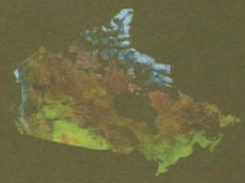
Natural Resources Canada | Ressources naturelles Canada



A Centennial to Celebrate

Energy and Minerals Science and Technology

100 years of excellence

Improving the quality of life of Canadians through natural resources

Canada

Acknowledgement

This document draws upon material prepared by **Dr. John Udd** and **Dr. David Reeve**, as well as other current and past Natural Resources Canada staff members.

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Energy and **Minerals**
Science and **Technology**

100 years of excellence

Through One Hundred Years

1907 – Department of Mines

1936 – Department of Mines and Resources

1950 – Mines and Technical Surveys

1966 – Energy, Mines and Resources

1995 – Natural Resources Canada

The year 2007 marks the 100th anniversary of Natural Resources Canada's (NRCan's) contribution to science and technology excellence in energy and minerals.

Over the past hundred years, the thousands of men and women who have worked with skill and dedication at NRCan and in its predecessor organizations have made a significant difference to our economy and the well-being of Canadians. This is their story.

In 1907, this centennial of excellence began with the creation of the federal Department of Mines. The *Geology and Mines Act* (the *Act*) was given royal assent on April 27 after being passed by the House of Commons and the Senate. The Department consisted of two branches: the Mines Branch and the Geological Survey of Canada. The Mines Branch — evolving through various name and organizational changes — would become home to a growing range of skills and expertise in energy and minerals science and technology (S&T). Today, this S&T excellence continues in the Energy Technology and Programs, Energy Policy and Minerals and Metals sectors at NRCan.

The Mines Branch began with a staff of 21 people providing needed assistance to Canada's mining industry. The functions of the Branch were defined in the *Act* as follows:

- To collect and publish full statistics of the mineral production and of the mining and metallurgical industries of Canada, and such data regarding the economic minerals of Canada as related to the processes and activities connected with their utilization, and to collect and preserve all available records of mines and mining works in Canada

- To make detailed investigations of mining camps and areas containing economic minerals or deposits of other economic substances, for the purpose of determining the mode of occurrence, and the extent and character of the ore-bodies and deposits of the economic minerals or other economic substances

- To prepare and publish such maps, plans, sections, diagrams, drawings and illustrations as are necessary to elucidate the reports issued by the Mines Branch

- To make such chemical, mechanical and metallurgical investigations as are found expedient to aid the mining and metallurgical industry of Canada

- To collect and prepare for exhibition in the Museum specimens of the different ores and associated rocks and minerals of Canada and such other materials as are necessary to afford an accurate exhibit of the mining and metallurgical resources and industries of Canada

Since then, the Department has evolved to meet many of the socio-economic needs and concerns of Canadians. By meeting the challenges of the day and anticipating those of the future, NRCan and its precursors have consistently played an invaluable role over the past hundred years.

Examining both society's drivers and the achievements of the Mines Branch and its successors helps to provide an understanding of just how the Department has grown into a twenty-first century leader in energy and mineral science and technology excellence.

The Early Years

In its early years, the Mining Branch studied the direct reduction of iron ores, tested fossil fuels — including peat — and a wide range of ores from across Canada, undertook field studies related to iron ore, tungsten, gypsum and asbestos deposits, and examined the high accident rates in mining.

The spirit of collaboration and partnership that would become a hallmark of NRCan's research work can be seen in one of the Branch's first assignments: an investigation of the state of the coal industry and deposits across Canada undertaken with McGill University.

Another trait that could be seen at this time was the forward-looking and responsive nature of interests pursued by the Branch.

The oil sands (originally called "tar sands") of northern Alberta are a good example of this evolutionary development.

The first reference to the oil sands deposits in the Peace and Athabasca country is found in the Branch's report for 1912, where it was stated: "It is generally admitted that the occurrence of native bitumens, which outcrop along the Athabasca River, are among the largest, if not the largest, in the world."

The Department proposed to take steps to determine the probable economic value of the deposits. In 1913–1914, hundreds of samples were collected from the oil sands.

Research and development related to the exploitation of these valuable resources has continued throughout the past century.

Technologies developed by the Department in this area are considered to be one of its greatest contributions to the Canadian minerals industry.

First Fuel Testing Efforts

In 1907, a large portion of the iron ore and coking coal used in Canadian iron-making blast furnaces was imported. As well as leading a search for indigenous sources of iron ore, Dr. Eugene Haanel, the first Director of the Mines Branch, championed the idea of making iron-using electric furnaces for smelting, using peat as one of the reductants for iron ores.

Thus, the processing and utilization of peat, which was regarded as an abundant source of fuel, became the first fuel-related interest of the new branch. It was thought that the cost of dried peat would be less than that of bituminous coal, making it a candidate as a fuel for gas and electricity production.

In theory, peat would provide an alternative to what was thought to be the rapidly vanishing deposits of anthracite and the limited deposits of bituminous coal in the United States. The peat program continued for some years until it was realized that dried peat could not compete in terms of cost with other readily available energy sources.

First World War

Providing Metallic Ores and Minerals to the War Effort — The outbreak of the First World War in 1914 brought with it a great demand for minerals. Metals were vital to the war effort. As the Branch reported in 1915, the war had "become essentially a war of materials, as well as men," with supplies from Canada being purchased by the Imperial Munitions Board.

Many Canadian producers were small and had no ore-processing facilities. Therefore, the Board turned to the Mines Branch to be "the miller and assayer for the Board in all matters pertaining to the supply of metallic ores and minerals". Of particular importance was the processing and concentration of molybdenite from a number of small mines in the Ottawa area. The metal was used as an additive to strengthen armour-plating steel. During 1917, the demand for the metal was so great that the Ore Dressing Laboratory was operated as a molybdenite mill on an around-the-clock basis.

With the end of hostilities in November 1918, the demand for minerals needed for the war effort ceased. This was coupled with a general slowdown in the Canadian economy. It was time for a directional change.

The focus of the Ore Dressing and Metallurgical Division shifted to testing samples of Canadian minerals and ores of economic interest.

The 1920s and 1930s

Coal, Oil and Oil Sands — The Fuels and Fuel Testing Division's work included studies in the carbonization of peat, the use of bitumen from northern Alberta as a road paving material, as well as the application of the Trent Process for the purification of high-ash coals and the Hoffmann Potash Test in classifying coals.

At this period in Canada's history, the principal source of energy from fossil fuels was coal. Since all of Canada's deposits were in the Atlantic or Western provinces, Central Canada was vulnerable to fuel shortages due to stresses on production capabilities and the transportation distances involved.

In 1922, the Dominion Fuel Board was established as a departmental agency to find solutions to coal shortages being experienced by industry. The Fuels and Fuels Testing Division provided consulting advice to the Board and conducted special projects at their request. While the main focus of the Division was on coal during this period, the use of oil and oil products was increasing rapidly because of their growing use in transportation and for heating.

During this period, the Fuels and Fuels Testing Division achieved success in overcoming the main obstacle in the utilization of the oil sands — the difficulty of separating the bitumen from the sand. Oil sand was successfully separated through the use of hot water and flotation. This method was a precursor of the Clark "hot water" process still used today in the Fort McMurray oil sands operations.

This was but one of the achievements of the Mines Branch at the time. In the 1926 annual report, it was stated: "The work of the Mines Branch is a directly contributing factor to the greater development of Canada's mineral wealth. The reports and records of the Branch furnish a storehouse of information respecting the occurrence, preparation, and utilization of mineral products, and the department laboratories are continuously engaged in test work on the character of minerals and the determination of

methods of treatment, and in research investigations for the proving or development of new uses or processes."

The Branch was also instrumental in helping develop the gold mining industry during this period. By 1935, some 50 new gold mills had entered production, with most using processes developed in the Ore Dressing and Metallurgical Laboratories.

Not to be forgotten in the early years was the establishment of the Explosives Research Laboratory in 1920 following the proclamation of the *Explosives Act*. The Department of Mines established an Explosives Division with an associated laboratory. Following several relocations, the laboratory moved to its current location at the CANMET Bells Corners Complex in 1969, when it became the Canadian Explosives Research Laboratory, or CERL, as it is generally known.

Second World War

War Work — The Mines and Geology Branch focused its efforts on special investigations essential to the war effort, including study of the feasibility of using activated carbon in gas masks and the possibility of using crude oil from Turner Valley, Alberta, as a source of aviation fuel. It was found that the octane rating of Turner Valley oil could be increased by catalytic reforming and that high-purity toluene could be produced from the oil for use in the explosives industry.

Focus on Armaments

In the Metallic Minerals Division, no less than 25% of the engineering staff and 30% of the chemical laboratory staff were engaged in research and test work on the production of armaments. Metals were in great demand – especially those needed to strengthen steel.

In 1942, the Physical Metallurgy Research Laboratories (PMRL) were constructed on Booth Street in Ottawa to develop materials with improved properties and performance for the Allied war effort. These facilities — considered to be the best in the country — included melting furnaces, a foundry, equipment for a rolling mill, die casting, extrusion, heat treatment, and materials and creep testing. Microscope, spectroscope and X-ray facilities were available too.

At the end of the war, the Branch was permitted to disclose the details of what had been one of its most important secret contributions to the war effort — manufacturing a major component of equipment used in the detection of submarines.

Post-War Years

Increased Emphasis on Science — The end of the Second World War saw programs shifting from practical wartime investigations to an emphasis on science. The role of technology in assisting industry remained a priority.

Another shift occurred in 1950, when the Branch undertook a study to assist industry by improving the design of mine workings and decreasing the danger to miners posed by violent occurrences known as "bumps" or gas outbursts. This marked the beginning of mining research in the Branch.

In addition to the short-term applied projects needed to support industry needs, there was a move towards long-term research. This shift can be seen in the 1952–1953 report of the Mineral Dressing and Processing Division: for the first time, the annual report contained a section headed "Research." The focus of research activities included the extraction of titanium from the ilmenite ores of Allard Lake, Quebec, the high temperature chemistry

of blast furnace and basic open hearth slags, the fusion of magnetite concentrates, spectrographic analyses of rare earth elements, and the corrosion of metals. The new emphasis on research was also reflected in hiring practices. It marked the beginning of the recruitment of scientists with Ph.D degrees.

In 1957, the Branch annual report noted that "the Department continues to be concerned primarily with technical and scientific research directed to the economic and efficient development and utilization of Canada's wealth of mineral resources."

The Department's S&T excellence during this period is reflected in the fact that, by the 1950s, almost every milling process used at Canadian mine sites had been improved by Mines Branch staff.

In metallurgical research, there was a broad range of developments in zinc fuel rod coatings and uranium rolling procedures in response to the requirements of Canada's rapidly growing nuclear power industry. During the same period, work at PMRL improved the fracture toughness of steels and developed techniques to remove impurities during steel making. A desulphurization technique developed at PMRL, which was adopted as standard industrial practice, generated a 10-15% increase in steel-making capacity.

An indication of the work being undertaken in the area of energy research at this time can be seen in the organization of the division in 1969. There were three programs:

- Air Pollution and Combustion Research
- Evaluation of the Quality of Canadian Resources of Fossil Fuels
- Certification of Electrical and Diesel Equipment for Use in Coal Mines

Making Coal Mines Safer

In 1955, the Canadian Explosive Atmospheres Laboratory began testing and certifying equipment for use in explosive atmospheres. This work involved determining the intrinsic safety of electrical devices used in explosive atmospheres (particularly coal mines), testing the fire-retarding characteristics of conveyor belts and determining the constituents of diesel engine exhaust emissions.

Leduc Oil Discovery

A major turning point in the history of Canada's petroleum industry occurred in 1947, when oil was discovered near Leduc, Alberta. On February 13 of that year, the provincial mines minister turned a valve to start oil flowing from Leduc Number 1.

By the end of 1947, an additional 147 wells had been drilled and 5,600 barrels of oil were being produced daily. Canada was beginning to emerge as a major oil producer. Exploration for oil was booming in the West.

By 1953, petroleum had surpassed gold as Canada's leading mineral commodity. In the coming decades, the production of energy minerals would far outweigh the production of metallic and non-metallic minerals, with a resultant shift of economic power towards the Western provinces – particularly Alberta.

Changes in Energy Use

During the previous three decades, the pattern of the country's use of various sources of energy had changed dramatically.

In the 1940s, coal had been burned to produce 60% of Canada's energy needs. By 1969, this had decreased to 10%. At the same time, the use of oil and natural gas had increased to 54% and 29% from 30% and 3%, respectively.

Pipeline Materials Research

Since 1972, Branch research activities have ensured the integrity of Canada's vast network of pipeline infrastructure. The work on corrosion, stress corrosion cracking and methods of monitoring the structural integrity of Canada's pipelines has added substantially to the security of Canada's supplies of energy. In support of increased offshore energy exploration during the 1980s, Minerals and Metals Sector scientific staff developed new standards for the structural integrity of oil and gas platforms.

PERD Funds Energy Research

Following the oil embargo, in 1974 the Program of Energy Research and Development (PERD) was established to radically increase the energy research and development programs being conducted in government science-based departments.

The Mines Branch became the principal recipient within the department of these new funds. This resulted in energy-related programs receiving significantly increased budgets, allowing the creation of new programs. An indirect benefit for minerals-related programs was that a portion of the previous energy base funding was reassigned to minerals priorities.

In July 1985, a five-year plan for PERD was developed which would support the policies for economic renewal. The main thrusts were to be the efficient uses of energy; fossil fuels; nuclear fission; renewables; new liquid fuels; conventional oil, gas, and electricity; and environmental issues.

The 1970s and 1980s

New Concerns — The 1970s marked a major turning point that was to prompt a significant realignment of science and technology within the Department. In fact, these changes were to be felt throughout Canadian society.

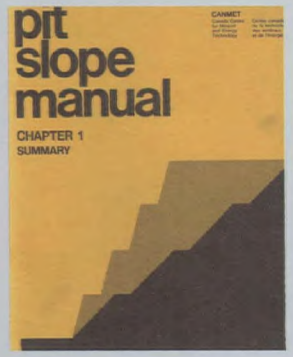
The conservation of resources and alternative energy sources moved to the forefront — especially after the 1973 Middle East war, when Arab states reduced their crude oil production by 25% and indicated that further monthly reductions of 5% would commence two months later. This cutback of production and an embargo on oil exports to the United States plunged the world into its first energy crisis. In Canada, the price of oil quadrupled within months. There was a request for voluntary restraints on the pricing of Canadian crude oil and, for the first time, a one-price system was introduced in the country. For Canadians, the days of cheap energy were over. The focus would now be on the supply and distribution of energy, alternative sources, and conservation.

The energy crisis also brought about a renewed interest in coal and the oil sands as sources of energy, with resulting research being undertaken in these areas.

Air pollution also became a global issue. Throughout the world, legislation was being enacted to establish acceptable limits for air pollution and the penalties that would be applied for exceeding these limits. The role of the Mines Branch was to help industry to find practical solutions to some of the atmospheric problems resulting from combustion. Work in this area focused on improving the process of combustion and eliminating the resulting pollutants by dispersion into the atmosphere.

Environmental concerns would grow in the coming years — bringing with them a new focus for departmental research and policy. Science would take on an additional role. It would now help drive government policies and strategies.

CANMET Created — The greater emphasis on research and development was recognized on January 15, 1975, with the transformation of the Mines Branch into CANMET — the Canada Centre for Mineral and Energy Technology. In addition to underlining the role of technology, the new organization also reflected the increased role for energy-related research.



The new Branch had four divisions in Ottawa, which represented its spheres of activity:

- Energy Research Laboratories (Bells Corners)
- Mining Research Laboratories (Bells Corners)
- Mineral Sciences Laboratories (Booth Street)
- Physical Metallurgy Research Laboratories (Booth Street)

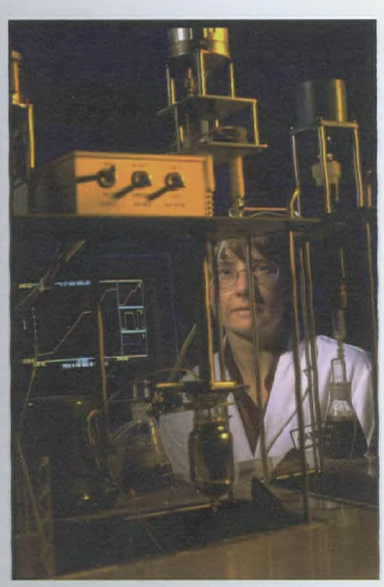
In addition, there were facilities in Québec City, Elliot Lake, Calgary and Edmonton. In total, there were about 700 people in the new organization, which had a budget of about $15 million.

Departmental Focus — The energy crisis of 1973 continued to cause economic shocks. Added to this was concern that the world's energy supply would fall short of demand by 1990.

These drivers caused the Department — Energy, Mines and Resources at this time — to focus on stimulating exploration for oil and gas, finding alternative sources of energy, reducing consumption and taking other conservation measures.

In fuels research, a major breakthrough in technology transfer was achieved when Petro-Canada announced the construction of a demonstration plant, with a capacity of 800 cubic metres per day (5,000 barrels/day), using the CANMET hydrocracking process, to upgrade heavy residual oils at its Montréal refinery.

Mining S&T moved forward with the Pit Slope Project (1972–1977), which put the design of open pit mines on a sound engineering footing. It was one of the most significant scientific and engineering contributions ever made by departmental mining researchers. With tens of thousands of copies of the individual chapters having been sold around the world since 1977, it was the Mine Branch's best-selling publication and resulted in the elevation of the Canadian government's mining research to that of a world-class player.



By 1978, CANMET had grown to about 750 people, 275 of whom were scientists. The level of activity during this period can be seen in the more than 1,000 scientific and research papers that were produced and the more than 2,000 requests for advice and information that were answered.

The minerals research focus during this period was on renewing the Canadian minerals industry and strengthening its position in world markets. Work by the Mining Research Laboratories showed the cooperative approach being taken to devising solutions for industry concerns.

By the early 1980s, rockbursting (or the explosive failure of highly-stressed rock) had become a serious problem in Ontario mines. By mid-1985, the federal government, the Ontario government and the Ontario mining industry had come together to set up the five-year Canada-Ontario-Industry Rockburst Research Project. CANMET agreed to provide its research expertise, while the Ontario government and the industry provided the equipment needed and field installations and support. Each of the three contributions was valued at $1.4 million (for a total of $4.2 million), making it the largest tripartite mining research project established to date. Within five years, Canada had attained world-class status in rockburst research. The project also resulted in a very large payback for both the industry and its workers.

This joint partnership approach could be seen in other CANMET activities. In 1986–1987, more than 200 research contracts were issued. The focus was shifting to joint projects, cost-shared work and cost recovery. These activities were seen by government as indicators of the value that client organizations placed on the work performed in government laboratories and of the relevance of its research programs to the needs of industry and society.

As a newly designated government technology centre, CANMET worked closely with its client industries to ensure that technologies and knowledge were transferred to end users. During 1986–1987, CANMET recovered a total of $1.39 million for its services and sponsored 30 seminars, workshops and conferences. The organization spent about $72 million, and its work represented about 10% of all of the research conducted in Canada in the minerals, metals and energy industries.

The 1990s to the Present

The last decade of the twentieth century saw further dramatic changes in the driving forces affecting the Department and its S&T activities, as well as in society itself.

With an increased focus on the environment, the federal government issued its Green Plan in December 1990. The Plan laids out strategies to improve the environment with action on issues ranging from urban smog to the protection of historical resources. One of those cited was the reduction of acid emissions from coal combustion.

The CANMET organization chart for 1993–1994 reflects the concerns of this period. The organization was now headed by an Assistant Deputy Minister and was called the Minerals and Energy Technology Sector.

The list of main research groups provides insight into the activities being pursued at this time:

- Mineral Sciences Laboratories
- Metals Technology Laboratories
- Western Research Centre – Devon (oil sands)
- Energy Research Laboratories
- Mining Research Laboratories
- Energy Efficiency
- Alternative Energy
- Energy Diversification Research Laboratory – Varennes
- Canadian Explosives Research Laboratory

By 1995, CANMET was concentrating a large part of its research on alternative transportation fuels such as propane, natural gas, methanol and ethanol on sources of alternative energy for transportation, such as fuel cells, and on hydrogen-powered vehicles.

This was also a significant year for the organizational setup of the Department. In January 1995, Natural Resources Canada was created through the merger of two departments — Energy, Mines and Resources and Forestry Canada. Later that year, NRCan was reorganized to achieve closer linkages between scientific work and policy objectives and generate policy benefits from the input of sound science.

This resulted in CANMET being divided into two separate branches: the Energy Technology Branch and the Minerals Technology Branch. The two S&T streams were now in different sectors — the Energy Sector and the Minerals and Metals Sector.

Energy S&T moved forward with an increased focus on climate change issues and sustainable development. Renewable energy and energy efficiency were also key research drivers.

Minerals and metals S&T continued against a backdrop of significant reductions in private sector mining research. At the Materials Technology Laboratory (MTL), research focused on the development of stronger steels for oil and gas pipelines and standards for weld integrity in severe marine environments. MTL researchers also made significant contributions to the development of lead-free alloys for use in plumbing infrastructure carrying potable water supplies. The Laboratory's Advanced Concrete Technology program developed technology to reduce the amount of Portland cement required in concrete by partially replacing it with fly ash, a by-product of coal-fired power plants. The use of high-volume fly ash concrete significantly reduces the carbon dioxide (CO_2) signature of every cubic metre of concrete produced while retaining the durability and mechanical properties of conventionally produced concrete.

In 1996, new funding was allocated to the CANMET Energy Technology Centre (CETC) – formerly the Energy Research Laboratories. This considerably expanded its mandate, which had been essentially restricted to fossil fuels since 1907. It enabled CETC to provide leadership in the development of clean energy technologies aimed at reducing Canada's greenhouse gas emissions.

Combustion research focused on the suppression of acid rain emissions through bench-, pilot-, and demonstration-scale projects. New clean energy technologies were implemented with private sector partners and utility companies and under cooperative arrangements through the International Energy Association.

In 1997, CETC-Ottawa continued its support of alternative transportation solutions with its participation in an $8 million investment in Ballard Power Systems' work on fuel cell development for vehicles.

That same year, CETC-Devon developed an advanced process for the separation of bitumen and sand. The results formed an integral part of Shell Canada's $1.3 billion oil sands processing plant.

S&T Drivers

- Sustainable development
- Clean air
- Global warming
- Climate change
- Reduction of greenhouse gases
- Energy efficiency
- Alternative energy
- Health and safety

Combustion technology

CETC's hundred years of providing national leadership in combustion technology resulted in the following achievements:

- Developed design criteria to allow the efficient burning of Canadian coals for electricity generation
- Introduced advanced combustion technologies to minimize acid gas emissions
- Put Canada at the forefront of developing new "zero emissions" clean coal technology

The high standard of S&T work carried out by the Department was reflected in the ISO certification obtained by the energy and minerals and metals laboratories.

By 2003–2004, climate change was identified as one of the greatest challenges to sustainable development in Canada. There was scientific evidence that human activities, particularly deforestation and energy production and consumption, were accelerating the production of greenhouse gases, particularly CO_2 .

Several of the initiatives funded through the Climate Change Action Plan for Canada were in the areas of energy efficiency and alternative energy. They would have positive effects in reducing greenhouse gases. Longer-term solutions to greenhouse gas emissions were also being sought.

The focus of research activities, which were born out of the energy crisis of the 1970s, can be seen in the budgetary allocations for the two S&T streams. In 2003–2004, $51 million was budgeted for the Minerals and Metals Sector, while $724 million was allocated to the Energy Sector.

Some Current NRCan S&T Activities

- **Alternative Energy** programs are improving domestic and commercial energy end-use efficiency. They include solar storage district heating systems, the SolarWall® to heat ventilation air for large buildings, wind-energy systems, small hydro (run-of-the-river) development, and the development and deployment of hydrogen and fuel cells. In addition, biomass conversion programs provide an alternative source of gaseous and liquid fuel bioproducts.

Energy S&T Today

Energy Technology and Programs Sector

CANMET Energy Technology Centre (CETC) – Ottawa

- Increasing energy efficiency in residential, commercial and institutional buildings
- Reducing energy intensity of industry through new processes, products and services
- Increasing energy efficiency of communities through district energy and urban planning
- Reducing emissions from fossil fuel fired combustion (CO_2, particulate matter, mercury, NO_X, SO_X)
- Reducing emissions from transportation (particulates, NO_X, CO, VOCs) and promoting alternative fuels such as natural gas, alcohols, other biomass-derived liquids, and hydrogen
- Developing more efficient hydrocarbon (coal, oil and gas) conversion processes
- Developing and promoting novel alternative/renewable energy technologies, particularly fuel cells (mobile and stationary) and wind, biomass, small hydro, solar (active and passive)

CANMET Energy Technology Centre (CETC) – Devon

- Oil sands environmental issues
- Development and testing of bitumen froth treatment technologies
- Water management
- Oil sand extraction and processing technologies

CANMET Energy Technology Centre (CETC) – Varennes

- Encouraging targeted sectors of the Canadian economy to reduce greenhouse gas (GHG) emissions, use energy more sustainably, and improve their innovation capabilities
- Clean power
- RETScreen International Clean Energy Decision Support Centre
- Refrigeration technologies for arenas and grocery stores

Minerals and Metals S&T Today

Minerals and Metals Sector

CANMET Mining and Mineral Sciences Laboratories (CANMET-MMSL)

- Research and development on a wide range of processes and technologies involved in extracting ore from the ground and transforming it into a concentrate, mineral product or metal
- Ground stability monitoring and control, mine mechanization/automation, mine air quality and ventilation, and coal mining health and safety
- Metallurgical processing and minerals and metals recycling development, applied mineralogy development and support
- Treatment of gaseous and liquid mine and mill effluents (including acidic drainage), mine decommissioning and rehabilitation, and scientific input for development of environmental policies and regulations for metals
- **Sudbury laboratory** focuses on automating mine ventilation and controlling diesel pollutants and other toxic substances
- **Val-d'Or experimental mine** is an underground facility for in-situ testing and research in a mining environment

CANMET Materials Technology Laboratory (CANMET-MTL)

- Materials technologies to enable weight reduction for transportation vehicles, leading to improved fuel efficiency, reduced emissions, and enhanced durability and safety
- Corrosion management tools and remote monitoring systems for the oil and gas pipeline industry
- Materials for next-generation nuclear reactors
- Materials for other sectors (defence, aerospace, health, advanced manufacturing) requiring niche technological assistance via composite or nanostructured and related processing techniques

CANMET Canadian Explosives Research Laboratory (CANMET-CERL)

- Testing of explosives, fireworks, pyrotechnics and other energetic materials for authorization under the *Explosives Act*
- Testing and certification of equipment for use in hazardous locations (explosive atmospheres)
- Assessment of the hazards associated with energetic materials to improve process safety
- Research into the properties of energetic materials
- Protection of buildings and infrastructure against blast

- **Energy Efficiency for Buildings, Industries and Communities:** Working in partnership with Sterling Homes, the Town of Okotoks, Alberta and other partners, CETC-Ottawa is supporting the installation of North America's first large-scale seasonal storage project. Solar energy will provide over 90% of space heating requirement for 52 homes, saving up to 5 tonnes of greenhouse gas emissions per home.

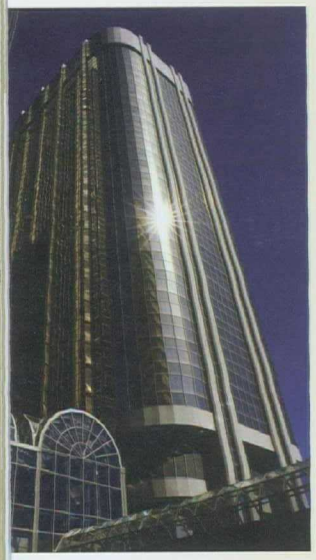
- **Clean Coal:** Clean coal technologies provide a platform to establish the clean and efficient use of coal for power generation, and to contribute to the reduction of emissions and the conservation of energy resources. CETC-Ottawa, with its expert staff and unique pilot scale research facilities, is advancing clean coal near-zero emissions technologies such as oxy-fuel combustion and coal gasification, in cooperation with a large network of national and international participants, the CETC Oxy Fuel CO_2 Research Consortium. The latest developments and emerging technologies in clean coal, combined with CO_2 capture and sequestration, have the potential to remove almost 100 percent of atmospheric emissions of criteria air pollutants, toxic substances such as mercury, and carbon dioxide.

- **Oil Sands Tailings and Water Management:** The extraction of bitumen from surface-mined oil sands is a water-based process that currently consumes 3 to 4 barrels of water per barrel of bitumen produced. Much of this water ends up as fine tailings, a fluid mixture of water and clay. There is currently about 625 million cubic meters of these fine tailings being stored in vast tailings ponds in Northern Alberta. NRCan's research into effective tailings and water management technologies is continuing with such partners as the University of Alberta's Oil Sands Tailings Research Facility, which is located at CETC-Devon. The first reclamation of an existing tailings pond will be completed by

2010. Solutions to the water and tailings issues are critical to the planned increases in production from the oil sands.

- **Community Energy Systems:** CETC-Ottawa has provided support and advice to several Canadian communities for the application of combined heat and power systems (CHP). For example, Hamilton, Ontario, uses a CHP system to provide both heating to its downtown core and electricity to City Hall. Ground-source heat pumps are being considered by the City of Winnipeg, eliminating the need for natural gas.

- **RETScreen®:** Empowering cleaner energy decisions around the world, RETScreen was developed by CETC-Varennes. It is recognized as the world's leading software for screening or assessing the viability of renewable energy and energy-efficient technology (RET) projects. RETScreen's popularity is undeniable — more than 123,000 users in 218 countries have downloaded the software, which is now available in 26 languages. The recently released expanded version now helps engineers, architects and planners evaluate a variety of energy efficiency opportunities for residential, commercial and institutional buildings and industrial facilities. By 2012, worldwide project costs will be reduced by $8 billion as a result of RETScreen use, facilitating the implementation of clean energy projects that improve air quality and reduce greenhouse gas emissions. It clearly illustrates NRCan's leadership role in creating and disseminating knowledge.



- **Hybrid Scoop:** One of the biggest costs in mining is ventilation, and diesel-powered equipment is a major contributor to that requirement. A hybrid diesel-electric mining scoop is expected to improve health and safety for miners by lowering emissions almost to zero. A ceramic filter developed by MMSL and a Canadian industry partner is playing a large part in the development work. Besides allowing near-zero emissions hybrid equipment to be developed, the filters enable existing diesel equipment to meet newly implemented air quality standards for underground mining. The hybrid scoop is to be tested at the Experimental Mine in Val-d'Or.

- **Anti-Vibration Rock Drill Handle:** A problem with handheld mining drills is vibration, which causes a condition known as "white hand." Anti-vibration measures developed by MMSL and a Canadian industry partner are now being commercialized. The anti-vibration unit can reduce vibration by 60%. Employee retention and the aging workforce are significant factors in the mining industry, and this development is expected not only to help improve worker health and safety but also to reduce costs.

- **Mine Waste Management:** Portland cement is used as a binder in mine backfill and for stabilization of mine waste products. However, it is expensive. MMSL, in close collaboration with a Canadian company, investigated the synthesis of a low-cost binder for stabilization of mine backfill, leach residues and sulphide tailings, using inexpensive by-product materials such as slag, power plant fly ash, lime, and gypsum.

- **Green Mines - Green Energy:** To return these areas to productive land use, an NRCan-led consortium has been formed to examine use of "waste" organic materials (municipal compost, pulp and paper waste) to rehabilitate mine sites by establishing energy crops (canola, corn, soy) for the production of biofuels. This use of brownfield sites for green energy production has the potential for on-going cash flow on reclaimed tailings as a means of subsidizing monitoring and treatment costs. Project partners include the mining and forestry industries, cities and universities.

- **Materials Technology Laboratory Relocation:** In July 2005, NRCan announced the relocation of the Materials Technology Laboratory to Hamilton, Ontario. By relocating the new laboratory within an existing cluster of industries and research organizations in the heart of Canada's automotive and steel manufacturing industries, the move will foster increased synergies among industry, the academic community and government research. It will also better enable NRCan to serve key industries that manufacture value-added metal products.

- **Corrosion management tools for the oil and gas pipeline industry:** Internal pitting corrosion causes about one failure per day in Canadian production pipelines, many of which transport highly toxic hydrogen sulphide gas. The industry's response has been to use corrosion inhibitors. But no single inhibitor suits all situations because the effectiveness of an inhibitor is determined by many different variables, such as the properties of the inhibitor, the means of application, and the pipeline operating conditions. MTL's Infrastructure Reliability program has developed software, standards and laboratory testing equipment for evaluating corrosion inhibitors to take these multiple variables into account.

- **Lightweight magnesium engine cradle:** Magnesium, the lightest of all structural metals, is 35% lighter than aluminum and 75% lighter than steel. An MTL research team contributed to the development of a magnesium engine cradle — the cradle is a major structural component in automobiles that holds the engine block and other power train components in place and is normally made of steel or aluminum. MTL identified coatings that improved the resistance of magnesium alloys to corrosion and developed a technique to measure the ability of fastening devices to hold together dissimilar metals. The team received an award from the U.S. Department of Energy for their work in 2006 and an NRCan Departmental Award in 2007.

- **Mine Environment Neutral Drainage Program**
  - The Mine Environment Neutral Drainage Program (MEND) program was developed to provide the knowledge to address acidic drainage - the largest environment liability facing the mining industry.
  - This co-operative volunteer research program between the Canadian mining industry, federal and provincial governments and non-government organizations developed a toolbox of technologies for stakeholders.
  - This volunteer program established Canada as the recognized leader in research and development on acidic drainage.
  - MEND has significantly advanced environmental management practices and thus contributed to the long-term sustainability of the mining industry.
  - It is estimated that the environmental liabilities of the Canadian mining industry have been reduced by over $400 million since the beginning of MEND (over 20 years ago) and its related programs.

- **Metallurgical Processing:** The need to control atmospheric pollutants has resulted in targets for significant reductions in emissions from base metal smelters. While efforts are underway to develop cleaner technologies within smelters, MMSL is conducting research into alternatives to smelting. Ongoing research is examining methods to remove or reduce impurities from concentrates before they enter the smelting process as a method to reduce emissions, thereby extending the sources of concentrates that could be processed and contributing to the ongoing operation of smelters that are an important economic base for several Canadian communities.

- **Counter-terrorism:** NRCan's CANMET Canadian Explosives Research Laboratory (CERL) in Ottawa is one of this country's most important assets in the struggle to protect against or, if possible, prevent the use of the terrorists' most notorious weapon — explosives. Researchers at CANMET-CERL have dramatically improved our ability to identify and detect explosives and handle them safely. They also possess recognized expertise in the difficult task of making buildings more resistant to blasts.

- **Clean energy**: In January 2007, a new initiative was announced. The ecoENERGY initiatives will help Canada meet its challenge of becoming a clean energy superpower. The four-year $230-million investment in the ecoENERGY Technology Initiative will accelerate the development and market readiness of clean energy technologies. It will foster the next generation of clean technologies and lead the breakthrough to emissions-free energy production and use.

The ecoENERGY Technology Initiative is a focused, integrated approach built on key priorities that include CO_2 sequestration, clean coal, clean oil sands production and renewable energy. It will be managed in collaboration with the Program of Energy Research and Development.

It All Adds Up to a Century of Success

The achievements of the past hundred years clearly show that this really is a centennial to celebrate.

This is also a time to look at NRCan's current achievements and see what the Department's role will be in the future.

While this booklet provides some information about the past century of S&T excellence, it is only the tip of the iceberg. There are many more success stories below the surface that show how energy and minerals S&T at NRCan has grown and evolved over the past hundred years.

At the same time, this brief overview shows clearly that Natural Resources Canada has played — and will continue to play — a major role in ensuring the sustainable development of Canada's resources.

Today, hundreds of men and women are striving to meet this goal. This centennial is their legacy. It honours them and those who came before them. Without their scientific contributions and dedication to public service, the Department's success would not have been possible.

For more information, visit the Natural Resources Canada Web site nrcan.gc.ca.