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OPPORTUNITIES FOR MINING RESEARCH IN CANADA'S ATLANTIC PROVINCES

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OPPORTUNITIES FOR MINING RESEARCH IN CANADA'S ATLANTIC PROVINCES

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Abstract

During the past five years, an enormous change has taken place in mining research in Canada. The severe recession of the early 1980's resulted in a general recognition that the survival of the industry lay in improved productivity. The mining part of the typical operation offered the greatest potential for improvements and return on investments in new technology.

Concurrently with this recognition, an opportunity for funding research arose through a series of Mineral Development Agreements between the federal government and the provinces. The scale of the funding made it possible to move from bench-scale laboratory research to field-scale demonstration projects.

Simultaneously, the industry began to coordinate its research efforts through the formation of technical advisory groups at both the national and provincial levels.

CANMET, as the principal federal organization responsible for the delivery of mining research, has been deeply involved in all of these developments.

In this paper, an overview is given of the most important accomplishments of the past five years. A summary is made of the research thrusts accomplished through the federal/provincial mineral development agreements and of the other funding mechanisms which have developed. A summary is also made of the opportunities for future research which are particular to Atlantic Canada.

Keywords
Atlantic Canada, CANMET, Mineral Development Agreements, Mining, Mining Research, Research Coordination

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INTRODUCTION

Because most minerals and mineral products are produced in many countries and because the prices for these products are established on international exchanges, the average mine operator has little, if any, control over the prices received for the mine's production. Apart from those instances in which the prices of rare or scarce minerals are tightly controlled (such as diamonds) the only means of achieving some degree of control lies in establishing long-term contracts for future deliveries at agreed-upon prices. Unlike manufacturers, the mining company cannot pass along increased costs of production to the consumer.

The costs of production, however, can be controlled to some extent. In the mining industry, costs can be reduced through the increased productivity of workers, through increased efficiency and cost-effectiveness of machinery and equipment, and through improved recoveries of ores and minerals. Perhaps at no time in the history of the Canadian mining industry has greater emphasis been placed on these aspects than at present.

During the early 1980's, much of the Canadian mining industry was in a desperate situation. Caught between costs of production, which had continued to rise during a long period of prosperity, and prices, which had suddenly plummeted to almost historic lows, the key word in the industry was "survival". Productivity of workers, in terms of tonnes per shift was in a period of decline which reached its nadir in 1982. There were many who referred to mining as a "sunset" industry.

As a result of the exceptionally hard times of the early 1980's, the industry began to seek ways of improving productivity and efficiency, and in controlling and reducing costs. The mining cycle, which up to that time was probably the most traditional and conservative part of the operation, was quickly recognized as

offering the greatest potential for improvements and returns on investments in new technology. The trend towards large-scale low-cost bulk methods of mining, which had begun some years previously, was accelerated greatly.

Concurrently, there was a much heightened awareness of the benefits which could be derived from mining research. Previously, largely due to the tradition and culture of mining, this had been neglected. Today, however, at the end of the 1980's, an industrial revolution in mining research is taking place in Canada. The payoffs that have been achieved since the beginning of the Mineral Development Agreements in 1984 have been so great that there is now concern about being able to maintain the momentum. With research being greatly accelerated across the country, a key word today is "coordination".

Mining Research in the Mineral Development Agreements

In the first half of the 1980's, a series of Economic Regional Development Agreements (ERDAs) were signed between the federal government and the governments of most of the provinces and the territories. These Agreements contained sub-agreements which reflected local needs and priorities for development in the various sectors of the local economy. Mineral Development Agreements, or MDAs, were a feature of several of the ERDAs.

The allocation of funds that were made to various areas of economic activity resulted from negotiations between officials from both levels of government. In all instances, efforts were made to assign funds to the areas of highest priority. As the result of these negotiations some of the Mineral Development Agreements made provision for mining research while others did not.

From a minerals perspective, one of the first lessons that was learned from the MDA negotiations was that, in comparison with the

geological fraternity, the mining community was relatively unskilled in collecting, assessing, and priorizing its research and development needs. The discussions which took place in the provinces prior to the signing of the MDAs, and the vacuums which were found to exist, were one of the driving forces behind the formation of the provincial committees and research directorates which will be mentioned later.

Apart from the value of the technology which has resulted from the MDAs, a significant benefit of long-lasting importance has been the development of a structure and process for determining and addressing the R&D needs of the Canadian mining industry.

The mining research projects, which were, or are being, completed through the original federal/provincial or territorial MDAs are listed in Table 1. It must be emphasized that the projects were chosen locally by the industry and, for the most part, were completed by the industry with funding provided by the MDAs. Funding for the work, depending on the agreement, was provided either by the federal or provincial governments. The sources of funding are shown in the table.

TABLE 1

CANADA/MANITOBA MDA

Federally-funded

Design guidelines for the VBM method for a steeply-dipping deposit in Manitoba

Procedures for blasting down hang-ups in ore passes and chutes

Development of a geomechanical data-base for ground control in deep mines

Evaluation of methods for delayed backfill consolidation

Delayed backfill consolidation

Ground stability evaluation with particular reference to en-echelon lensed ore bodies

Optimization of blast design for blasthole mining operations

Communications systems for Isolated areas in mines, especially in multilensed ore bodies

Provincially-funded

Manitoba mines overburden stabilization

Secondary recovery of base metals by in situ bacterial leaching

Waste heat recovery - mine water to heat mine air

Evaluation of non-destructive testing devices for mine shaft ropes

Low-cost stressmeter

Microfiche - Mines Branch records

TABLE 1 (Cont'd)

CANADA/NEW BRUNSWICK MDA

Federally-funded

Use of backfill in New Brunswick potash mines

Hanging wall response to mining of Denison-Potacan

Utilization of CO_2 as an engineering control parameter for automated mine ventilation

Evaluation of improved methods for the non-destructive testing of mine shaft wire ropes

Study and evaluation of sulphide dust/SO_2 monitoring systems

CANADA/NORTHWEST TERRITORIES EDA

Territorial-funding

Post pillar recovery strategies for a frozen ore body

Improved fragmentation and reduced wall damage in a narrow vein ore body

CANADA/ONTARIO MDA

Federally-funded

In situ determination of dewatered tailings fill properties in Ontario mines (two projects)

Liquefaction potential of dense backfill

In situ monitoring and computer modelling of a cemented sill mat and confines during tertiary stage pillar recovery

The use of cemented fills for controlling violent failure in room-and-pillar mining in Ontario

Computer program specifications for the Ontario mining industry

In situ properties of backfill alternatives in Ontario mines

Simulation of bulk mining at depth with backfill in Ontario mines

TABLE 1 (CONT'D

CANADA/QUEBEC MDA

Federally-provincially co-funded

Mining techniques for narrow veined ore bodies

Technical and economic feasibility of mine backfill

Expert systems for the use and maintenance of hoisting systems in mines

Vibration measurement and analysis of jacklegs used in underground mines

CANADA/SASKATCHEWAN MDA

Federally-funded

Subsidence related to potash mining

Research in microseismic technology

Salt Anomaly Prediction

As mentioned, all of these projects were developed after numerous talks had been held between government officials and the mining industry. The latter was contacted by visiting mine operations and meeting with the various mining associations.

In the chronology of events, the Canada/Manitoba MDA was the first to have been negotiated and signed (in 1984). The process of consultation between industry and government that resulted in the selection of the final projects in the MDA has met with broad approval and has served as the model for all of the other Agreements.

The projects included in all of the MDAs were designed by the regional industry in order to meet their own R&D needs. Since the major part of Canadian mining takes place under similar hard-rock shield conditions, the results from most projects are broadly applicable on a national scale.

Thus, because the R&D needs and priorities of individual mine operators may be common to the industry as a whole, there is the potential for some duplication between the research being addressed in the various provinces.

While some duplication and overlap is probably essential if the various pieces of research are to be assembled together into a coherent whole, one of the roles of CANMET as a national organization is to steer and encourage projects in different locations along complementary and compatible lines. CANMET, because of its national mandate and perspective, is in a singularly good position to be aware of the national pattern and to exert a coordinating influence.

Mining Research Coordinating Bodies in Canada

Prior to the advent of the MDAs, mining research in Canada was addressed either through: government laboratories - of which CANMET is the major player; universities - only 8 of which in Canada offer mining programs; or companies - of which only some of the majors (Cominco, Denison, Falconbridge, INCO, Kidd Creek, the Noranda organization, the Potash Corporation and Rio Algom) were very active in research.

A measure of the activity and the national pattern can be obtained from an analysis of the entries in CANMET's first "Index of Mining Technology Development". Published in 1985, as CANMET Special Report SP85-12, the results of our national survey in that year showed that exactly 400 mining research projects were in process across Canada. Of these: 169 were being performed by the industry (and no less than 110 by the companies named previously); 78 by universities; 28 by private sector research organizations; and 125 by public sector research organizations.

By the publication of the fifth edition of the "Index" in 1989, now in press as CANMET SP89-8, the number of projects reported has increased to 802. Of these: 281 are in progress in industry; 235 in universities; 96 by private research organizations; and 190 by public research organizations.

A comparison of the figures shows very clearly that the balance has shifted from public sector organizations to the private sector and universities. While there has been growth in all areas, government research has grown the least (Table 2).

A further examination of the Index shows that in some areas of research there are a great many projects in progress, the best example being the 251 projects on Ground Control listed in the 1989

Index. This emphasises the need for awareness through communications and coordination.

TABLE 2

The Pattern of Mining Research in Canada

(Number of Projects)

	1985	1989	Change (%)
Industry	169	281	+ 66.3%
Universities	78	235	+201.3%
Private Sector Research Organizations	28	96	+242.9%
Public Sector Research Organizations	125	190	+ 52.0%
Total	400	802	+100.5%

Sources: CANMET "Index of Mining Technology Development" (1985 Edition, SP85-12; 1989 Edition, SP89-8 (in press))

In 1984, when the first MDAs were being planned, there was no way of determining the mining industry's research needs other than by contacting the mine operators individually. Gathering information on a national scale and distilling this down into a few key areas for research thrusts was, and continues to be, a monumental undertaking. There are several hundred mines operating in Canada. Complete coverage of the industry may be achieved only after considerable expenditures of time and money.

During the last half of the 1980's, however, the process has been facilitated through the development of a number of research coordinating bodies, networking together.

At the provincial level, a Mining Research Directorate (MRD) has been founded by the Ontario Mining Association, and Research Committees have been formed by the Quebec Mining Association and the Saskatchewan Potash Producers' Association. In British Columbia, a mining research coordinator has been appointed by the Chamber of Mines.

Other organizations, either recently founded or in the formation stage, include: the Canadian Centre for Automation and Robotics in Mining (CCARM), formed by Ecole Polytechnique and McGill in Montreal; a possible centre for Surface Mining, currently being discussed by the Universities of Alberta and British Columbia; a centre for Narrow Vein Mining, at Laval University in Quebec City; and the Geomechanics Research Centre at Laurentian University in Sudbury.

In addition, a network for geomechanics research has developed between Laurentian and Queen's universities and the University of Toronto, in Ontario. MIROC has been relocated to Queen's University in Kingston.

At the national level, the Mining Association of Canada founded the Mining Technology Council of Canada (MITEC) whose purpose is to provide a national coordinating role and to provide advice and direction at the most senior executive levels in government, industry, and academe. A pattern that is now emerging is that each of the various provincial research directorates will occupy a specialty niche within the overall mosaic of research activities. The Ontario MRD, for example, has been directed to address rock mechanics and ground control on a national scale. CCARM was formed to focus on equipment automation, and MIROC has been asked to devote its energies to mining health and safety.

After a period of rapid formation and development, the various organizations are now coordinating efforts between themselves.

Research Opportunites

An inspection of the titles of the MDA projects listed in Table 1, and any of the editions of the "Index of Mining Technology Development", which CANMET has published annually since 1985, allows one to quickly establish the mining research priorities of the Canadian industry. Regardless of the region of the country, the greatest interest is in applications of rock mechanics and ground control. The trend to bulk mining, with the larger underground openings that are required, has made geomechanics absolutely essential as an element in the design and post-excavation monitoring of safe mine openings. The needs of the industry span the spectrum from better predictive models to more durable and rugged monitoring instrumentation. Methods of support are prominent, with great emphasis being placed on backfill.

Next in importance are projects which relate to making improvements to the mining cycle. Many in the industry recognize that the traditional "drill-blast-muck-stabilize" cycle is an

impediment to a smooth and continuous flow of ore from a mine. The entire infrastructure of a mine is built around the mining cycle.

The research which is presently in progress addresses improvements or alternatives to all aspects of the mining cycle - from exploring new methods of penetrating and breaking rock to developing improved mining equipment and alternative materials handling systems. Mine equipment automation, mine information and communications systems, and applications of information technology, are prominent in the lists of project titles.

The next major category, and one which is rapidly gaining in prominence, relates to improvements to the health and safety of workers and to the environment of work, excluding ground control, which is listed as a separate category. If one includes ground control under health and safety, which in large measure it is, this expanded category attains the top importance. The key point is that safety is the primary concern of mine operators. Often, as in rock mechanics, research connects to both productivity and safety and it is impossible to separate the two. Nearly all mining research has a safety implication.

In this category are included projects such as: improved ventilation; reducing equipment vibrations; improved lighting; improved personal protective equipment; reducing engine emissions and other pollutants; mine shaft wire rope testing; and research into dusts, noise, radiation, ore dust explosions, and explosives safety - to name but a few.

None of the project areas mentioned is restricted to the interest of any one province. All are of national importance.

At present, many of the federal/provincial MDAs are either expiring or entering their final year. In the anticipation that there might be a renewal of some of the MDAs, CANMET/MRL staff have

recently made many visits to mines, mining associations, researchers, consultants, and provincial colleagues across the country. As was done before the first MDAs, we have endeavoured to determine the industry's needs and priorities for research and to collect and group these in such a way that regional needs are met while duplications are avoided, or at least kept to a minimum. Because many research needs are common to the entire industry, this has been a tall order!

In the Maritime provinces there has been great interest in CANMET'S specialized work on crown pillars and in the methods and equipment which can be used to mine small and narrow vein deposits. Some of these deposits are located in severely fractured rock masses through which exceptionally great water inflow is encountered. Consequently, the geotechnical techniques, which apply to fractured rock masses, rock mass stabilization, dewatering, and water control strategies, have all been identified as high-priority possible projects.

In the Atlantic provinces, as elsewhere in Canada, there is also concern about the treatment of, and control strategies for, the acidic water drainage from tailings ponds and waste embankments. The industry has needs for better methods and strategies, and for guidelines in the development of abandonment plans for mining properties being closed down. There is strong support for the Mine Environmental Neutral Drainage (MEND) program, which is being coordinated by the industry. Several of the possible projects for future MDAs will probably fit into that overall program.

Conclusion

In this paper, I have presented a general overview of the industrial revolution that began in mining research in the second half of the 1980's. This resulted from the severe recession in the

minerals industry in the early years of the decade, from which it was learned that the economic vitality of the industry would be strongly dependent on increases in both productivity and safety. The mining part of the production chain offered the greatest potential for return on investment in research.

The research which resulted from that awareness has been very practically orientated and, to a large measure, has been achieved by the industry itself. Because of its practical relevance, its value and the payback has been assured.

The Mineral Development Agreements were the catalysts which brought government and industry together to determine the R&D needs and priorities of the time. Much of the funding for the projects was provided by the MDAs.

A second benefit of the MDAs, which must not be overlooked, was that these stimulated the creation of formal mechanisms for the initiation and monitoring of government-funded research projects in partnership with industry. The mechanisms, and the way in which this had led to the creation of research coordinating efforts at the provincial level will be a lasting legacy of the MDAs.

The projects that have been, and are being, accomplished through the MDAs are listed in this paper. Some mention has been made, in general terms, of the industry's priorities for future research. Particular reference is made to those areas which we believe are of particular interest to Atlantic Canada.