Mineral processing, research and development projects in Nova Scotia conducted through the Canada/Nova Scotia Mineral Development Agreement

P.J. HANNON*
Nova Scotia Department of Mines and Energy
and
D.M. DOYLE
CANMET, EMR

Patrick Hannon

Patrick Hannon was born in Ireland and educated in Canada. He graduated from the Provincial Institute of Mining at Haileybury, Queen's University, with a B.Sc. (Eng.) in geological sciences, and the Technical University of Nova Scotia with an M.Sc., in mining engineering.

Between graduation from Queen's in 1972 and 1983, Mr. Hannon worked in mineral exploration, development and production for Esso Minerals Canada. At the time of the presentation of this paper, Mr. Hannon was manager of mining engineering with the Nova Scotia Department of Mines and Energy. Mr. Hannon is currently chief mining engineer with A.C.A. Howe International Limited. He is a Professional Engineer, a member of The Mining Society of Nova Scotia and a member of AIME.

D.M. Doyle

Don Doyle received a B.Sc. in mining from Michigan Technological University in 1957. Prior to joining the Mines Branch (CANMET) in 1985, he held various positions in research, operations, senior management and private consulting, with Noranda, Sherritt Gordon, Johns Manville, Falconbridge, Indusmin and Watts, Griffis, McOuat Consultants. His experience has been in the mineral processing of asbestos, base metal ores, precious metals and various industrial minerals. Don Doyle is head of the Ore Dressing Section of CANMET and its sub-section, dealing with beneficiation of metallic and non-metallic ores. He is a Member of CIM, Past Chairman and currently, Secretary, of the Canadian Mineral Processors, Association of Professional Engineers of Ontario and Co-Chairman, Research and Technology Sector of the Canada/Nova Scotia Mineral Development Agreement.

Introduction

The Canada/Nova Scotia Mineral Development Agreement (M.D.A.) is a subsidiary of a five-year Economic and Regional Development Agreement, signed on June 11, 1984. The objectives of the M.D.A. are to strengthen and diversify the Nova Scotian mineral industry and to coordinate federal and provincial policies and programs. The agreement outlines the activities and responsibilities of each government, including the division of the cost (60:40, federal:provincial) between governments. The agreement established a framework for joint planning to avoid overlap or duplication of programs.

The M.D.A. programs are broadly divided into five sectors (Table 1 and Fig. 1): Geoscience, Minerals Technology, Development, Firm Specific and Public Information. Each sector is administered by a subcommittee composed of one federal member and one provincial member. The subcommittees report to a Management Committee. The Canada/Nova Scotia Mineral Development Agreement (M.D.A.) Management Committee is made up of Dr. Jack Reeves from EMR and Dr. Richard Potter from the NSDME.

The Geoscience subcommittee, co-chaired by Peter Giles (NSDME) and William Poole (EMR), manages the regional geologic, geochemical and geophysical studies in the province. Included in this sector are studies into mineral deposits and the basic geological relationships between mineral deposits.

The Mineral Technology sector is co-chaired by the authors, Don Doyle (CANMET) and Pat Hannon (NSDME). This sector of the M.D.A. conducts studies into mineral processing, sampling, deposit byproduct commodities and project feasibility analysis.

The Development Studies sector is co-chaired by Don

*Currently chief mining engineer, A.C.A. Howe International Limited.

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TABLE 1. Summary of maximum sector expenditure

Sub-Programs	Provincial	Federal (thousands)	Total
Geoscience	$ 5,552	$ 8,955	$14,507
Mineral Technology	1,707	3,275	4,982
Development Studies	946	895	1,841
Firm Specific Program	300	1,300	1,600
Public Information and Administration	2,315	1,700	4,015
Totals	$10,820	$16,125	$26,945

Stonehouse (EMR) and Danny Murray (NSDME). This sector of the M.D.A. examines the markets for industrial mineral commodities and also prepares commodity specific reports for the province. Industrial minerals rank first in value of mineral production in Nova Scotia. The Development Studies are concentrated on this important sector of the mineral economy.

On the provincial side, the Mineral Technology sector and Development Studies sector funding has been combined.

The Firm Specific sector, co-chaired by Terry Daniels (EMR) and Derek Johnson (NSDME) provides marketing and development assistance, on a dollar for dollar basis, directly to industry. The maximum amount of assistance provided to any one approved project is $50,000.

The Public Information and Administration sector, co-chaired by Ed Sampson (EMR) and Howard Donohoe (NSDME) promotes the Nova Scotian mining industry to the general public and the M.D.A. to the mining industry. Activities included in this sector of the M.D.A. are promotion of programs, land use planning, public information, program evaluation and direct technology transfer.

This paper will concentrate on the Minerals Technology sector, with emphasis on mineral processing studies and commodity specific studies now underway.

Mineral Technology Sector

The Mineral Technology Sector of the M.D.A. is composed of commodity specific studies and capital spending for Industrial Minerals testing equipment. Over the five-year life of the agreement, the federal government is committed to spend a maximum of $3 275 000, while the provincial government is committed to spend a maximum of $2 315 000. (R&T and the Development Studies funding combined). This represents 20.7% of the total funds available to the M.D.A.

Table 2 is a year-by-year tabulation of the operating and capital allocation and forecasted expenditures for Resource Studies and Research and Technology projects. The unallocated funds will be available for future projects that have not yet been identified.

When the agreement was being negotiated, both the federal and provincial departments had a number of areas of interest. The Canadian government negotiated with a more regional outlook. For instance, both the silica study and the barite/fluorite study were undertaken with other Atlantic

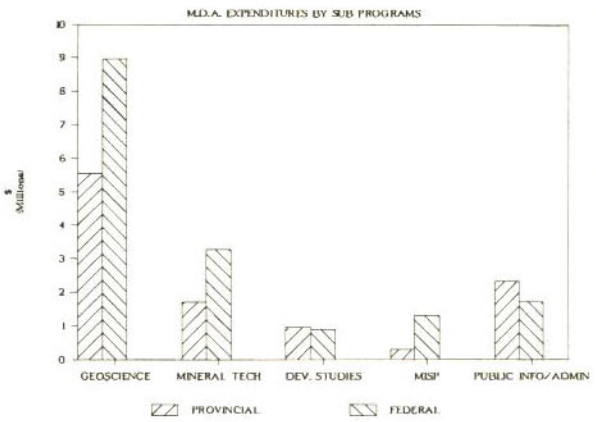

FIGURE 1. Mineral Development Agreement expenditure by sub-program.

provinces, as regional studies. As well, the federal purchase of industrial minerals testing equipment for the CANMET laboratories may be used to test minerals from other parts of Canada.

The Nova Scotia government's concentration is on the Nova Scotian mineral industry, even though the reports on the work completed are public and will be of value in other parts of Canada.

Federally Funded Projects

Table 3 outlines the projects scheduled by the federal government.

Lightweight Aggregates

Funding has been set aside for R&D into the production of lightweight aggregates from Nova Scotia coaly wastes. The project is on hold while we await results from a similar program under way in New Brunswick.

Fly Ash

A major project is a study into the use of fly ash and blast furnace slag in the production of concrete. Nova Scotia produces over 150 000 tonnes of fly ash each year at coal-fired thermal plants. Preliminary results indicate that fly ash can replace up to 30% of the cement (with a similar cost reduction) with no loss in the structural properties in the concrete product. A contract to study the fly ash from the Lingan plant has been let to L.E. Shaw Ltd. and W.S. Langley Ltd. The fly ash concrete will be tested for strength, durability, and for use in harsh marine environments.

Barite-Silica

Reports are available on the results of contracts to Jacques Whitford who reviewed the processing and markets for barite,

TABLE 2. Funding of federal research and technology and provincial development studies and mineral technology

	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Total 1984-90
				(thousands)			
Federal: Research and technology							
Total allocation	$309	$465	$996	$690	$600	$214	$3,275
Year-end forecasted expenditures	309	465	638	251	221	19	1,903
Unallocated funds as of July 1986	$ 0	$ 0	$358	$439	$379	$195	$1,372
Provincial: Development studies mineral technology							
Operating and capital allocation	$ 63	$221	$473	$600	$600	$700	$2,653
Year-end forecasted expenditures	84	132	473	668	300	218	1,875
Unallocated funds as of July 1986	($ 21)	89	0	($ 68)	$300	$482	$ 778

TABLE 3. Research and technology sector federally funded projects

Project	Title	Budget	1984/85	1985/86	1986/87
			(thousands)		
A1	Lightweight aggregates	$ 450	—	—	$100
A2	Fly ash and blast furnace slag	650	—	$ 98	150
A3	Barite/fluorite	70	—	31	—
A4	Silica sand	70	—	21	—
B1	Industrial mineral test equipment	500	$309	175	—
A5 and 6	Gold metallurgical studies	20	—	18	—
A7	Gold off-shore sampling strategy	145	—	36	115
A8	Recovery gold from arsenic ores	50	—	2	48
A10	Evaluation of McRae celestite	250	—	0	250
	Totals	$2,205	$309	$381	$655

TABLE 4. Development studies — mineral technology provincial delivery

Project	Title	Budget	1984/85	1985/86	1986/87
			(thousands)		
1	Aggregates, Part 1	$ 215	$21	—	$ 90
2	Aggregates, Part 2	383	—	—	—
3	Building stone	400	—	$ 20	63
4	Diatomite	110	—	—	48
5	Fillers	65	—	—	65
6	Gypsum/anhydrite	189	—	56	58
7	Various commodities	105	—	—	64
8	Gold	240	—	56	85
Other		881			
Completed Projects					
1	The effect of location on mineral development	15	13	—	—
2	Gypsum industry study	50	50	—	—
	Totals	$2,653	$84	$132	$473

TABLE 5. Projects considered research and technology sector

Project	Title	Budget	1986/87 (thousands)	Future
A9	Study of industrial minerals for fillers	$ 50	$ 50	$ 0
A11	Mineral based chemical industry	$375	$ 75	$300
A12	Extraction of sulphur from anhydrite	$100	$100	$ 0
A13	Evaluation of Pine Brook barite	$ 30	$ 30	$ 0
A	Planning off-shore mineral development	$172	—	$172
A	Mineral process equipment for TUNS	$230	—	$230
A	Hydrometallurgical treatments of ores	$300	—	$300

and from Fenco Shawinigan Ltd. who conducted similar investigations for Nova Scotia silica deposits. CANMET has recently completed laboratory investigations on most of the province's barite and silica deposits, and these results are available.

Gold

The gold fields of Nova Scotia have been subject to a great deal of exploration work over the past years. A report identifying potential R&D project work into gold metallurgical studies has been completed by Peter Maltby and the report is available from CANMET and from NSDME. The report reviews the nature of Nova Scotian gold deposits, including lode deposits, placer deposits and old mill tailings. Gold beneficiation is discussed and various R&D projects recommended include: (1) fluid bed roasting of auriferous arsenopyrite ores; (2) pressure leaching of auriferous sulphide ores; (3) atmospheric oxidation leaching; (4) bacterial leaching; (5) mineralogical studies by image analysis; and (6) sampling and testing of lake bottom residue, basal till and river sediment.

The first phase of our offshore gold study is nearing completion as well as reports on the techniques used to obtain representative samples and methods for on-board analysis. Requests to quote on the next phase of the program will soon be issued and this program will attempt to design a sampling-processing system suitable for installation on a small fishing vessel.

A contract has been let to Lakefield Research for mineral processing investigations on gold ore samples and tailing samples from earlier mining activities.

The potential for offshore placer deposits of gold and other heavy minerals, as well as the potential for offshore aggregate deposits, has been recognized by industry and government. There is a federally-funded project now under way examining offshore sampling strategy.

The contract for Phase I of this project has been let to Nordco Ltd.

Phase I of this project includes: an examination into the feasibility of sampling offshore placer deposits from a modified fishing boat; the investigation of processing alternatives for placer gold; and the preparation of an engineering prefeasibility report into the equipment requirements, costs and the program necessary to define offshore placer reserves.

This program may lead to opportunities for overseas sales of Canadian services and technology, in response to the efforts of numerous nations to explore for seabed mineral resources within their exclusive economic zones.

Other federal projects include laboratory and pilot plant tests into the optimum extraction of gold from an arsenopyrite

ore and the design of a flow sheet for the McRae celestite deposit at Loch Lomond.

Celestite

Timminco Ltd. has been awarded a contract to perform metallurgical tests and produce a prefeasibility engineering study to determine the viability of producing a strontium carbonate concentrate from the McRae celestite ore body.

Provincially Funded Deposits

The provincial projects (Table 4) are commodity specific studies, with a concentration on industrial minerals.

The output from the provincial projects will be commodity-specific reports such as the 1972 limestone and dolomite report by D.A. Murray, and the barite, celestite and fluorite report by G.W. Felderhof.

The diversity of geology and the ideal location of Nova Scotia with respect to the Northeast U.S.A. market and the European market bodes well for the province's industrial mineral development. The commodities to be reported on include: building stone, aggregate, gypsum/anhydrite, diatomite, gold, fillers, and various other commodities. The reports will provide the private sector with location and analytical data, market requirements and market opportunities. From this base, the private sector will be in a good position to do further development work on the deposits.

The commodity-specific studies are being completed under the direction of D.A. Murray, John Fowler and Jim Bingley of the Mineral Development Division, NSDME.

Two projects have already been completed. These are the Centre for Resource Studies' report into the gypsum industry and the study into the locational effect on mine development opportunities. This latter report documented that Nova Scotia ranks at the top of the provinces with respect to return on investment from similar mining opportunities.

As well, a report on the aggregate deposits of Cape Breton Island, along with four, two-colour maps showing the deposits and identifying all pits and quarries, is in the final editing stage.

Aggregates

For the fiscal year 1986-87, a detailed aggregate resource study, including a local and offshore market study, will be implemented in Colchester and Cumberland Counties. This will be a two-year program, conducted by one full-time geologist and one part-time field assistant. Following the field work, a report with maps similar to those described for the Cape Breton Aggregate Study will be published.

A Phase II has been planned for the aggregate project. This will be a sonic drill program, designed to quantify and qualify the most important aggregate deposits outlined in Aggregate Studies, Part I.

The information gleaned from the study will be useful to industry and to government agencies involved in land use planning.

Building Stone

Another important study is the building-stone project. Nova Scotia has a history of producing quality building stone to the nation and offshore. The province has the potential to supply quality building stone for restoration, as well as for new building work.

A full-time geologist has been hired for a five-year term, to research the Nova Scotia building-stone industry. This work will include locating, mapping, and sampling the quarries in the province and also visiting producing quarries in Canada and abroad.

A report and a series of polished samples will be produced, with the objective of promoting the building-stone industry in Nova Scotia to builders and achitects.

Diatomite

A study into the province's diatomite deposits is also under way. Diatomite (also called diatomaceous earth and kieselguhr) consists chiefly of the siliceous remains of diatoms. Diatoms are unicellular aquatic plants similar to algae.

Processed diatomite, because of the unusual particle structure and chemical stability, is a highly-desirable material for filter aids for municipal water supply. Diatomaceous earth is also used as an absorbent, as a filler and as an extender in paper, rubber and plastics. One interesting example of its use is as an absorbent in pig feed. The diatoms adsorb many of the ions that cause the smell after the pig has processed the feed.

A geologist has been assigned to locate, map and sample diatomite deposits in Nova Scotia. This geologist will complete a report on the diatomite deposits, including the deposits in the Cobequids and the potential deposits underlying peat occurrences.

Fillers

Mineral fillers are important industrial minerals. They are inert mineral materials that are included in the composition of a product for some useful purpose, such as the reduction or the alteration of the product's physical or chemical characteristics.

Examples of fillers are limestone, talc, barite, clay, diatomite, feldspar, micas and silica.

A filler might be added to a composition to increase the product density, hardness, fire resistance, smoothness, electrical conductivity or a host of other physical characteristics.

Most filler materials are now imported to the province even though local resources are probably available.

The first part of this program, Fillers Part I, was the acquisition of the Kline report. The Kline report reveals what filler quality is required for a wide range of products.

A geologist has been taken on for Part II of the project to document fillers currently being used in Nova Scotia. The potential of local sources to supply domestic and offshore markets will be examined.

Gypsum/Anhydrite

Nova Scotia is Canada's premier province in the mining and exporting of gypsum and anhydrite. Nevertheless, the documentation of the deposits, their ownership and extent has not been adequate.

A geologist has been hired for a three-year term to compile data, sample and assess the deposits and to examine new market possibilities (i.e. sulphur from anhydrite). A gypsum/anhydrite report, complete with maps and reserve estimates (when possible), will be produced.

Various Commodities

There are several occurrences of unique industrial minerals in the province that may have the potential to become producers. These are andalusite, beryllium, borates, brucite, wollastonite, silica, phosphate, and talc.

A geologist has been hired for a two- to three-year term to examine, sample and assess these deposits. A report will be prepared for each commodity. The report will include a description of the deposits, grade and tonnage estimation, accessibility and also an estimate of the economic potential of the deposit.

Gold

A provincial gold commodity study is also under way. This project will include a comprehensive review of the known gold occurrences in Nova Scotia.

A review of all available reference material on gold occurrences in Nova Scotia will be completed. An attempt will be made to examine each occurrence in the field. Each occurrence will be sampled, analyzed and categorized according to mineralogy, structure and environment.

The Procedure Followed for M.D.A. Project Approval

Federal contracts for M.D.A. projects are awarded through

the Department of Supply and Services. The steps leading to an M.D.A. contract are listed below.

1. Industry and government representatives recommend a particular study that could enhance the economic viability of a mineral commodity, mineral deposit or a mine byproduct.
2. A project identification and annual plan must be approved by the technical sub-committee.
3. The management committee normally accepts the recommendations of the technical sub-committee, but is vigilant to see that the projects are not duplicated by other sectors of the M.D.A. and that the provisions of the M.D.A. agreement are followed.
4. The project is then passed on to scientists and engineers working with CANMET for scientific comment and program outline. A work statement will be prepared at this stage.
5. The Department of Supply and Services will issue a request for proposals to organizations with expertise in the particular field.
6. Proposals will be reviewed and graded by the Scientific Authority.
7. A contract will be awarded.

This procedure normally takes a minimum of six months from the original project recommendation through to the letting of the contract. Provincially funded programs follow Steps 1 to 3. If the program is accepted by the management committee it is submitted to the Provincial Management Board for approval and awarded.

The programs that are now under consideration for funding are listed in Table 3. The members of the R&T sub-committee welcome suggestions for additional mineral industry projects. The technical sub-committee members are as follows: Geoscience Sector — P.S. (Peter) Giles (902) 424-4700, W.H. (Bill) Poole (613) 992-7791; Resource Studies and Research and Technology Sector — P.J.F. (Pat) Hannon (902) 424-4048, D.M. (Don) Doyle (613) 992-7782; Economic Development Sector — D.A. (Dan) Murray (902) 424-4162, D.H. (Don) Stonehouse (613) 995-9466; Firm Specific (MISP) — D. (Derek) Johnston (902) 424-4161; T.D. (Terry) Daniels (902) 426-6988; and Public Information, Administration — H.V. (Howard) Donohoe (902) 424-4700, E.D. (Ed) Sampson (902) 426-2183.

Conclusion

The Canada/Nova Scotia Mineral Development Agreement has provided funds over a five-year period for projects designed to enhance the mineral production capacity of Nova Scotia.

The cooperation between the mineral industry, CANMET and the NSDME has been excellent. The authors wish to thank The Mining Society of Nova Scotia for the opportunity to present this paper and trust that the paper has helped explain the mineral processing research and development projects in Nova Scotia.

Symposium on measurement of toxic and related air pollutants

The 1988 EPA/APCA Symposium on Measurement of Toxic and Related Air Pollutants being held **May 2-4, 1988,** at Mission Valley Inn, Raleigh, North Carolina, is co-sponsored by the U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory, and APCA.

APCA is an international association dedicated to air pollution control and hazardous waste management.

The technical program will include both invited and contributed papers emphasizing emerging technology in the measurement of toxic and related air pollutants (gases and particulates).

Topic categories include the following:

- Hazardous waste emissions
- Acid deposition
- Source measurements
- Quality assurance
- Ambient measurements
- Indoor air pollution
- Exposure assessments
- Wood stove emissions
- Atmospheric chemistry
- Complex chemical data analysis

Persons interested in presenting a paper should send a 200-word abstract including title, author(s), affiliation and description to arrive no later than December 15, 1987, to: Seymour Hochheiser, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, U.S.A.; or Dr. R.K.M. Jayanty, Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709, U.S.A.

Geology 88

China has become increasingly dependent on its natural resources. Though the country has outstanding reserves of ferrous and non-ferrous metals, precious metals, chemical fertilizers, minerals and mineral fuels, much of these resources has yet to be exploited. China is, therefore, in a rather demanding situation where the country is compelled to research, locate, unearth, and utilize its vast deposits and reserves, all in an extremely limited period of time.

Other similar problems facing China and its environment fall in the fields of meteorology, seismology, and oceanography. China has an usually high occurrence rate of climatic irregularities; for the protection of the country's populace and inestimable agriculture, it is becoming more and more essential that China perfect its monitoring techniques and systems.

Both of these are formidable tasks. The major obstacle China faces is its marked paucity of modern equipment and technology. A major thrust of the current Five-Year Plan, however, is China's determination to alleviate this demand and outfit both of these major sectors with the advanced facilities that are so badly needed.

A major aid in this campaign is Geology 88, International Exhibition on Geological Prospecting, Surveying, Seismology and Meteorology, to be held in Beijing, China, on **October 11-17, 1988.**

The exhibition has the official support of several of China's most important government bodies, including the Ministry of Geology and Mineral Resources, and is sponsored by the Head Office of the China Council for the Promotion of International Trade. Taking into account the excellent market conditions, along with the strong official backing of the exhibition, Geology 88 represents premium opportunities for overseas manufacturers.

The organizer of the exhibition, SHK International Services Ltd., has extensive experience in staging China shows, and is organizing a total of twenty-one shows in China in 1987 and 1988. Enquiries into Geology 88 are welcome, and should be addressed to: SHK International Services Ltd., 22/F., 151 Gloucester Road, Hong Kong; Tel.: 5-8326100; Telex: 89587 SHKIS HX; or 3/F., Prince Rupert House, 64 Queen Street, London EC4R 1AD, United Kingdom; Tel.: 01-236 2399; Telex: 887443 SHKLDN G.