally safe manner, will remain important for CANMET-MMSL and our industrial collaborators.

## ***Workshops and Conferences***

Technology transfer to industry and information dissemination are an important part of CANMET-MMSL's mandate. In support of this, CANMET-MMSL hosted and/or co-organized several workshops and conferences during the year, including the following:

- CANMET-MMSL Short Course on Process Mineralogy, held in conjunction with the 36th Meeting of the Canadian Mineral Processors, Ottawa, Ontario, January 19, 2004.
- 36th Annual Meeting of the Canadian Mineral Processors, Ottawa, Ontario, January 20-22, 2004.
- Workshop on Sludge Management and Treatment of Weak Acid or Neutral pH Drainage, Sudbury, Ontario, May 26-27, 2004.
- 28th Annual British Columbia Mine Reclamation Symposium, Cranbrook, British Columbia, June 21-24, 2004.
- CANMET-MMSL Field Course on Metal Leaching and Acid Rock Drainage, Smithers, British Columbia, September 13-17, 2004.
- 10th Mining Diesel Emissions Conference (MDEC), Toronto, Ontario, October 13-15, 2004.
- 2nd International Symposium on Mining Techniques for Narrow-Vein Deposits, Val-d'Or, Québec, October 18-21, 2004.
- CANMET-MMSL Workshops on Primary Openings for Long-Hole Mining Methods and Alimak Raise Mining Method, held in conjunction with the Symposium on Mining Techniques for Narrow-Vein Deposits, Val-d'Or, Québec, October 19, 2004.
- 11th Annual BC/MEND Workshop on Metal Leaching and Acid Rock Drainage (ML/ARD), Vancouver, British Columbia, December 1-2, 2004.

## **Lectures Organized by CANMET-MMSL**

Throughout the year, CANMET-MMSL organized several lectures including the following:

- *Corporate Social Responsibility: Challenges to Mining Companies in Developing Countries*, James P. Cooney, General Manager, Strategic Issues, Placer Dome Inc., Ottawa, March 24, 2004.
- *Microwave Pretreatment of Sulphide Ores*, Augustine Orumwense, Research Scientist, CANMET-MMSL, Ottawa, March 31, 2004.
- *Environment Canada's Minerals and Metals Strategy Development*, Patrick Finlay, Director, Minerals and Metals, Environment Canada, Ottawa, April 16, 2004.
- *Voisey's Bay Environmental Assessment: Challenges and Successes*, Les Hulett, Director, Environmental Affairs, Inco, Ottawa, April 21, 2004.
- *Pressure Leaching of Furnace Slags for the Recovery of Residual Metal Values*, Walter Curlook, Professor, Department of Materials Science and Engineering, University of Toronto, Ottawa, May 17, 2004.
- *Heavy Metals from Oil Sands: An Update from Titanium Corporation*, John Oxenford, Senior Vice-President, Titanium Corporation Inc., Ottawa, July 26, 2004.
- *Documenting Crown Intellectual Property: Proper Laboratory Notebook Practices to Remember*, Bruce Faiers, Technology Transfer Officer, Natural Resources Canada, Ottawa, September 22, 2004.
- *Towards Sustainable Mining: Taking Roots in Canada's Mining Industry*, Pierre Gratton, Vice-President, Sustainable Development, and Elizabeth Gardiner, Vice-President, Technical Affairs, Mining Association of Canada, Ottawa, September 28, 2004.
- *Overview of the First Chemical Science and Commercialization Conference, Moscow, Russia*, Saviz Mortazavi, Research Scientist, CANMET-MMSL, Ottawa, October 29, 2004.
- *Research and Development Action Plan for Canada's Mining Industry*, Louise Laverdure, Deputy-Director, Mining, CANMET-MMSL, Ottawa, November 24, 2004.
- *Mining in Ethiopia*, His Excellency Berhanu Dibaba, Ambassador of Ethiopia to Canada, Ottawa, December 6, 2004.
- *From Remote Sensing to Bacteria: Illustration of Research and Development Projects Related to Mining Environment*, Yann Itard, Engineer-geologist/geochemist, Mineral Resources Service, Bureau of Geological and Mining Research (BRGM-France), Ottawa, December 9, 2004.

## **Publications**

The 2004 list of publications follows.

## ***CANMET-MMSL Locations***

Ottawa  
(Booth Street Complex)



Ottawa  
(Bells Corners Complex)



Val-d'Or  
(Experimental Mine)



Sudbury  
(Regional Laboratory)





## PUBLICATIONS 2004

### REFEREED JOURNAL PUBLICATIONS / PUBLICATIONS DE REVUE AVEC COMITÉ DE LECTURE

- Beauchemin, S., Hesterberg, D., Nadeau, J. and McGeer, J.C. (2004): *Speciation of hepatic Zn in trout exposed to elevated waterborne Zn using X-ray absorption spectroscopy*. Environmental Science & Technology, 38 (5): 1288-1295.
- Bétournay, M.C., Bonnell, G., Edwardson, E., Paktunc, D., Kaufman, A. and Lomma, A.T. (2004): *The effects of mine conditions on the performance of a PEM fuel cell*. Journal of Power Sources, 134 (1): 80-87.
- Bétournay, M.C., Desrivières, G., Laliberté, P., Chan, J., Replogle, B., Miller, A.R., Barnes, D.L., Spratt, D. and MacKinnon, T. (2004): *Design, testing and performance of the world's first fuel cell mine vehicle, a production locomotive*. The Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Bulletin, 97 (1083): 72 and on CIM Web site.
- Bonnell, G. and the participants of Underground Coal Mining Safety Research Collaboration (UCMSRC) (2004): *Striving for a safer future - An update on the state of the Canadian underground coal mining industry*. World Coal, 13 (5): 43-46.
- Boullemant, A., Vigneault, B., Fortin, C. and Campbell, P.G.C. (2004): *Uptake of neutral metal complexes by a green alga - Influence of pH and humic substances*. Australian Journal of Chemistry, 57 (10): 931-936.
- Chen, T.T. and Dutrizac, J.E. (2004): *Gold in the electrorefining of copper and the decopperizing of copper anode slimes*. Journal of Minerals, Metals and Materials, 56 (8): 48-52.
- Chen, T.T. and Dutrizac, J.E. (2004): *Mineralogical changes occurring during the fluid-bed roasting of zinc sulphide concentrates*. Journal of Minerals, Metals and Materials, 56 (12): 46-51.
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