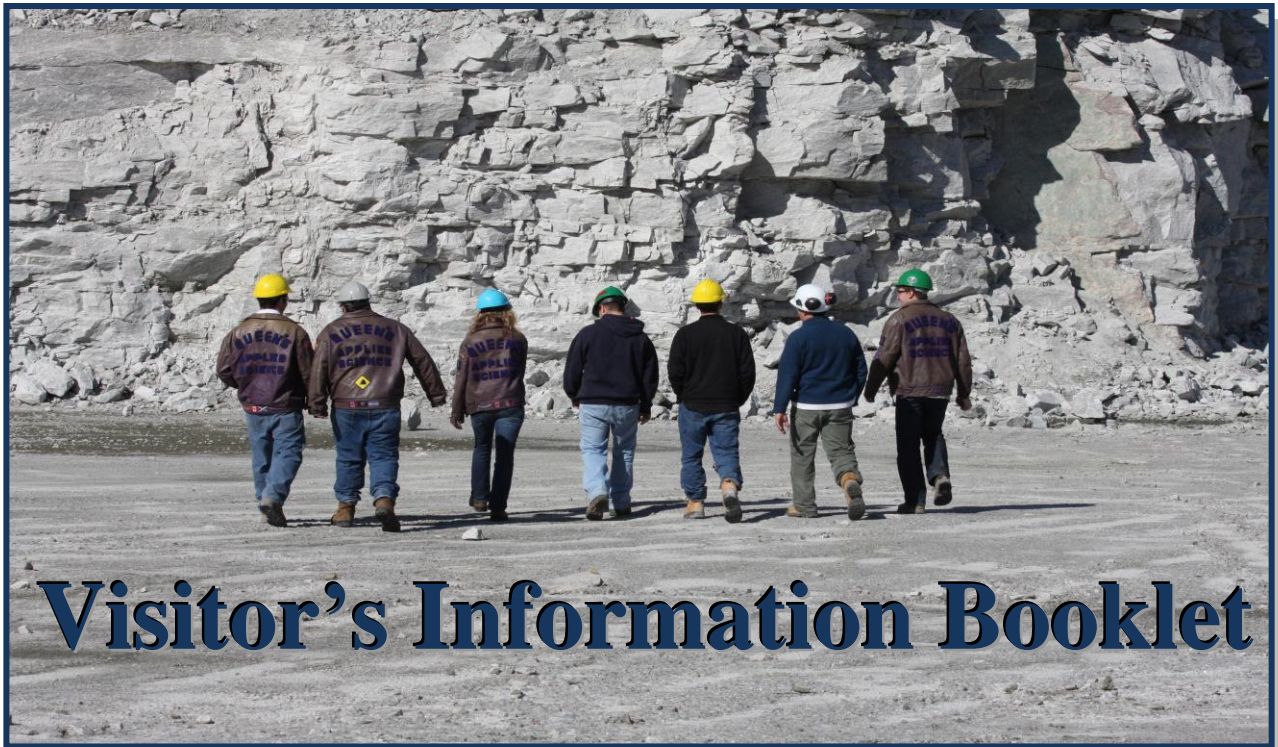


The Robert M. Buchan Department of Mining at Queen's University



Visitor's Information Booklet

2011

FOREWORD

The purpose of this booklet is to provide basic information about the Mining Department's objectives, policies and expectations. Sections have been organized to give the reader a clear understanding of the important aspects of the Mining Program offered at Queen's.

Vision Statement - The Department's vision is to excel in applied science education and research related to the stewardship and recovery of the earth's mineral resources, accomplished through the development of exceptional engineers and scholars for a sustainable global society.

Mission - The Department will strive for excellence in the minerals, environmental, and related fields, through:

- programs leading to broadly educated graduates equipped to pursue a variety of rewarding and meaningful careers
- the scholarship of its faculty and students, leading to the advancement and application of knowledge for a sustainable global society
- delivery of high quality continuing education to the engineering profession
- service to the profession and its stakeholders.

In pursuit of this mission, the goals are:

Goal One: Quality Students - To attract and retain students with outstanding potential and diverse backgrounds from across Canada and around the world.

Goal Two: Quality Faculty - Great students deserve great teachers. A dynamic relationship between professional competence, fundamental and applied research and creative teaching is essential to the achievement of the Department's Mission and Vision.

Goal Three: Innovation and Excellence - To provide rigorous, relevant and challenging programs of study and research, which cross traditional boundaries in order to address the complex challenges faced by the minerals, environmental, and related fields.

We hope that this booklet will assist you in understanding our values and our pledge to quality education. Welcome to Queen's Mining!

L.K. Daneshmend – Head of Department



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CAREER INFORMATION - MINING

DID YOU KNOW THAT...



Open Pit Equipment.

- Canada produces about 60 minerals and ranks first among producing countries, on a per capita basis.
- Canada is one of the world's largest exporter of minerals and mineral products. The contribution of minerals and metals exports represents 15% of total Canadian export value.

- Minerals and mineral products account for more than 60% of the total volume handled at Canadian ports and more than 55% of total rail revenue freight generated for the Canadian railway system.
- Canada is the world leader in mining engineering technology. The old image of miners with picks and shovels has been replaced by workers using computers, robotics, and high-tech equipment.
- There are approximately 750 mining establishments in Canada. In addition, approximately 600 companies in Canada receive over 30% of their revenues by supplying the mining industry.
- The impact of mining is felt in every region of the country. With over 70 per cent Canadian ownership, the industry is truly national.
- Canada remains a leading world target in terms of exploration expenditure.
- The mining industry is the foundation of Canada's economy. The value of production for the mining industry represents some 4% of total Canadian GDP. This is more than that of Agriculture, Fishing and Forestry combined (2.5%), more than Communications (3.6%), and more than Electric Power, Gas and Water Utilities (3.6%).
- In a typical year, the mining industry is responsible for almost 20 per cent of Canada's total export earnings.
- Canada is the world's centre for mine financing with almost 50% of global mining equity financing being raised by Canadian financial institutions.

- Toronto is the global capital for mine financing.
- The industry directly employs 368,000 people in this country.
- Average weekly earnings from mining industry employment are at the highest level of any industry in the Canadian economy.
- Canada's mineral resources will continue to be one of the mainstays of our economy making mining an industry of the future.
- The Mining program at Queen's is the largest in Canada and rated one of the best in the world. We graduate about 33% of the total number of mining and mineral processing engineers within Canada.

MAJOR AREAS OF WORK IN MINING

This section illustrates the breadth of fields and also the scope of jobs in mining:

- Explosives Technology
- Drilling and Blasting
- Mine Planning and Design
- Production Engineering
- Management
- Mine Valuation and Finance
- Mineral Economics
- International Trade
- Mine Management
- Occupational Health
- Rock Mechanics
- Numerical Modelling
- Geotechnical Design
- Excavation and Tunnelling Design
- Mine Ventilation
- Environmental Control
- Automation and Robotics
- Computer Applications
- Process Development
- Process Control
- Plant Design
- Separation Systems
- Transportation
- Materials Handling and Shipping
- Instrumentation Technology
- Communications
- Equipment Maintenance
- Equipment Manufacturing
- Mineral Exploration
- Geostatistics

Source of factual and statistical information provided in this booklet: 'Beyond the Mine Gate - Mining in Canada, Facts and Figures', The Mining Association of Canada.

QUESTIONS ?

The opportunities presented by The Robert M. Buchan Department of Mining at Queen's and by the mining industry should not be underestimated. Challenging and rewarding careers and experiences are available to the capable and independent individual. If you have questions concerning mining engineering and our program, by all means please contact any staff member in the department.

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For further information about the Mineral Industry or Mining Engineering, visit the following web pages:

Mining Association of Canada (MAC)	http://www.mining.ca/
Mining Association of Ontario	http://www.oma.on.ca/
Natural Resources Canada (Mineral Statistics)	http://www.nrcan.gc.ca/ms/efab/mmsd/
Natural Resources Canada (Kid Resources)	http://www.nrcan.gc.ca/edu/
Canadian Institute of Mining, Metallurgy and Petroleum (CIM)	http://www.cim.org
Prospectors & Developers Association of Canada	http://www.pdac.com



Surface buildings of an underground mine.



Haulage road of an open pit mining operation.

THE MINING PROGRAM AT QUEEN'S

MINING AND THE MINERAL INDUSTRY

Canada is the world's largest exporter of minerals. The contribution to Canada's gross national product is more than three times that of the automotive industry and is larger than the total value of all agricultural production. There are approximately 750 mining establishments in Canada. In addition, more than 600 companies in Canada receive over 30% of their revenues by supplying the mining industry. The value of production for the industry approximates \$50 billion and the GDP output by the mineral industry, excluding the equipment and services related to mining, represents some 4% of total Canadian GDP. This is more than that of Agriculture, Fishing and Forestry combined (2.5%), more than Communications (3.6%), and more than Electric Power, Gas and Water Utilities (3.6%). Canada is the world's centre for mine financing with almost 50% of global mining equity financing



Highland Valley Copper Mine in British Columbia.



A gold pour at a Barrick Gold Mining operation.

being raised by Canadian financial institutions. The industry directly employs some 370,000 people in this country; mining industry employment is highly paid with average weekly earnings having the highest level of any industry in the Canadian economy. The average weekly wages and salaries are approximately \$1013 and are well ahead of Forestry, a distant second at \$790, Manufacturing (\$720), Finance and Real State (\$720) and Construction (\$600).

Canada is a world leader in mining engineering technology and the mining industry is today one of the major users of high-tech systems. Because of intense international competition, the industry is seeking productivity improvements more aggressively than most industries. Such systems include mine automation technology, robotics and computer aided design. There is an opportunity here for highly skilled, dedicated engineers to make a major contribution to the Canadian economy. The mineral industry offers many challenges and is closely linked to the

economic well-being of our country. The industry is currently expanding and job prospects for the future are stronger than ever.

MINING AND QUEEN'S UNIVERSITY

From its inauguration in 1893, Mining at Queen's has held a significant position in the Canadian Mineral Industry, and the Department is currently the largest mining school in North America and one of the largest in the world. Its graduates are involved in all facets of the Canadian mineral industry, in senior engineering, and in management, and can also be found in most major mining operations throughout the world.

Currently we graduate about 33% of the total number of mining and mineral processing engineers within Canada. We serve the entire Canadian industry and have developed an international base as well. Our engineers work in base metals, gold, iron ore, industrial minerals, coal, uranium, oil, with consulting companies, geotechnical groups, environmental groups, heavy and light equipment manufacturing companies, computer software and hardware development organizations, banks, government institutions and university organizations. The Mining Department at Queen's is at the forefront in developing computer applications for engineering design and works in close contact with the mineral industry.

THE PROGRAM

Traditionally, mining engineering has been one of the broadest engineering fields offering the most general program. A mining professional is required to be familiar with all of the engineering work involved in the operation of a mining project from the initial discovery stage to the marketing of a final product. For this reason, mining engineers receive some basic training in each of the major engineering fields.

The Mining program consists of three major options, **Mining**, **Mineral Processing and Mine Environment** and **Mine-Mechanical**. Within these categories there exists a broad study and research capability encompassing areas of significance to the Canadian mining industry. Heavy emphasis is placed throughout the program on the application of computer technology.

Mining students at Queen's receive basic preparation in Electrical, Civil, Industrial, Mechanical, Metallurgical and Chemical Engineering concepts in order to be able to relate to and coordinate work in these fields. Furthermore specialized preparation in areas such as computer applications, automation and robotics, mine evaluation, equipment selection, industrial equipment design, heavy equipment maintenance, transportation systems, mine design and planning, rock mechanics, explosives technology, drilling and blasting, mineral processing, plant and process design, management and labour relations, environmental control and energy related topics ensures a broad exposure to technical issues and provides a high employment potential.

The Mining Option is designed to produce engineers capable of designing, operating and managing a mining operation. Mining engineers acquire knowledge about all relevant mining processes, from exploration to production, also including management and environmental issues. Production and engineering operations involve computerized planning, excavation design, drilling and blasting, ore handling, dispatching systems, equipment automation, and mine services including mine ventilation and dewatering.

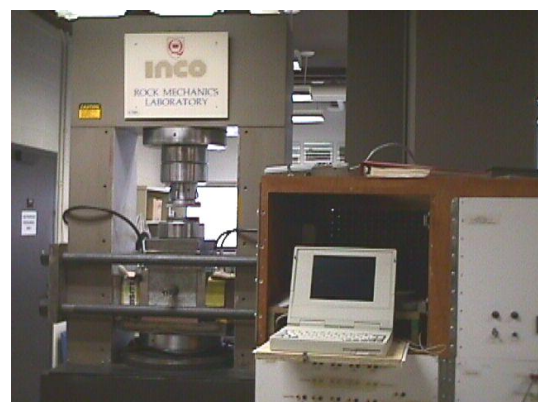
The Mineral Processing and Environmental Option is designed to produce engineers capable of designing, operating and controlling the plants that treat mined ore to produce a valuable product for market. Mineral processing engineers also design and operate the environmental processes required by government regulations. Mineral processing engineers acquire knowledge about all relevant separation and extraction methods, flowsheet development, instrumentation and process control, marketing and environmental technology.

The Mine-Mechanical Option is designed to produce engineers who understand heavy and specialized equipment applications in the mining and construction industry and are capable of designing, modifying and maintaining this equipment. The program is structured to provide good career flexibility covering mining operations, equipment design and applications, and engineering houses, contractors and equipment manufacturers.

Before completing their program, all mining students will either design and analyze an underground or open pit mine installation, conduct a detailed feasibility study of a process plant flow sheet and layout, or evaluate and design mechanical requirements associated with a mine and/or plant facility. Computer aided design and control systems are essential in the design and operation of mines and mineral extraction plants. Computer applications in the mineral industry make up an integral part of our program of study in all three options.

OUR FACILITIES

The department is located in Goodwin Hall which contains attractive, modern and convenient lecture, laboratory and study facilities. Our teaching and research facilities include laboratories in the areas of Rock Mechanics, Geotechnical Instrumentation, Centrifuge Testing, Computer Applications, Automation and Robotics, Mine Design, Mine Ventilation, Mine Environment, Explosives and Mineral Processing.



Material Testing System that can apply hundreds of tonnes of force onto a sample instantly.

Rock Mechanics Laboratory



The rock mechanics laboratory, in addition to the usual equipment for physical properties testing, has: 880 kN and 4000 kN closed loop electro-hydraulic testing machines; a 200 kN lateral pressure triaxial cell; tensile and shear testing equipment; borehole instrumentation for measuring in-situ rock stresses; a cold environment laboratory (capability to -35 degrees Celsius); a large diamond saw for cutting rock blocks; a large mobile diamond drill; and microseismic monitoring systems for rockburst detection.

Geotechnical Instrumentation Laboratory

The instrumentation laboratory contains typical sensor technology (electrical, vibrating wire, optical, hydraulic, microseismic, etc.) utilized for the manufacturing of rock mechanics instrumentation. An extensive range of instruments available in the market are provided for testing and calibration. These include extensometers, strain gauges, joint meters, stressmeters, strain cells, pressure cells, load cells, piezometers, etc. The application of data communication and data management techniques is also practised through a number of available data acquisition systems.

Computer Laboratory

Open pit and underground mine designs are produced using high performance workstations and colour graphic video display terminals. The Department also has several digitizers, plotters, various IBM compatible microcomputers and numerous in-house conversational computer terminals connected to the University's mainframe computer. A number of major computer programs used for the simulation of mine haulage circuits, two and three-dimensional orebody interpretation, mine planning, and mine design have been developed.



Undergraduate Computer Lab.

Automation and Robotics Laboratory

Advanced mining technology provides a competitive edge for the Canadian mining industry, and mechanical equipment related issues are a key aspect of such technology. The laboratory provides both undergraduate and graduate students with exposure to state-of-the-art techniques and tools for the maintenance, design, mechanization, and automation of mining equipment. Training is imparted primarily through software-based analysis, design, and simulation tools. These enable students to study complex mechanisms at the machine level, while also evaluating machine and process interactions at the systems level. The simulation software tools also enable the programming and evaluation of machine control and automation strategies. The laboratory is an integral part of the Mine Mechanical Engineering program at Queen's University. This program is unique in North America in providing a blend of mining and mechanical engineering training, to equip engineers with the necessary skills for the increasingly equipment intensive mining industry. Undergraduates in the program utilize the laboratory for their final year design projects, as well as for courses in industrial automation and mine maintenance.

Ventilation Laboratory

The concentration of airborne dust particles, mine gases and radiation is precisely determined with specialized digital instrumentation. The laboratory is equipped with standard instruments used for ventilation surveys including, barometers, manometers, anemometers and psychrometers. A ventilation analogue is used to simulate mine ventilation network systems, a simulator is used to evaluate pressure losses in mine roadways and an air flow system is used to size mine fans. Two automated ventilation systems permit computer controlled testing, simulation and characterization of main mine fan installations. A wind tunnel is also available to permit instrumentation calibrations and flow simulations.

Explosives Test Laboratory

Queen's is the only University in Canada which has a well equipped Explosives Test Facility. It is located 50 Km north of Kingston. The facility includes a bunker equipped with an ultra high speed streak and framing camera, digital oscilloscopes and data acquisition systems, a Hycam high speed camera, and a Locam relatively high speed camera. The facility also has two blasting chambers for the study of dust explosions and detonation products, a preparation room and an explosive magazine. The laboratory also uses numerical tools for the study of explosives, fragmentation and throw. Examples of these tools are the Tiger, Cheetah, TDL, SIN and Autodyn codes.

Mineral and Gold Extraction Laboratories

The mineral extraction facilities include a service laboratory which contains modern analytical instruments such as an X-ray fluorescence analyser; X-ray, atomic absorption and ultra-violet scanning spectrophotometers, a zeta meter; a spectroscope; a carbon and sulphur analyzer; a Quantasorb specific surface area analyzer; a cyclosizer; a laser particle size analyser; gold fire assay and extraction facilities, FTIR and a surface tensiometer.

The unit operations laboratory and the unit processes laboratory are fully equipped for every aspect of mineral processing, from physical separation processes through to flotation and leaching operations. A modern gold extraction laboratory is available for undergraduate and graduate studies and industry sponsored research projects. Various computer codes are available to analyse the operation of industrial mineral processing plants. Such codes include mass balancing, data adjustment and process simulation packages for flowseet development and plant design. Computer methods to study metal ion/mineral equilibria and to predict the metal species interactions in aqueous environments, such as flotation and tailings disposal, are also available.



Mineral processing laboratories in Goodwin Hall.

Centrifuge Laboratory

The centrifuge is a powerful tool for solving geotechnical problems and has applicability in a multitude of engineering problems. In mining, several areas of research, encompassing the broad fields of rock mechanics, mine environmental engineering and blasting, are conducted. In the field of Rock Mechanics, applications include: investigation of the validity of empirical theories of rock mechanics design; development of new techniques for material property characterization; validation of numerical predictions in excavation design; hydraulic and paste backfill design; bulkhead design; excavation stability analysis; mine support design; simulation of rockburst effects; water inflow control techniques; mine subsidence prediction and control; slope stability analysis and slope reinforcement; the stability of tailings dams; ground freezing. Mine environmental studies include: acid mine drainage; mine waste migration and hazardous waste pollutant transport; the development of environment clean up techniques; performance of tailings/waste covers; the application of ground contamination mitigation barriers and liners; and the study of groundwater transport of radioactive waste.

The centrifuge is a 5.3 m diameter machine driven by a 50 kW hydraulic motor and speed control assembly. It is designed to rotate up to a maximum speed of 350 rpm and is capable of exerting up to 330 gravities on typical models. It is rated at 30g-tonne, since it can accelerate a 0.1 tonne mass to 300 gravities. The main beam of the centrifuge is 5 m long and fabricated from a 200 mm steel box section of 13 mm wall thickness. A number of strong boxes are available to house the centrifuge models. The beam rotates on a 76 mm diameter steel shaft which is powered by the 50 kW hydraulic motor. The speed is controlled by ramping mechanisms in the hydraulic power supply, and can be maintained at any level between 50 and 350 rpm. The centrifuge has a total of 12 slip rings. Models can be viewed or videoed during flight through a port in the centrifuge concrete pit, and with the aid of a high intensity strobe light.

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STUDY AND RESEARCH OPPORTUNITIES

A series of research and study programs are available at the undergraduate and graduate levels:

MINING ENGINEERING:

- Open Pit Mining
- Underground Mining
- Rock Mechanics
- Centrifuge Modelling
- Drilling, Blasting and Explosives
- Mine Services

MINE-MECHANICAL ENGINEERING:

- Design of Industrial Machinery and Equipment
- Structural Design Applied to Mining
- Mine Automation and Robotics Applied to Mining

COMPUTING AND MATHEMATICAL APPLICATIONS:

- Mine Planning, Design and Simulation
- Orebody Modelling and Numerical Modelling
- Mine Survey, Photogrammetry, Mine Monitoring
- Production Modelling/Schedules
- Reliability Theory and Maintenance
- Process Control and Design

ENVIRONMENTAL ENGINEERING:

- Mine Ventilation and Environmental Control
- Occupational Health
- Solid/Liquid Waste Disposal
- Revegetation and Reclamation
- Risk Assessment

MINERAL ECONOMICS:

- Exploration and Risk Analysis
- Mine Valuation and Financing
- Management/Labour Relations
- Marketing Mineral Commodities
- Business Organization



Mine centrifuge used to generate high g-forces to model mining problems.



Explosive testing conducted at the Department's blast site.



Spray-on plastics liners have been developed by the Department to strengthen rock in underground tunnels.

ENERGY RESOURCE EXTRACTION:

Tar Sands Mining/Processing
Coal Mining/Cleaning
Uranium Mining

PROCESS ENGINEERING:

Surface Chemistry
Mineral Beneficiation
Process Development, Process Simulation
and Control
Extractive Metallurgy

PRECIOUS METAL EXTRACTION:

Refractory Ore
Non-Cyanide Reagent
Carbon in Pulp, Ion-Exchange
Pressure Oxidation
Biotechnology



Pit wall stability being automatically monitored by computer controlled laser survey instruments.



Processing student performing mineral separation research.

CONTINUING EDUCATION COURSES

The Robert M. Buchan Department of Mining offers a number of continuing education courses to engineers, technologists and management personnel who want to upgrade their knowledge in various areas related to Mining Engineering. Some of the most recent courses offered include:

- Blasting Technology
- Basics of Geology, Mining and Mineral Processing for the Investment Community
- The Professional Supervisor
- Mine Ventilation

GENERAL AWARDS AND SCHOLARSHIPS

Financial assistance is available within the Mining Department in the form of general awards and scholarships, sponsored by the Canadian Mineral Industry. The staff will be glad to discuss, with any student or other interested persons, financial assistance and support funds for Mining Engineering studies. Details of each award and other awards are listed in the Faculty of Applied Science Calendar.

STUDENT ACTIVITIES

FIELD TRIPS

Each year, the graduating class goes on a field trip to see mining activities either in Canada or in other parts of the world. Past classes have taken trips to Sweden, Mexico and Poland. The trip organization is conducted by the fourth year class along with staff members and industry contacts. The trips are not only educational but provide an opportunity for socializing and having some fun.

The second year class, early in its program, also has the opportunity to visit a mining operation so the students better understand the practical concepts introduced in the classroom. The field trip generally takes place either in Northern New York State or in Ontario.

The third year class goes on a field trip to see open pit and underground mining activities in Canada. Past classes have taken trips to Eastern and Western Canada and Northern Ontario.



**Undergraduate students visiting
Los Pelambres in Salamanda,**

THE MINING CLUB

Similar to other organizations, the Mining Club consists of a president, vice-president, treasurer, secretary, industrial liaison, social convenor and 2nd, 3rd and 4th year class representatives. Annual events organised by the club include a fall barbecue to welcome the second year students, a golf tournament, a Christmas dinner, Mining Games, and an end of year Party.

Guest speakers from industry give presentations to students and staff within the Department throughout the school year. More recently, speakers from Amec, Cameco Corporation, Goldcorp, Hudson Bay Mining & Smelting, Norwest Corporation, Ontario Ministry of Labour, Ontario Ministry of Northern Development and Mines, Saskatchewan Labour and Xstrata, have participated.



Annual Fur Cup Hockey Game with Geology

Annually, the students within the Mining Department vote on the allocation of a Bed Fund, available specifically for improving undergraduate laboratory and classroom teaching. Professors submit ideas as to where improvements could be made to our program with the addition of new, high tech equipment or the replacement of older, obsolete equipment.

In the winter, the University Advisory Council comes to speak to the students of each year in order to hear their concerns regarding their courses, professors and gender issues. After discussion, the Council prepares and submits a report to the department so changes can be implemented and problems can be solved. Student participation in all aspects of the Mining Department is always encouraged.

MINING GAMES

The Mining Games is an annual weekend event that occurs in February where students from Universities across Canada with Mining Engineering programs gather for some friendly competition. Events include mineral identification, computer aided design, and surveying. This event is an excellent opportunity to meet other students with similar interests who will become contacts for future career development. Each year, a different University organises and hosts the event. Participating Universities include The University of Alberta, The University of British Columbia, Ecole Polytechnique, Laurentian University, Laval University, McGill University, Queen's University, and Dalhousie University.



Undergraduate students performing a simulated mine rescue during the annual Mini-Mining Games.