Mineral Development Agreement
Canada–British Columbia 1985–1990

MDA
SUMMARY REPORT
Summary Report

on the

Canada/British Columbia
Mineral Development Agreement
(1985 – 1990)

Compiled by Brenda Janke

Under contract to the British
Columbia Ministry of Energy,
Mines and Petroleum Resources

Funded jointly by the
Energy, Mines and Resources Canada
and British Columbia Ministry of Energy, Mines and Petroleum Resources
Funding for this publication was provided by the Canada-British Columbia Mineral Development Agreement - a five year (1985-90) $10 million program cost-shared equally by the federal and provincial governments.

Canadian Cataloguing in Publication Data

Janke, Brenda.
  Summary report on the Canada/British Columbia

Cover title: MDA summary report.
At head of cover: Mineral Development Agreement
Co-published by the Government of British Columbia.
"Funded jointly by Energy, Mines and Resources
Canada and the British Columbia Ministry of Energy,
Mines and Petroleum Resources."
ISBN 0-7718-8993-3

1. Canada/British Columbia Mineral Development
   Agreement. 2. Mines and mineral resources
   - British Columbia. 3. Mineral industries - British
   Columbia. I. Canada. II. Canada/British Columbia
   Mineral Development Agreement. III. British Columbia.
   V. British Columbia. Ministry of Energy, Mines and
   Petroleum Resources. VI. Title. VII. Title: MDA
   summary report.

TN27.B7j36  1990  553'.09711  C91-092038-9

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This is a joint publication of Energy, Mines and Resources Canada
and the British Columbia Ministry of Energy, Mines and Petroleum
Resources.

Produced and distributed by the Ministry of
Energy, Mines and Petroleum Resources.

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FOREWORD

This report summarizes the results of projects carried out under the Canada-British Columbia Mineral Development Agreement (MDA), 1985-1990. This agreement was one of several subsidiary agreements developed under the Canada-British Columbia Economic and Regional Development Agreement (ERDA).

The purpose of the MDA was to coordinate the efforts of Canada and British Columbia to strengthen and diversify the province’s minerals industry. Funding of $10 million was provided for the agreement, cost shared equally by the federal and provincial governments. The term of the agreement extended from April 1, 1985 to March 31, 1990.

The activities sponsored under the MDA were grouped into three programs: 1. Promotion of British Columbia Mineral Potential; 2. Financial Assistance for Mine Development; and 3. Management, Public Information and Evaluation. About 80 percent of the total budget was allocated to activities funded under Program 1, 18 percent for Program 2 activities and two percent for Program 3 projects.

A Management Committee appointed by the federal and provincial ministers was responsible for planning and coordinating activities. Implementation of most of the activities was supervised by the British Columbia Ministry of Energy, Mines and Petroleum Resources (BCEMPR). About six percent of funds were directed towards aeromagnetic surveys, which were conducted under the supervision of Energy, Mines and Resources Canada.

There are 130 project summaries presented in this report. Each project is described according to the fiscal year(s) in which it was funded, the amount of MDA funding received, the principal researcher(s), the supervising agency and the area in the province where the research was located. The objectives, and achievements of each project are summarized, as well as an estimate of the impacts generated. A listing of all of the project’s outputs, in terms of papers, reports and presentations, is given at the end of each project summary. If the project was cost shared with industry, the industry participants are listed and the total project cost is estimated. Expenditures for the 1990-1991 fiscal year are not actual expenditure amounts and are only budgeted figures at this time.

The results summarized in this report indicate that MDA activities have had a significant impact on the mining and exploration industry. The acquired geoscientific data has already led to increased exploration activity and more appropriate targeting of exploration and development programs. A number of potentially significant mineral occurrences have been discovered and documented. As well, the opportunities presented by industrial minerals are now more widely understood and several new prospects are under consideration by industry.

Studies carried out under the market, technical and feasibility sub-component have provided economic and technical data to assist industry and guide government policy. Industry is currently using several of the applications for new techniques and technologies to enhance resource recovery. Significant progress has been made with respect to understanding and developing possible solutions to the environmental problems associated with mining, and in particular for the prevention, treatment, monitoring and control of acid mine drainage.

Infrastructure assessments carried out under the Financial Assistance for Mine Development program have helped to bring some of the province’s more remote ore bodies into production. Three of the access roads studied have been constructed - to the Golden Bear, Nickel Plate and Lawyers mines. Two others, the Windy Craggy and Iskut River roads, are currently under review.

Although it is too early to measure all of the impacts generated by the MDA, it is clear from this report that considerable progress has already been made towards strengthening and diversifying the province’s minerals industry. The effects will be felt far into the future.
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1. Promotion of B.C. Mineral Potential

The purpose of this program was to provide the province's exploration and mining industry with timely geological, market and technology information to enable more appropriate targeting of exploration and development activities leading to the operation of new mines. During the term of the Agreement, expenditures on this Program totalled $8,286,547.

Program I consisted of three components: Geological Surveys, Geoscience Data Systems, and Market, Technical and Feasibility Studies. Expenditures on each component were $6,662,978, $418,000 and $1,205,569, respectively.

In the early years of the MDA, most of the major geological survey projects were carried out under contract by specialists in the private sector. In later years, the Geological Survey Branch of the British Columbia Ministry of Energy, Mines and Petroleum Resources (MEMPR) expanded and thereafter Ministry geologists performed much of the work. The aeromagnetic surveys delivered by the Geological Survey of Canada were the only MDA activity carried out and supervised by the federal government.

Most of the geological survey data that was produced under the MDA was made available to the public in a timely manner through Open File maps, reports in the Geological Survey Branch annual publications, geoscience journals and in public workshops and presentations.

GEOCHEMISTRY

During the term of the MDA, three types of geochemistry projects were carried out. MDA expenditures on geochemistry projects amounted to approximately $1,148,000. Most of the funding was directed towards completion of six regional geochemical surveys conducted by the MEMPR.

MDA funding allowed the Ministry to build up a team of geochemists in the province with expertise to manage and deliver the regional geochemical survey (RGS) program based on national standards. British Columbia was the first jurisdiction in Canada to release regional geochemical survey data on floppy diskettes, thereby facilitating use of these data by industry. Several new mineral showings were discovered resulting from follow-up of RGS anomalies. As well, pioneering research conducted under the MDA on moss mat sampling, has demonstrated the effectiveness of this sampling medium for defining both base and precious metal exploration targets.

1:50 000 SCALE MAPPING

Geologic maps are the primary data source for nearly all pure and applied earth science research. These maps are used by scientists, planners, exploration geologists and engineers in the search for energy and mineral resources, in studies of geologic hazards, land use issues, and waste disposal.
Prior to the start of the MDA, small scale (large area, limited detail) geologic maps were available for essentially all of British Columbia. Less than 10% of the province, however, was mapped at the larger scales (1:50 000 or larger) essential for most users of geologic maps. To make matters worse, many of the available small scale maps were obsolete, having been compiled decades ago without the benefit of modern geologic concepts and techniques.

Recognizing the importance and need for large scale up-to-date mapping, the MDA initiated a program of 1:50 000 scale geologic mapping in selected areas of the province. Through this program, regional 1:50 000 scale geologic mapping was demonstrated to be not only viable, but probably the optimum scale to portray geology and mineral potential in British Columbia’s mountainous terrain. As well, the early success of MDA projects provided the impetus for the establishment of a 1:50 000 scale mapping program initiated by the Ministry in 1987.

The MDA provided funding for six 1:50 000 scale geological mapping projects. Total MDA expenditures in this sub-component amounted to about $2,718,000. Four of these projects were multi-year investigations conducted north of Bridge River in southwestern British Columbia, in the Smithers-Whitesail Lake area in the west central part of the province, on Vancouver Island and in the Midway-Cassiar area.

The provincial geoscience data base has been expanded as a result of the 1:50 000 scale geologic mapping program. A better understanding and definition of the potential distribution of mineral deposits in the province has been achieved. MDA projects have helped to focus industry attention on areas with greater mineral potential and increase the effectiveness of exploration activities, thereby reducing industry costs. Several mineral discoveries made during the MDA are currently under investigation by industry.

**METALLOGENIC MAPPING**

Over twenty deposit scale mapping projects throughout the province received MDA funding. As well, support was given to another nineteen projects conducted at the University of British Columbia. Total MDA expenditures in this sub-component were about $1,544,000.

MDA funding expanded the Ministry’s established program of mineral deposit studies. The results of many of the smaller MDA projects were incorporated into subsequent work done by the Geological Survey Branch. In some cases, the initial MDA funded work led the way for future projects.

The five coal projects carried out under the metallogenic mapping component have increased awareness of the potential metallurgical, thermal and coalbed methane resources in southeastern and northeastern British Columbia. Future industry exploration and development activities will be guided by the new information.

The nine MDA projects that were focused on gold have provided a better understanding of provincial gold resources. The potential of gold bearing skarns was recognized and several companies are currently exploring gold skarns in south central and northwestern British Columbia and on Vancouver Island. An extensive study of the Quesnel mineral belt has led to a more effective assessment of mineral claims in the region. The other regional studies of gold occurrences have focused industry attention on under explored areas with high precious metal potential elsewhere in the province.

Seven other MDA metallogenic mapping studies resulted in an improved understanding of the different types of mineral deposits hosted in the province’s diverse geologic environment. The largest project was a four year investigation of Alaskan mafic and ultramafic rocks to evaluate their potential as sources of platinum group elements. Specific targets were defined which are currently undergoing further evaluation by industry. Another major project involved the mineral evaluation of a proposed park in the Chilko Lake area. This project identified zones of high mineral potential, some of which have been staked by industry, and provided valuable information for use in a provincial park assessment.

Nineteen studies were undertaken by faculty and staff at the University of British Columbia. These projects led to a better understanding of the geology and mineral potential of the province and complemented research by government and industry. In addition, this work contributed to the education of the next generation of geoscientists.

**INDUSTRIAL MINERALS**

MDA expenditures on twelve industrial mineral projects amounted to about $627,000. These projects compiled an inventory of provincial industrial minerals with development potential. The first provincial scale maps of industrial minerals known occurrences were produced. Provincial resources of dimension stone, limestone and dolomite, peat, olivine, nepheline syenite, feldspar, carbonatites, garnet, silica, talc, zeolites, fluor spar, magnesite and phosphate were documented.

The MDA projects have increased awareness of provincial industrial minerals, which should contribute towards a more diversified mining industry in the future. Significant industry interest was generated in the potential of provincial industrial minerals and many private sector companies began or intensified exploration activities as a result of project findings. Further, plans are currently underway by private companies to develop provincial garnet and talc resources.

**GEOPHYSICS**

Regional aeromagnetic surveys were conducted in three areas of British Columbia by the Geological Survey of Canada. Total expenditures in this sub-component amounted to $625,000. The data collected will aid in geological mapping and interpretations.
1.1 Geological Surveys

1.1.1 Geochemistry

Geochemical Surveys - the collection, preparation, and analysis for a suite of elements of geological materials such as rock, soil, stream and lake sediments, water, and vegetation to identify variations in element distribution that may be interpreted as indicating areas of enhanced mineral potential.

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<th>Project name</th>
<th>GEOCHEMICAL INTERPRETATION</th>
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<td>MDA expenditures</td>
<td>$102,503 (1986-1987)</td>
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<td>Principal researcher(s)</td>
<td>P. MATYSEK AND J. GRAVEL</td>
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<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
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<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
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OBJECTIVES To enhance the mineral industry's knowledge and use of exploration geochemistry in British Columbia and thereby improve the probability of discovering new ore deposits. This project intended to conduct research into geochemical sampling, analysis and interpretation methods.

ACHIEVEMENTS As a result of this project, the British Columbia Geological Survey Branch (GSB) was one of the first in Canada to release regional geochemical survey (RGS) data in a digital format on 5 1/4" floppy diskettes. The data are accessible by personal computer and can be manipulated by various commercial statistical and plotting programs. Sales of these digital packages indicate there is a growing use by both individuals and major exploration firms of this type of data and technology.

Pioneering research on moss-mat sediment as an alternative stream sampling medium and its incorporation into the Regional Geochemical Surveys was initiated by this project and has since stimulated the exploration community to follow suit. The GSB has become a source of expert information on the sampling, handling and interpretation of moss-mat surveys.

IMPACT Digital RGS data packages have increased user flexibility, which has resulted in a more sophisticated level of geological interpretation. To date over 1000 digital data packages have been sold.

Several new mineral showings can be directly accredited to the use of moss-mat sediment in stream surveys as reported by individuals and private firms. Old mining camps are being rejuvenated as exploration firms re-assess their mineral potential using moss-mat sediment surveys. The following are but a few of the companies that have recently incorporated moss-mat sampling into their exploration programs: Battle Mountain (Canada) Incorporated, BP Canada Incorporated, Cominco Limited, Placer Dome Incorporated, and Teck Corporation.

OUTPUTS

Fieldwork Articles


Other Publications

Talks


The Geological Survey Branch developed the in-house resources (personnel and computer) to generate all Open Files to ensure timely release of RGS data. Innovations in program design, content and presentation were introduced to increase both information content and ease of use. Developments included the use of moss-mat sediment as a primary sample media, new field data collection techniques, in-house computer programs for quality control of analytical data, statistical interpretation techniques to aid anomaly definition and down sizing of element plots that are collated into a map booklet. Also, regional geochemical data were continued to be made available on 5 1/4” floppy diskettes.

**IMPACT**

On average, for recent releases (1987-1990), 100 data and map packages were sold on release day. A production run of 210 packages was generally sold out within the first year.

A claim staking review process initiated in 1989 revealed a 20 to 25% increase in the number of claims held on Northern Vancouver Island which can be directly related to the release of British Columbia RGS Open Files. Explorationists within the industry have reported several new important mineral showings which were discovered on northern Vancouver Island resulting from follow-up of RGS anomalies. Consolidated Paytel Limited, Placer Dome Incorporated and Transtel Communications Corporation are a few of the companies whose exploration work has been influenced by the geochemical survey data.

In addition, RGS innovations in sampling, analytical and interpretation methods are being adopted by the industry thus advancing the science of geochemistry in British Columbia.
OUTPUTS

Fieldwork Articles


Gravel, J.L. and Matysek, P.F. (1988): 1988 Regional Geochemical Survey, Northern Vancouver Island and Adjacent Mainland (92E, 92K, 92L & 102I); British Co-

Open Files
RGS 13 - Prince George (93G/W 1/2)
RGS 14 - McBride (93H/W 1/2)
RGS 15 - McLeod Lake (93J)
RGS 16 - Whitesail Lake (93E)
RGS 17 - Smithers (93L)
RGS 18 - Iskut River (104B)
RGS 19 - Sumdum (104F) and Telegraph Creek (104G)
RGS 20 - Tulesequah (104K)
RGS 21 - Nootka Sound (92E)
RGS 22 - Bute Inlet (92K)
RGS 23 - Alert Bay (92L) and Cape Scott (102I)
RGS 24 - Victoria (92B) and Cape Flattery (92C)
RGS 25 - Alberni (92F)
RGS 26 - Vancouver (92G)

Papers

Talks

Project name: ANALYSIS OF ARCHIVED RGS SAMPLES
MDA expenditures: $49,998 (1989)
Principal researcher(s): P. MATYSEK, W. JACKAMAN AND S. FEULGEN
Supervising agency: B.C. GEOLOGICAL SURVEY BRANCH
Other participating agencies: GEOLOGICAL SURVEY OF CANADA
Project location: SOUTH CENTRAL, CENTRAL & NORTHWEST B.C.

OBJECTIVES To re-kindle exploration activity by releasing new analytical data for archived sediment samples collected on previous Regional Geochemical Surveys. Concentrations of gold plus 33 other elements including the rare earths were to be determined by neutron activation analysis. The project intended for these new data, in combination with advances in data presentation and statistical interpretation, to highlight subtle mineral trends which had escaped previous detection and to provide a new database with useful information for environmental, land use assessment and health studies.

ACHIEVEMENTS The Mineral Development Agreement funded in part the analysis of 24,972 samples from 21 map sheets.

Archive analysis data from the Nelson and Larder areas were compiled with original data to produce the Purcell Wilderness Conservancy geochemistry study which was released as an Open File in February 1990.

IMPACT The initial release of archived samples analytical data comprising map sheets for the Penticton, Nelson, Larder and Vernon areas is tentatively scheduled for Spring 1991. Response is anticipated to be at least comparable to earlier RGS releases which generally saw release day sales of approximately 100 data and map packages and a flurry of pre- and post- release staking activity.

The initial run of 50 data and map packages for the Purcell Wilderness Conservancy Study were sold out and a second run has been completed.

OUTPUTS

Open Files
ANALYSIS OF ARCHIVED RGS SAMPLES
1.1.2 1:50 000 Mapping

1:50 000 Scale Geological Mapping - the identification, within a specific geographical area, of the bedrock types, their origins, their spatial and chronological relationships and the setting of known mineral occurrences to provide a geological data base for resource assessment, and to define broad areas of enhanced mineral potential.

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<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
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<td>Other participating agencies</td>
<td>GEOLOGICAL SURVEY OF CANADA</td>
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<td>Project location</td>
<td>NORTHEAST B.C.</td>
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OBJECTIVES  To assist industry in the focus of their exploration activity in the Gataga area of northeastern British Columbia by producing a model of the structural and sedimentological evolution of the district.

ACHIEVEMENTS Four 1:50 000 scale maps were produced which detail the geology in the vicinity of the Driftpile sedimentary-exhalative (SEDEX) Camp. This work has contributed to a better understanding of the stratigraphic and structural setting of the deposits.

IMPACT The maps have not yet been published. Future exploration work will be guided by the new maps when they are made available.

OUTPUTS

Fieldwork Articles
OBJECTIVES To guide industry exploration in the Sicker Group of rocks on southern Vancouver Island by providing a detailed analysis of the area's stratigraphy, structure and by metatectonic definition. This objective was to be achieved through 1:50 000 scale geological mapping and geochemical surveying of the area and by studying the extent of polymetallic sulphide deposits and their similarity to Westmin Resource's Buttle Lake deposits.

ACHIEVEMENTS Three 1:50 000 scale geological maps were produced which covered the Cowichan Uplift area of southern Vancouver Island. This mapping has led to an improved understanding and a modification of the stratigraphy of the Paleozoic rocks, which in turn has resulted in a better definition of the potential distribution of base metal and other mineral deposits. Major contractional faults of Tertiary age were identified and mapped throughout the uplift. It was discovered that these faults have had a profound effect on the distribution of rocks and mineralization, as well as themselves being conduits for gold-bearing fluids. Studies of the geochemistry of the volcanic rocks of the area are proceeding and will result in a model of the development of the Paleozoic island arc and subsequent igneous events.

IMPACT Extensive private sector exploration of the Paleozoic rocks of the Cowichan uplift took place prior to and during the project. Initial targets were volcanogenic base-metal massive sulphides similar to the Westmin's Buttle Lake deposits. Work has since expanded to encompass the whole range of diverse mineral deposits in the area, particularly those that are gold-bearing. This project has helped to focus the attention of explorationists on other areas of southern Vancouver Island, especially in areas underlain by similar Sicker Group volcanic rocks.

OUTPUTS

Fieldwork Articles


Open Files


Papers


Abstracts

Talks
Presentations were made at the following:
- University of Victoria Geography Department, "The Geology of Southern Vancouver Island," Victoria, British Columbia, April 1988.

Workshops
An informal workshop was presented to industry representatives on the Sicker Group geology and mineral deposits in Ladysmith, British Columbia, August 1988.


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<thead>
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<th>Project name</th>
<th>TASEKO-BRIDGE RIVER</th>
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<td>46,500 (Budgeted, 1991)</td>
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<td>Principal researcher(s)</td>
<td>P. SCHIARIZZA, R.G. GABA AND J.K. GLOVER</td>
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<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Project location</td>
<td>SOUTHWEST B.C.</td>
</tr>
</tbody>
</table>

OBJECTIVES To encourage mineral exploration in the Taseko-Bridge River area of southwestern British Columbia by providing a geological framework for known mineral occurrences, alteration zones and geochemical anomalies. This objective was to be achieved through 1:50 000 scale geological mapping, lithogeochemistry and moss mat geochemistry. The project intended to produce an assessment of the overall mineral resource potential of the area, which would be useful for future regional and site specific studies.

ACHIEVEMENTS Four 1:50 000 and two 1:20 000 scale geological maps were produced, which have contributed to a better understanding of the definition, distribution, and stratigraphic and structural relationships of late Paleozoic through Tertiary rock units. A better understanding was also developed of the structural/plutonic controls of metallic mineral occurrences, which include porphyry-style copper-molybdenum, mesothermal gold-quartz veins, auriferous polymetallic veins, stibnite veins, scheelite veins, and cinnabar veins and disseminations. These metallic mineral concentrations, formed over a protracted interval during mid-Cretaceous to mid-Tertiary time, were found to be coincident with several pulses of igneous activity within a changing structural regime that generated contractional, strike-slip and extensional faults.

IMPACT Two specific discoveries made by the project are known to have prompted immediate action by explorationists: 1) The Pat claims were staked by Esso Minerals in 1987 after assays returning 331 to 377 ppm silver were reported from samples collected in 1986 along the margin of the Warner Lake stock. 2) MacNeill International Industries Incorporated implemented a $250,000 diamond drilling program in the fall of 1989, after a project member discovered disseminated molybdenite and auriferous quartz veins on their Cub 200 claim earlier that summer. In addition, recent exploration activity elsewhere in the area has been concentrated in areas shown as favourable on geology and mineral potential maps produced by the project.

OUTPUTS

Fieldwork Articles


MDA mapping projects have helped industry meet the challenges of exploring in B.C.'s mountainous terrain.


Open Files


Abstracts


Talks


Project name: WHITESAIL
MDA Expenditures: $478,244 (1987 - 1990), 40,000 (Budgeted, 1991)
Principal researcher(s): L. DIAKOW
Supervising agency: B.C. GEOLOGICAL SURVEY BRANCH
Project location: WEST CENTRAL, B.C.

OBJECTIVES To stimulate and guide industry exploration in the Whitesail area of west central British Columbia and improve the geological database in areas underlain by Mesozoic and Cenozoic volcano-plutonic arc assemblages perceived to have epithermal precious metal potential. This objective was to be achieved through 1:50 000 scale geological mapping and sampling for geochronologic, geochemical and petrographic studies. This project intended to lead to a better understanding of the temporal relationships of major igneous events and their evolution in the Stikine Terrane. Mineral deposits were to be classified and their salient features documented in order to delineate metallocents and aid exploration by private sector companies.

ACHIEVEMENTS Four 1:50 000 scale geological maps were produced which refined lithostratigraphic subdivisions of lower and middle Jurassic and Eocene volcanic rocks. New potassium and argon ages from volcanic and plutonic rocks helped to constrain timing of mafic magmatic events in the project area.

Porphyry copper and molybdenum mineralization in the Whitesail Lake area were found to be related to the emplacement of Late Cretaceous and Eocene granitoid intrusions. As well, high-level, base metal-rich quartz veins, some with sporadic gold-silver concentrations, were discovered to be generally controlled by steeply dipping extensional fractures and faults near the margin of many of these plutons.

IMPACT Mining company involvement in the area was consistently moderate throughout the duration of the Whitesail project. In 1988, publication of results for the Geochemical Reconnaissance Survey conducted in the Whitesail Lake area resulted in elevated staking activity and follow-up property evaluation. Regional mapping in conjunction with the RGS survey impacted on private sector programs by delineating favorable structure-alteration localities and new geochemically anomalous areas. These surveys also confirmed the close spatial and probable genetic relationship of Cretaceous and Eocene plutonism with precious metal bearing veins and porphyry type mineralization. Several companies have initiated programs to evaluate the precious metal potential of granitoid intrusions and associated high-level argillic alteration that had previously been explored for porphyry type mineralization.

OUTPUTS

Fieldwork Articles
Open Files


Papers


Talks

Presentations were made at the following:

Project name MIDWAY-CASSIAR

MDA expenditures $386,492 (1987-1990)
3,500 (Budgeted, 1991)

Principal researcher(s) J. NELSON

Supervising agency B.C. GEOLOGICAL SURVEY BRANCH

Project location NORTH CENTRAL B.C.

OBJECTIVES To help to focus private sector mineral exploration activity in the Midway-Cassiar area of northern British Columbia by determining the settings and controls of known gold-silver-lead-zinc deposits and evaluating the asbestos potential. The project intended to identify settings likely to host Midway type deposits and investigate other potential resources in order to contribute to geological knowledge of the area.

ACHIEVEMENTS Four contiguous 1:50 000 map sheets were produced in an area which previously had been mapped only at 1:250 000 scale. The much greater definition of large-scale mapping allowed subdivision and interpretation of the Sylvester allochthon, a complexly deformed Paleozoic oceanic package. The Sylvester allochthon was found to host two out of the three major mineral deposit types in the region: gold-quartz veins and asbestos. Both deposit types were determined to be partially controlled by the low-angle thrust faults that dominate the Sylvester structure. The outcrop extent of the McDame Group and the Devonian carbonates that host the Midway silver-lead-zinc manto deposit were also outlined.

IMPACT This mapping has aided both exploration companies and prospectors by delineating structures and lithologies of economic importance at appropriate levels of detail. Several mineral prospects discovered in the course of this project have either been staked or are under investigation by private sector parties. In particular, these include two silver-lead-zinc prospects, one rhodonite body that may be commercially exploitable, and an alteration zone linked to the Erickson gold-quartz system.

OUTPUTS

Fieldwork Articles


Industry has seized new opportunities thanks to over 60 MDA geological survey projects.


Talks

Presentations were made at the following:


**Project name** BULLMOOSE

**MDA expenditures** $56,709 (1987)

**Principal researcher(s)** W. KILBY

**Supervising agency** B.C. GEOLOGICAL SURVEY BRANCH

**Project location** NORTHEAST B.C.

**OBJECTIVES** To assist with coal exploration in the northeastern part of British Columbia by mapping and describing the coal-bearing strata using automated computer-based techniques for data compilation, presentation and analysis.

**ACHIEVEMENTS** Two 1:50 000 scale geological maps were produced and data from the areas were compiled. In addition, two open file maps, orientation and formational data from 7600 outcrop stations were compiled and stored in a database.

**IMPACT** The mapping assisted one of the major land holders to reassess its exploration program and provide for a more efficient use of funds. Major interest in the mapping has come from the petroleum industry in their search for gas.

Open Files


Abstracts


1.1.3 Metallogenic Mapping

Metallogenic Mapping - detailed studies of local geological environments to determine the specific geologic features that influence the location, size and grade of ore deposits so that theoretical models for mineralization processes can be developed to guide exploration.

Coal

<table>
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<td>B.C. GEOLOGICAL SURVEY</td>
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<td>Project location</td>
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</table>

OBJECTIVES To guide industry exploration by providing a better understanding of the coal potential of the Flathead Ridge in the Crownsnest Coalfield of southeastern British Columbia. This objective was to be achieved by constructing a computer model to calculate coal resource figures for the Flathead Ridge area. This project intended to supplement a larger project investigating the entire Dominion Coal Block.

ACHIEVEMENTS All available data on the geology, coal quality and mining characteristics of the Flathead Ridge area were summarized and used to construct a computer model. Calculations based on this model verified the existence of significant quantities of coal, capable of being mined by underground methods. The summarized data and the model have been incorporated with the larger project.

IMPACT This study has heightened awareness of the Dominion Coal Block as a potential resource of metallurgical and thermal coal and coalbed methane. Measurable impacts are not yet available, as the land tenure situation does not encourage development (coal rights are held by the federal government).

OUTPUTS

Fieldwork Articles

Papers
Talks

**Project name** COAL PETROLOGY
**MDA expenditures** $4,000 (1986)
**Principal researcher(s)** J. SCHWEMLER
**Supervising agency** B.C. GEOLOGICAL SURVEY BRANCH
**Project location** VICTORIA

**OBJECTIVES** To determine the thermal maturity of sedimentary rocks by undertaking vitrinite reflectance analysis. This project intended to provide technical support to the Elk Valley project.

**ACHIEVEMENTS** Analyses were completed and used in a study of the coal measures around Weary Ridge and Bleasdell Creek in the Elk Valley.

**IMPACT** The rank of the coal in the Elk Valley is critical to the understanding of the coal quality. The ultimate end use of the coal and its coalbed methane potential are both characterized by the reflectance values.

**OUTPUTS**

**Fieldwork Articles**


**Project name** ELK VALLEY
**MDA expenditures** $19,514 (1986 - 1987)
**Principal researcher(s)** D. GRIEVE
**Supervising agency** B.C. GEOLOGICAL SURVEY BRANCH
**Project location** SOUTHEAST B.C.

**OBJECTIVES** To acquire and publish basic information concerning the north half of the Elk Valley Coalfield, the least understood portion of the southeastern British Columbia coalfields. This project intended to develop a model of the geology of Weary Ridge in the Elk River and Forthing River properties in order to determine its potential for open-pit mining, as a possible alternative to the proposed Elco Mining mine-site on Little Weary Ridge. A comprehensive Bulletin was to be compiled which would guide future development of the entire Elk Valley Coalfield.

**ACHIEVEMENTS** Geological mapping of the area was completed at 1:10 000 scale on an orthophoto base. For large portions of the study area, this is the only geological map currently available. Modelling of the stratigraphic sequences in sections and cores has yielded new insight into the deposition of fluvial-alluvial sediments in the Kootenay Group. Exposed coals were sampled and ranked and maceral compositions were determined. The distribution of coal ranks, which is somewhat anomalous in the study area, is now much better understood. A comprehensive Bulletin is currently being prepared.

**IMPACT** This study has generated interest within Forthing Coal Limited. The published maps will be of benefit to licence holders in the area, and to those evaluating the relative potential of the coal reserve at the north end of the Elk Valley. The Bulletin will be a widely used reference for all geologists working with the Kootenay Group coals in southeastern British Columbia and will guide both private and public sector decisions regarding future development in the region.

**OUTPUTS**

**Fieldwork Articles**

Other Publications


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**Project name**  
COAL TRENDS IN THE GETHING FORMATION

**MDA expenditures**  
$21,204 (1987-1988)

**Principal researcher(s)**  
A. LEGUN

**Supervising agency**  
B.C. GEOLOGICAL SURVEY BRANCH

**Project location**  
NORTHEAST B.C.

**OBJECTIVES**  
To assist industry by conducting an analysis of coal thickness trends in the Gething Formation of northeastern British Columbia, near the Bullmoose and Quintette mine areas.

**ACHIEVEMENTS**  
This project produced a stratigraphic fence diagram of the Gething Formation in the southern half of the Peace River coal belt. Reference sections for the Gething Formation are now available for large areas that include the coal belt and the plains. The Gething Formation was subdivided into three members and a database...
integrating data from coal boreholes, petroleum wells, trenching and measured sections was compiled. A 1:100,000 scale geological map was produced.

IMPACT The project is awaiting publication. Its impact is expected to be improved stratigraphic control for coal, petroleum exploration and other studies involving correlations. Units in the coal belt may have significance in the plains (e.g., gas bearing porous sandstones) and units in the plains (coal intersections) may have significance in the coal belt. The stratigraphic database will be useful in a regional assessment for coalbed methane. The study reconciles the stratigraphic framework of two geologic disciplines (coal and petroleum).

OUTPUTS

Fieldwork Articles

Papers

Talks

Project name: CARBON CREEK

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<td>A. LEGUN</td>
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OBJECTIVES To compile updated information on coal formations in the Carbon Creek area of northeastern British Columbia in order to assist industry in exploration and add to the geological database on the area.

ACHIEVEMENTS A 1:50,000 scale geological map was produced which traced the major coal seams in the Carbon Creek basin and more clearly defined the areal extent of the coal measures. Stratigraphic thickness data were compiled, new sections measured, regional cross-sections produced and the sedimentology of Jurassic-Cretaceous Formations described.

IMPACT A number of oil exploration companies and consulting firms have made enquires about the project. The structural and stratigraphic definition of the mapped area is of a quality that enables the interpretation of subsurface petroleum plays. Stratigraphic thickness data has proved useful for calculating depth of reservoir rocks (Triassic and older) beneath mapped structures. The impact on coal exploration to date, however, has been minimal, likely due to the fact that other areas in the Peace River coalbelt have shown greater potential.

OUTPUTS

Fieldwork Articles

Papers

Other Publications

Gold

Project name: HEDLEY GOLD

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<td>G. RAY AND G. DAWSON</td>
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<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
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<td>Project location</td>
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OBJECTIVES To guide precious metal exploration by mapping the Hedley gold skarn camp in the southern Okanagan region and determining the controls on mineralization. This project intended to outline deposit models which would guide and assist exploration programs for skarns in other parts of the province.

ACHIEVEMENTS Geochemical sampling was undertaken at the Nickel Plate, French, Canty and Goodhope mines. Core logging studies of the Nickel Plate deposit and geochemical microprobe studies of the garnet-pyroxene assemblages associated with the various skarn deposits were completed. U-Pb zircon analysis was used for age dating. The ages of the sedimentary rocks in the district were determined using conodont microfossils. A deposit model for gold skarns was established, which should prove useful for gold skarn exploration elsewhere in the province.
The Nickle Plate mine near Hedley, B.C. is the site of the largest gold skarn in Canada.

**IMPACT** This project has helped make the exploration community aware of the potential of gold skarns. Battle Mountain Gold Limited is currently exploring gold skarns in the Greenwood area, and Noranda Minerals Incorporated is looking at the Merry Widow skarn on Vancouver Island. The mapping outlined a potential skarn area south of the Nickle Plate deposit which has been staked and is currently being explored by Chevron Minerals Limited. A massive garnet deposit was also outlined on Mount Riordan (Crystal Peak) which Polestar Explorations Incorporated has since proposed for development. This project is currently before the provincial Mine Development Review Process.

**OUTPUTS**

**Fieldwork Articles**


**Open Files**


**Other Publications**


**Talks**

Presentations were made at the following:


**Project name**

GOLD SKARNS

**MDA expenditures**

$61,499 (1988)

**Principal researcher(s)**

G. RAY AND A. ETTLINGER

**Supervising agency**

B.C. GEOLOGICAL SURVEY BRANCH

**Project location**

PROVINCE WIDE

**OBJECTIVES**

To stimulate industry interest in the potential of gold-bearing skarns in British Columbia by compiling data on all known gold and silver bearing skarns, including details on geology, geochemistry, mineralogy and mining production. The controls on gold skarn mineralization in the province, with regards to distribution, tectonic terrain and age of host rock, were to be determined.

**ACHIEVEMENTS**

Detailed mapping at 1:20 000 scale and sampling was completed at 10 gold skarn mining camps in British Columbia, including Hedley, Texada Island, Zeballos, Merry Widow, Tillicum Mountain, Greenwood and Banks Island. Data were compiled and published on 126 precious metal enriched skarns occurrences.

**IMPACT**

This project has contributed to an understanding of gold skarn in the province and generated exploration interest. Battle Mountain Gold Company has undertaken exploration work at Greenwood in the southern interior of the province and at Zeballos on northern Vancouver Island, and Noranda Minerals Limited has explored the skarns at Merry Widow on northern Vancouver Island. Industry exploration activity on Texada Island and in the Iskut River area of northwestern British Columbia has also been stimulated.

The Ministry of Energy, Mines and Petroleum Resources has received numerous national and international inquiries about the gold skarn potential of the province as a result of this investigation. As well, this project led the way for a large program, currently underway, which is looking at all of the province’s skarn deposits (iron, copper, gold, tungsten, tin, molybdenum and lead-zinc).
ACHIEVEMENTS
This was to be achieved through sampling and mapping of Tatshenshini area (e.g. and Tatshenshini areas were examined and documented, mineral prospects, on both property and regional scales, with a specific emphasis on deposit types.

OBJECTIVES
The study and examination of selected deposits. In particular, the Toodoggone, Muddy Lake, Bennett Lake and Tatshenshini areas were examined and documented, with a specific emphasis on deposit types.

OUTPUTS
Fieldwork Articles

Papers


Talks
Presentations were made at the following:
- Saskatchewan Geology and Mining Association Meeting in Regina, Saskatchewan, October 1990.

Project name: NORTHWESTERN BRITISH COLUMBIA GOLD STUDIES

MDA expenditures: $13,485 (1986)
Principal researcher(s): TOM SCHROETER
Supervising agency: B.C. GEOLOGICAL SURVEY BRANCH
Project location: NORTHWEST B.C.

OBJECTIVES
To stimulate and enhance mineral exploration activity in northwestern British Columbia by examining precious metal deposits in the Muddy Lake (e.g. Golden Bear), Toodoggone River and Bennett Lake areas, and precious-base metal massive sulphide deposits in the Tatshenshini area (e.g. Windy Craggy, Mount Henry Clay). This was to be achieved through sampling and mapping of selected deposits.

ACHIEVEMENTS
The study and examination of selected mineral prospects, on both property and regional scales, served to document and update information for MINFILE. In particular, the Toodoggone, Muddy Lake, Bennett Lake and Tatshenshini areas were examined and documented, with a specific emphasis on deposit types.

IMPACT
By using the Toodoggone area as an example, a British Columbia Epithermal Model was developed and is being used by the private sector. Mineral exploration continued at an advanced stage on several properties studied during the project, the most significant culminating with the opening of the Lawyers gold-silver mine in January 1989. The Omineca Resource Road was completed into the area in 1989 to serve the Lawyers mine and benefit further exploration.

In the Muddy Lake area, documentation of 'no-see-um' type gold mineralization in a new area stimulated regional exploration. In 1989, road access was established to the Golden Bear mine which officially opened in early 1990. Several promising properties on a regional scale remain to be thoroughly tested.

The Bennett Lake mini-project drew attention to the area as a potential host for primarily precious metals bearing vein-type deposits. Since the study, several mining companies have acquired ground in the area and have conducted advanced exploration programs, especially along the Llewellyn fault system. The Geological Survey Branch initiated a systematic program of 1:50 000 scale geological mapping in 1987 which is still in progress.

In the Tatshenshini area, attention focussed on the similarities/differences between the world class Windy Craggy massive sulphide deposit and deposits in the Mount Henry Clay area. Continued work on the Windy Craggy deposit has brought the project to the feasibility stage, including submission to the Mine Development Review Committee.

OUTPUTS
Fieldwork Articles


Talks

A presentation was made at a Gold Conference in Reno, Nevada, U.S.A. in October, 1988.

**Project name**

SOUTHERN BRITISH COLUMBIA GOLD STUDIES

**MDA expenditure**

$29,797 (1987)

**Principal researcher(s)**

T. SCHROETER

**Supervising agency**

B.C. GEOLOGICAL SURVEY BRANCH

**Project location**

SOUTHERN B.C.

**OBJECTIVES**

To encourage precious metal exploration in southern British Columbia by studying gold-bearing mineral deposits in the Abo, Blackdome, Bralorne-Bridge River, Grand Forks-Greenwood, Hedley, Tillicum and Willa areas.

**ACHIEVEMENTS**

A variety of gold deposits were visited and a written summary of "type" deposits was produced which included such topics as: regional and local geology, composition of host rocks, age of host rocks, structural controls, mineralogy of ore, and gangue, alteration assemblages, fluid inclusion and isotope data (if available), age of alteration and/or mineralization, classification of deposit and deposit correlations/comparisons including modelling and metallogenesis.

**IMPACT**

This project has provided up to date information on gold deposits in southern British Columbia. The data collected has already been of use to companies currently exploring in the area.

**OUTPUTS**

**Fieldwork Articles**

Talks
Presentations were made at the following:

Project name  NORTHERN BRITISH COLUMBIA STUDIES

MDA expenditures  $12,207 (1987)

Principal researcher(s)  D. LEFEBURE

Supervising agency  B.C. GEOLOGICAL SURVEY BRANCH

Project location  NORTHWEST B.C.

OBJECTIVES  To promote exploration in northwestern British Columbia by identifying geologically favourable areas for precious metals exploration.

ACHIEVEMENTS  Detailed geological maps with up-to-date compilations of industry data were prepared for the Bronson Creek and Atlin areas. The settings of the major mineral occurrences were determined and little known prospects were identified. This project produced the first published geological map at any scale for the Bronson Creek area. In the Atlin area, the work led directly to a Geological Survey Branch A-Base program of 1:50 000 scale mapping.

IMPACT  Bronson Creek and Atlin were two of the more active exploration areas of British Columbia from 1987 to 1989. Both areas were almost completely covered by claims with numerous companies drilling on their properties. The Northwest British Columbia MDA project provided exploration geologists with access to regional expertise both in the field and through publications. The field work in the Bronson Creek area led directly to a regional Jurassic model for gold-silver-copper mineralization modified from earlier work completed near Stewart.

OUTPUTS

Fieldwork Articles

Open Files


Papers


Talks


MDA projects have helped the B.C. mining industry target most likely areas for mineral exploration.
**Project name:** QUESNEL GOLD

**MDA expenditures:** $94,377 (1987)

**Principal researcher(s):** A. PANTELEYEV

**Supervising agency:** B.C. GEOLOGICAL SURVEY BRANCH

**Project location:** CENTRAL B.C.

**OBJECTIVES**  
To supply industry with new, uniformly consistent regional geological information on the base and precious metal deposits in the Quesnel mineral belt of central British Columbia. Through a program of 1:50 000 scale geological mapping, this project intended to conduct detailed structural studies of the gold deposits in the region.

**ACHIEVEMENTS**  
A 1:50 000 scale regional mapping program was initiated in 1986 using MDA funding for field activities and capital equipment costs. The project was extended for two additional years using Ministry funding. Approximately 300 square kilometers were mapped at 1:50 000 scale in 1986 and a number of radiometric, assay/geochemical and fossil samples were collected. In the central volcanic axis, evidence of widespread low temperature hydrothermal activity (including some mercury mineralization) was noted. In the basal black phyllite unit, the stratigraphy and structural complexity of the host rocks for gold-quartz vein mineralization was resolved.

**IMPACT**  
A geologically consistent mapping base was provided to the north of Quesnel River and south of Quesnel Lake. It extended and outlined lithologically favourable regions previously described. The mapping supported and emphasized the southward extension of highly mineralized environments, leading to a more effective assessment and reassessment of mineral claims in volcanic-intrusive regions.

Studies in the black phyllite unit did much to resolve the structural controls and origins of auriferous quartz veins in the Eureka Peak area. The findings contributed towards the understanding of similar mineralization in northern parts of this belt of rocks in the Spanish Mountain area and to the north of Quesnel River.

**OUTPUTS**

**Fieldwork Articles**


**Open Files**


**Papers**


**Other Publications**


**Talks**


**Project name** | **VANCOUVER ISLAND, ISLAND METALLOGENY**
---|---
**MDA expenditures** | $13,470 (1986-1987)
**Principal researcher(s)** | P. WILTON
**Supervising agency** | B.C. GEOLOGICAL SURVEY BRANCH
**Project location** | VANCOUVER ISLAND

**OBJECTIVES** To re-examine the ore controls and age relationships of mineralization at a number of gold properties on Vancouver Island, with particular emphasis on suspected Tertiary-age mineralization at Mount Washington, Zeballos and Kennedy River, in order to guide exploration into new areas. This was to be achieved through 1:50,000 scale geological mapping.

**ACHIEVEMENTS** The major field component consisted of systematic mapping and detailed examination of mineralized showings at Mount Washington. This resulted in the better definition of a suspected late-Tertiary epithermal gold camp in which the major mineralization was related to shallow-dipping structures of unknown tectonic significance. A variety of other gold occurrences on Vancouver Island were visited and examined. Samples of alteration and intrusive rocks believed to be directly related to mineralization were collected for future examination and dating.

**IMPACT** As a result of this project, companies and prospectors became more aware of the potential for unrecognized Tertiary mineralization associated with flat structures on Vancouver Island. Two later research projects undertaken by the British Columbia Geological Survey Branch were initiated on the basis of observations made and conclusions reached in this study.

**OUTPUTS**

Papers


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**Project name** | **MT. WASHINGTON MINERAL DEPOSIT**
---|---
**MDA expenditures** | $10,000 (1989)
**Principal researcher(s)** | R. DAHL
**Supervising agency** | B.C. GEOLOGICAL SURVEY BRANCH
**Other participating agencies** | CARLTON UNIVERSITY
**Project location** | VANCOUVER ISLAND

**OBJECTIVES** To assist industry exploration by providing a detailed and comprehensive description of the mineral deposits presently being explored at Mount Washington on Vancouver Island. This project intended to clarify the age, origin and tectonic setting of the mineralization and compare it with similar occurrences at Gem Lake, Faith Lake, Piggot Creek and Wolf Creek.

**ACHIEVEMENTS** Approximately five weeks of detailed field mapping on Mount Washington were completed. A limited amount of petrographic and analytical work was carried out on samples collected.

**IMPACT** Some of the observations made in this study represent significant contributions to the understanding of Mount Washington geology and the origin of its mineral deposits. Results have been used and referenced in other research (most significantly in Geological Fieldwork, 1988).

**OUTPUTS**

Talks


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**Project name** | **FLATHEAD SYENITE INTRUSIONS**
---|---
**MDA expenditures** | $9,857 (1989)
**Principal researcher(s)** | A. LEGUN
**Supervising agency** | B.C. GEOLOGICAL SURVEY BRANCH
**Project location** | SOUTHEAST B.C.

**OBJECTIVES** To guide private sector exploration in southeastern British Columbia by examining the potential size and distribution of gold occurrences in the Flathead syenite intrusions. This project intended to add to geological knowledge on the type, setting, structure, timing and relations of the syenites.
ACHIEVEMENTS Geological mapping at the 1:10 000 scale was undertaken in the Howell Creek area, focusing on the structural setting of alkanic intrusives. The project was able to redefine the trace of a number of important faults because a series of recent forest fires had increased exposure in the area. The intrusives were subdivided according to petrography and chemistry and the alterations were described.

IMPACT The project has generated enquiries from a variety of exploration companies regarding the regional setting of the intrusives. Draft copies of the map have been distributed. Shell Canada Resources Limited is using the information to pursue the potential relationship between intrusives and high CO₂ generation in wells in the Flathead area. The project's dating of the age of the intrusives as Cretaceous rather than Tertiary, provided valuable information for an exploration play based on similarities to gold bearing Tertiary intrusives in the United States. The Geological Survey of Canada have also expressed an interest in the project.

OUTPUTS

Papers

Other

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<td>D. ALLDRICK</td>
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</table>

OBJECTIVES To stimulate industry exploration by documenting the regional geological setting and delineating areas of high mineral potential in the Kitsault River valley in the Alice Arm area of northwestern British Columbia. This was to be achieved through 1:50 000 scale geological mapping.

ACHIEVEMENTS A 700 square kilometre area was mapped at 1:50 000 geological scale, and several mineral occurrences were examined. The project demonstrated that all silver-rich deposits in the region were hosted within a single stratigraphic unit.

IMPACT A new celestite-pyrite showing, the IAN prospect, was discovered by one of the mapping team. The data from this program has been used by both Dolly Varden Mines Limited and Cominco Limited to guide additional claim staking in the area. Follow-up prospecting on Cominco's new ground has discovered additional workings around Kitsault Lake.

Fieldwork Articles

Open Files

Other Publications
MINFILE 1030, P: 120 entries in the 1990 MINFILE release were coded as part of this project.

<table>
<thead>
<tr>
<th>Project name</th>
<th>BARRIERE</th>
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<tbody>
<tr>
<td>MDA expenditures</td>
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<tr>
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<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Project location</td>
<td>SOUTHEAST B.C.</td>
</tr>
</tbody>
</table>

OBJECTIVES To guide industry exploration in southeastern British Columbia by extending southward an earlier mapping program carried out in the Adams Plateau - Clearwater area to include the Vavenby region. This project intended to provide a more complete understanding of the stratigraphy and structure of rocks assigned to the Eagle Bay Formation and evaluate its massive sulphide potential. The distribution and genesis of large-tonnage low-grade copper occurrences, such as the Harper Creek deposit, were also to be determined.

ACHIEVEMENTS The mapping program, which included the discovery of fossil archaeanuthids, established that rocks assigned to the Eagle Bay Formation included both a lower Paleozoic and a Devonian-Mississippian succession. This led to the recognition of a major thrust-imbriation within the Eagle Bay assemblage. The project resulted in an improved understanding of Eagle Bay stratigraphy and the diverse tectonic environments, which in turn created a better understanding of the different types of mineral deposits hosted. Specifically: 1) sediment-hosted Ag-Pb-Zn massive sulphide deposits were found to occur within.
a Lower Cambrian volcanic-sedimentary package that probably accumulated in a rift environment; 2) volcanogenic massive sulphides were discovered within a Devonian volcanic assemblage that probably represents arc-related volcanism; 3) disseminated copper mineralization was found to be spatially associated with Devonian granitoid intrusives that were probably comagmatic with the arc assemblage; and 4) uranium-fluorine mineralization was determined to be syngentic with trachytic volcanic and intrusive rocks that could be related to an extensional regime late in the history of the Devonian arc.

IMPACT This project was undertaken in an area that has been the focus of considerable exploration activity. The geological maps and reports produced have been widely used by explorationists because they delineate areas and rock units favorable for specific styles of mineralization within the diverse Eagle Bay package.

OUTPUTS

Fieldwork Articles

Open Files

Papers

Talks

Project name CHILKO LAKE

MDA expenditures $103,005 (1986-1987)
Principal researcher(s) G. MCLAREN
Supervising agency B.C. GEOLOGICAL SURVEY BRANCH
Project location SOUTH CENTRAL B.C.

OBJECTIVES To document the mineral potential and stimulate further industry evaluation of an area that is a candidate for provincial park status in the Chilko Lake area of south central British Columbia. This was to be achieved through 1:50,000 scale geological mapping, detailed stream sediment geochemical surveying, prospecting and extensive lithogeochemical sampling.

ACHIEVEMENTS Mapping identified favourable geological environments for at least four types of deposits (porphyry, vein, skarn and massive sulphide). Stream sediment geochemical anomalies further refined areas of higher mineral potential within favourable environments. Prospecting and lithogeochemistry resulted in discoveries of porphyry and vein-type mineralization and confirmed the tenor of known mineralization. Zones of high mineral potential can now be confidently identified.

IMPACT Mineral claim staking followed quickly after each year's release of information. Exploration work has been conducted on at least five separate claim groups as well as some limited follow-up to the stream sediment data on a regional basis. Industry interest in the area continues to be high. Between this study and the industry follow-up, a thorough evaluation of a future park status has been achieved.

OUTPUTS

Fieldwork Articles


Open Files


Other Publications

**Project name**  WAPITI LAKE

**MDA expenditures**  $6,230 (1986)

**Principal researcher(s)**  A. LEGUN

**Supervising agency**  B.C. GEOLOGICAL SURVEY BRANCH

**Project location**  NORTHEAST B.C.

**OBJECTIVES**  To guide mineral exploration activity in the Wapiti Lake area of northeastern British Columbia by evaluating and identifying the phosphate potential. This was to be achieved through 1:50 000 scale geological mapping.

**ACHIEVEMENTS**  Phosphatic intervals in the Sulphur Mountain Formation in the Wapiti Lake area were sampled and analyzed and the regional geological setting was reviewed.

**IMPACT**  Results from this study were incorporated into a province wide review of phosphate.

**OUTPUTS**

**Fieldwork Articles**  
A four year investigation examined the resource potential of Alaskan type mafic and ultramafic rocks for commercially viable deposits of platinum metals, chrome, nickel, cobalt, asbestos, jade and gold.

increased the public’s awareness of the program. The final impact of accumulated data will probably not be felt until the next phase of PGE exploration in the province.

**OUTPUTS**

**Fieldwork Articles**


**Open Files**


Papers


Other Publications


Talks


Project name | BABINE RANGE
--- | ---
MDA expenditures | $27,655 (1987)
Principal researcher(s) | D. MACINTYRE
Supervising agency | B.C. GEOLOGICAL SURVEY BRANCH
Project location | WEST CENTRAL B.C.

OBJECTIVES

To encourage mineral exploration in the Babine Range of west central British Columbia by developing a metallogenic model for the wide variety of mineral deposit types present in the area. This objective was to be achieved by undertaking a 1:50,000 scale mapping project in order to provide an accessible geological database for future exploration.

ACHIEVEMENTS

Two 1:50,000 scale map sheets were completed. The Jurassic stratigraphy was subdivided into several mappable units. The structure of the Dome Mountain gold camp was defined. A late Cretaceous caldera was defined in the Mount Cronin area. Several new mineral occurrences were discovered during mapping.

IMPACT

Detailed mapping in the Dome Mountain and Mount Cronin areas has assisted companies working in these areas with property assessments. Fault offsets of vein systems have been documented and used to predict prospective areas. New claims were staked after release of open file maps and assay data.

MDA projects have helped the B.C. mining industry stretch its dollar through better targeting of exploration funds.
University of British Columbia Mineral Research Support

<table>
<thead>
<tr>
<th>Project name</th>
<th>SEASONAL VARIATIONS IN GOLD</th>
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<tr>
<td>MDA expenditures</td>
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<td>W.K. FLETCHER</td>
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OBJECTIVES To improve the design and interpretation of gold exploration geochemical surveys by investigating the sedimentological behaviour of gold particles in streams. This project intended to determine the most favorable size fraction, sample amount and site for optimum sample collection and results.

ACHIEVEMENTS As part of a broader study examining the behavior of heavy minerals in streams, the distribution and transportation of free gold in streams was studied. Results suggested that heavy mineral concentrates from bar-head gravels provided the most reliable sample sites for detecting the presence of gold in low density reconnaissance surveys. It was found that samples collected immediately after peak discharge events were the best and large amounts of material (up to 250 kg) processed in the field were necessary to obtain a representative sample. Collection of bar-head samples that were too small were found to seriously compromise the reliability of a survey. The study recommended that if it was not practical to collect adequate samples at bar-head sites, sandy sediments from bar-tail pools should be considered as an alternative. This was also determined to be the most suitable approach for follow-up surveys.

IMPACT Stream sediment geochemistry and heavy mineral surveys have routinely been used in the early stages of gold exploration in the Cordillera. However, the results of such surveys have often been extremely erratic and difficult to reproduce or confirm. The practical implications derived from this study should help to increase the reliability of these surveys.

OUTPUTS

Fieldwork Articles

Fletcher, W.K. and Day, S.J. (1987): Seasonal Variation of Gold Content of Stream Sediments, Harris Creek, Near Vernon: A Progress Report, The University of British Columbia and British Columbia Ministry of En-
Other


Project name: PEACE RIVER PALYNODY

MDA expenditures: $11,000 (1987-1988)

Principal researchers: J.A. BROATCH

Project location: NORTHEAST B.C.

OBJECTIVES To determine the palynologic zonation and correlation of the Peace River coalfields in northeastern British Columbia. This project intended to examine the Lower Cretaceous coal-bearing rocks in order to generate a type section to be used in interpreting, correlating and dating the section.

ACHIEVEMENTS The Lower Cretaceous coal-bearing rocks were examined for palynomorphs (terrestrial spores and pollen and marine dinoflagellate cysts). Open marine and non-marine strata were identified on the basis of palynomorph type and abundance. Contact relationships were examined and clarified. The palynologic section was compared with the lithologic section and a geologic age for the rocks was established.

IMPACT A number of groups have expressed an interest in the results of this project. These include: the Geological Survey of Canada Institute for Sedimentary and Petroleum Geology (where ongoing studies of the region are being carried out), geologists working in the Peace River coalfield (who are trying to better understand the facies distribution) and geologists throughout western Canada (who may now use the section as a basis for age comparison).

OUTPUTS

Fieldwork Articles


Project name: BRALORNE

Principal researcher(s): C. LEITCH
Project location: SOUTHWEST B.C.

OBJECTIVES To provide an updated interpretation of the geology and genesis of the Bralorne gold vein deposit in southwestern British Columbia for use by explorationists.

ACHIEVEMENTS Mapping of the Bralorne gold vein deposit was updated by using modern methods of geochronometry, geothermometry, mineralogy, thermodynamic modelling, stable isotopes, galena lead isotopes and structural analysis. The age of the mineralization and relationship to the age of other deposits was established for the first time.

IMPACT This project provided a much better understanding of the Bralorne gold vein deposit which should prove useful to the exploration industry.

OUTPUTS

Fieldwork Articles


Abstracts


Other


The MDA supported graduate student work through 19 different geoscience studies at the University of British Columbia.
Project name: INDIAN RIVER

Principal researcher(s): D. REDDY
Project location: SOUTHWEST B.C.

OBJECTIVES
To determine the age and structural style of the volcanogenic deposits that occur in the Indian River belt of rocks in southwestern British Columbia.

ACHIEVEMENTS
The geology around known deposits in the area was mapped and the mineralization was compared to that of the major Britannia mine on Howe Sound, to the Seneca deposit near Harrison Lake and to volcanogenic deposits near Whistler. Work was done to determine the age of the stratigraphy and the final results are currently being compiled. Results to date indicate changes in structural style between the Indian River belt and the overlying volcanics associated with Sky Pilot Mountain (which are known to be Cretaceous Gambier Group units), which supports a Jurassic age. Galena lead isotope analysis suggests a common age among volcanic rocks.

IMPACT
This work represents the first published, modern, detailed mapping of this area of volcanogenic deposits. It will be of interest to companies involved in exploration for volcanogenic deposits.

OUTPUTS

Fieldwork Articles


Other

Displays

Project name: SILVER CREEK

MDA expenditures: $4,000 (1987-88)
Principal researcher(s): J. BRADFORD
Project location: NORTH CENTRAL B.C.

OBJECTIVES
To provide a better understanding of the Silver Creek, carbonate hosted, silver-lead-zinc-tin manto deposit in north central British Columbia by undertaking a detailed mapping program.

ACHIEVEMENTS
In addition to mapping, geochemistry, sulphur isotope studies and fluid inclusion studies were completed in order to provide a modern database for genetic interpretations. The causative pluton was identified at depth, karstic control was documented and the temperature and conditions of deposition were defined within narrow limits.

IMPACT
This project provided technical support to the Midway mapping project. Understanding of this type of deposit was enhanced by the work done in this study. While other such deposits are known in the province, few, including the famous Bluebell mine in the southeast, are well understood. These results should prove of benefit to the exploration industry.

OUTPUTS

Fieldwork Articles


Project name: WARNER PASS

MDA expenditures: $3,000 (1988)
Principal researcher(s): D. PAYNE
Project location: SOUTHWEST B.C.

OBJECTIVES
To unravel the stratigraphic, structural and geochemical relationships between spatially related felsic-intermediate volcanic rocks and the Mount Sheba intrusion.

ACHIEVEMENTS
A detailed stratigraphic section and a field map were produced which clarified the nature of the
contacts and the relative ages of the mappable units. Based on the observations, the Mount Sheba igneous complex was determined to have had three distinct phases of plutonic and volcanic activity.

**IMPACT** This study provided technical support to the Taseko-Bridge River project. The new insights obtained regarding the character of the Mount Sheba igneous complex will be an important reference source for future work.

**OUTPUTS**

**Fieldwork Articles**


**Project name**

FRANKLIN CAMP

**Petrology**

**MDA expenditures**

$11,600 (1988-1989)

**Principal researcher(s)**

M. KEEP

**Project location**

SOUTHERN B.C.

**OBJECTIVES** To study the petrology of the Averill plutonic complex in the Franklin Mining Camp.

**ACHIEVEMENTS** The chemical and mineralogical variations to magmatic processes were documented and the findings were related to the regional tectonics of southern British Columbia. The temporal relationship between magmatic processes and mineralization were established.

**IMPACT** This work has been of use to explorationists working on alkaline intrusions. Since Placer Dome Incorporated relinquished its option on the property, there has been little economic interest in the project area.

**OUTPUTS**

**Fieldwork Articles**


**Other**


**Project name**

GALENA LEAD ISOTOPE ANALYSIS

**MDA expenditures**

$27,000 (1987-1990)

**Principal researcher(s)**

J. GABITES

**Project location**

PROVINCE-WIDE

**OBJECTIVES** To provide a better understanding of the application of galena lead isotope analyses to exploration decisions.

**ACHIEVEMENTS** Galena lead isotope data from mineral occurrences around the province were analyzed. It was found that more information was yielded from samples in some areas of British Columbia than in others. On a regional basis, the following information was revealed: In the Stewart-Iiskut River area, Tertiary deposits could be distinguished from Jurassic deposits. In the Selwyn Basin in northeastern British Columbia, SEDEX deposits could accurately be dated and distinguished from intrusive-related epigenetic deposits. In the Purcell Group, Sullivan type SEDEX deposits had a different lead signature than the epigenetic veins such as Vine and Moyie. In the Smithers area, galena lead isotopes were found to smear along a line that could represent lead generated by plutons.

**IMPACT** This project showed that in several instances the application of galena lead isotope analyses has helped to focus exploration work. Many companies currently use this technology and the British Columbia Ministry of Energy, Mines and Petroleum Resources increasingly incorporates galena lead isotope studies into their regional mapping surveys.

**OUTPUTS**

**Fieldwork Articles**


Abstracts


Papers


Other


Displays


Talks


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<th>Project name</th>
<th>WELLINGTON COAL BED</th>
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<td>MDA expenditures</td>
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<td>Principal researcher(s)</td>
<td>C. BICKFORD</td>
</tr>
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<td>Project location</td>
<td>VANCOUVER ISLAND</td>
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</table>

**OBJECTIVES** To determine the regional geology and detailed stratigraphic framework of the Wellington coal bed. This was to be achieved through surface mapping, underground observations and borehole data analysis.

**ACHIEVEMENTS** Detailed geological information was compiled on the Wellington coal bed, which located, identified and collated all relevant drill records. In conjunction with a larger British Columbia Ministry of Energy, Mines and Petroleum Resources project, a 1:20 000 scale geological map of the Western Nanaimo Coal Field was produced. Selected key logs have been input into a PC computer and are now available in MS Word format from the Ministry.

A detailed geological map of the Wellington coal bed and associated rocks in the Western Nanaimo coalfield is currently being prepared and should be released as an Open File in 1991.

**IMPACT** As a result of this work, five companies have shown interest in the area, prompted primarily by the coal facies map in Geological Fieldwork. Two companies have investigated the potential of re-opening old mine workings and another company is currently considering a mine in an area not previously worked.

**OUTPUTS**

**Fieldwork Articles**

<table>
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<th>Project name</th>
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<td>Principal researcher(s)</td>
<td>G. ROUSE AND W. MATHEWS</td>
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</tbody>
</table>

**OBJECTIVES** To describe the lithologies, palynomorph assemblages and ages of core from two key drill holes in the Nechako Plateau of central British Columbia near Vanderhoof.

**ACHIEVEMENTS** The sediments underlying the volcanics, dated with K/Ar as Middle Eocene, proved to be
all Miocene in one well, and Miocene overlying Oligocene in the other. The palynomorph assemblages were found to correlate with those of the Australian Creek (Oligocene) and Fraser Bend (Miocene) formation near Quesnel. Overlying mid Eocene volcanics suggests overthrusting, or possibly sliding of blocks of volcanics in post-Miocene times.

IMPACT Explorationists examining the Wolf gold claims to the south and west of the project area have expressed an interest in the study results. In particular, a similar inversion of mid Eocene volcanics on Mio-Oligocene sediments has been found and a sample analysis has been requested to confirm these results.

OUTPUTS

Fieldwork Articles

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<thead>
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<tr>
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<td>U. MADER AND P. LEWIS</td>
</tr>
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</tr>
</tbody>
</table>

OBJECTIVES To map the Kobau Group metamorphic rocks outcrop between the Fairview and Oliver plutons in southeastern British Columbia.

ACHIEVEMENTS A mapping program was undertaken in the Kobau group rocks. Many of the questions concerning the existence and nature of the stratigraphy within the Kobau were resolved through this project.

IMPACT The map that was produced has been used extensively by geologists working in the Fairview gold camp.

OUTPUTS

Fieldwork Articles

Open Files

<table>
<thead>
<tr>
<th>Project name</th>
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OBJECTIVES To understand the nature of carbon in gold-quartz veins and alteration zones at the Total Erickson gold mine in north central British Columbia.

ACHIEVEMENTS Carbon isotopes were used as the principal tool to investigate the origin of carbon and its place in the genetic model for the gold-quartz veins of the area. The initial isotopic study has provided strong indications that elemental carbon associated with the Total Erickson gold-quartz veins originated from carbon-bearing sedimentary strata underlying the basaltic sequence that encompasses most of the veins. The isotope ratios were found to be unusual in resembling continental carbon.
IMPACT The anomaly discovered during this study has lead to an expanded study of the carbon utilizing new X-ray diffraction equipment at the University and including extended organic geochemistry studies.

OUTPUTS


**Project name** | **PHASE DIAGRAM SOFTWARE**
--- | ---
**MDA expenditures** | $3,000 (1989)
**Principal researcher(s)** | R. BERMAN
**Project location** | PROVINCE-WIDE

**OBJECTIVES** To provide an IBM-compatible computer program for the calculation of phase equilibria which could be used to understand the physiochemical controls on the formation of ore deposits.

**ACHIEVEMENTS** An IBM-compatible program, PTS-System, version 2.0, was developed. It is capable of calculating activity-activity, temperature-activity, and pressure-activity diagrams to elucidate ore-forming processes.

**IMPACT** This program has seen increased use in theoretical and applied research fields.

OUTPUTS

Fieldwork Articles


OUTPUTS

Fieldwork Articles


Papers

Abstracts


Other

Talks
Presentations were made at the following:
- British Columbia and Yukon Chamber of Mines Cordilleran Roundup, Vancouver, British Columbia, February 1990 (first prize in student poster competition).
- joint meeting of the Canadian Coal Petrographers Group and the Society for Organic Petrology, Calgary, Alberta, September 1990.

<table>
<thead>
<tr>
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<th>PLACER PALYNOLOGY</th>
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<tr>
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<td>G. ROUSE</td>
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</table>

OBJECTIVES To distinguish and date the various placer gold deposits in the Quesnel-Prince George area by using palynological analysis.

ACHIEVEMENTS A number of samples were collected from the old Bullion mine in the south, near Likely, through the Barkerville-Wells region, to the Cottonwood River-Quesnel-Prince George area. To date, all of the samples were determined to contain palynoassemblages of Tertiary age, corresponding to those from the Fraser Bend formation. Questions were raised as to whether some samples which appeared to be from mid-late Pleistocene glacial or postglacial events were really of Tertiary age, associated with later Tertiary-early Pleistocene glaciations.

IMPACT Several geologists working with placer deposits have expressed an interest in this project and future cooperative ventures are planned.

OUTPUT
**Project name**: HEDLEY

**MDA expenditures**: $14,000 (1990)

**Principal researcher(s)**: G. DAWSO

**Project location**: SOUTH CENTRAL B.C.

**OBJECTIVES** To provide more detailed knowledge on the Good Hope and French deposit areas in the Hedley gold skarn camp. This project intended to expand on the framework provided by the earlier British Columbia Ministry of Energy, Mines and Petroleum Resources project examining the Hedley camp.

**ACHIEVEMENTS** Detailed mapping and petrography of the Good Hope-French deposits revealed that the Hedley camp was a classical sediment sill complex. At the French mine, it appeared that the sill complex was intimately related to the development of the gold skarn.

**IMPACT** The new genetic parameters provided by the sediment-sill complex offers new exploration insight into the understanding of skarn mineralization in the Hedley camp and to the understanding of many other important skarn districts.

**OUTPUT**

**Fieldwork Articles**


**Abstracts**


### 1.1.4 Industrial Minerals

**Project name**: DIMENSION STONE

**MDA expenditures**: $25,594 (1986-1987)

**Principal researcher(s)**: G.V. WHITE

**Supervising agency**: B.C. GEOLOGICAL SURVEY BRANCH

**Project location**: PROVINCE-WIDE

**OBJECTIVES** To promote the dimension stone industry in British Columbia. This project intended to increase industry awareness of the availability of dimension stone in the province and identify deposits with good physical properties and excellent development potential.

**ACHIEVEMENTS** Thirty formerly producing dimension stone quarries or prospects were examined for their development potential. A promotional information circular was produced that illustrates the quality and variety of dimension stone available from quarries throughout the province. Several local buildings that used British Columbia dimension stone in construction were pictured.

**IMPACT** Since the project started, one intermittent and two permanent quarry operations have started production. Another company has prepared a business plan to build a processing plant along with operating a quarry. Plans have also been initiated to develop two new quarries.

Numerous overseas business inquiries have been received by the British Columbia Ministry of Energy, Mines and Petroleum Resources regarding dimension stone in British Columbia. As a result of this project, the Ministry has been able to respond to these requests by providing good quality information.

**OUTPUTS**

**Fieldwork Articles**


**Other**


**Long term diversification options for the B.C. mining industry were explored in twelve industrial mineral studies.**

Talks
Presentations were made at the following:

A presentation was also made to a representative of the Japanese dimension stone industry, in Victoria, British Columbia, 1990.

<table>
<thead>
<tr>
<th>Project name</th>
<th>CARBONATITES AND KIMBERLITES</th>
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<tr>
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<td>CENTRAL AND EASTERN B.C.</td>
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OBJECTIVES To stimulate industry interest in the industrial mineral potential of carbonatites, nepheline syenites and kimberlites in British Columbia by identifying favourable areas for exploration. This objective was to be achieved by documenting known occurrences of carbonatites, kimberlites and related rocks in terms of geology, petrology, geochemistry and geochronology. The tectonic and geologic controls on the emplacement of these bodies was also to be established.
ACHIEVEMENTS Mapping or sampling of 12 carbonatite/syenite intrusions/complexes and 11 diatremes or diatreme swarms was completed. At least 3 of the carbonatites were identified as having significant economic potential: the Aley for niobium, Rock Canyon Creek for fluorspar and rare earth elements and the Kechika prospect for yttrium and rare earth elements. Trident Mountain syenite was found to have some economic interest with respect to nepheline syenite. A tectonic model was established for the replacement of these bodies which relates to rifting on the ancient continental margin. Favourable areas for exploration were outlined.

IMPACT This project generated significant interest from academia, exploration companies and prospectors. All copies of the Open File report were sold. During the life of the project, a fair amount of exploration work took place and at least two new occurrences were found by private sector companies. This project encouraged industry to undertake the following work: Chevron Minerals Limited to study the Bison Mountain showings, Formosa Resources to examine the Kechika River area, and Teck Corporation to consider the Wicheeda Lake showings. As well, Trident Mountain nepheline syenite was staked and sampled and US Borax Limited expressed an interest in the nepheline syenite.

OUTPUTS

Fieldwork Articles


Open Files

Other


Talks
MDA applications. A preliminary market study identified moderate markets with potential to expand the economic potential of olivine. This objective was to be examined by identifying possible sites for exploration in the Tulameen area. One company began to examine the possibility of developing the area for olivine, indicating an improved awareness of olivine's characteristics.

PRESENTATIONS Were also made at the following:
- Canadian Institute of Mining and Metallurgy Meeting in Ottawa, Ontario, 1990.
- 8th International Association for the Genesis of Ore Deposits Symposium in Ottawa, Ontario, 1990.

**Project name**  OLIVINE

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</tr>
<tr>
<td>Project location</td>
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</table>

**OBJECTIVES** To encourage industry interest in the economic potential of olivine. This objective was to be achieved by identifying possible commercial reserves of foundry-grade olivine in the Tulameen ultramafic complex near Princeton and assessing market opportunities.

**ACHIEVEMENTS** The geological investigation identified three zones of relatively unaltered dunite. Bulk samples were collected for tests by CANMET who found the olivine specifications to be satisfactory for most foundry sand applications. A preliminary market study identified modest markets with potential to expand subject to the development of new applications of olivine's unique thermal characteristics.

**IMPACT** Private sector companies began or intensified exploration for olivine in the Tulameen area. One company, Dia Met Minerals Limited, undertook a diamond drilling program on its claims in the study area. Another company began to examine the possibility of developing an olivine by-product, indicating an improved awareness of olivine's development potential.

**OUTPUTS**

**Fieldwork Articles**

White, G.V. (1986): Olivine Potential in the Tulameen Ultramafic Complex Preliminary Report (92H1/10);


**Other**


**Talks**


A presentation was made at the Kootenay Exploration and Mining Conference in Nelson, British Columbia, 1989.

**Project name**  TERTIARY BASINS

<table>
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<th>MDA expenditures</th>
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<tbody>
<tr>
<td>Principal researcher(s)</td>
<td>P. READ AND Z.D. HORA</td>
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<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Project location</td>
<td>SOUTH CENTRAL B.C.</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To encourage and stimulate private sector exploration for industrial minerals by identifying favourable areas for deposits of kaolin, ceramic clays, bentonite, zeolites, pozzolanic materials, diatomite, germanium and beryllium in Tertiary volcano-sedimentary basins in southern British Columbia.

**ACHIEVEMENTS** A better understanding of the Tertiary stratigraphy and lithology of the area was achieved. Mapping identified and documented: zeolite, kaolin, bentonite, perlite volcanic glass, and diatomaceous earth occurrences in the Tertiary basins of southern British Columbia. A deposit model with potential exploration targets for residual kaolin and bentonite was developed. The project also discovered that certain drainage patterns established in the Eocene period had implications for current placer gold exploration.

**IMPACT** Interest in zeolites has developed from this project and research has been undertaken at the University...
of Guelph regarding its use in fertilizer production. Occurrences identified by the project's mapping have since been staked. Many inquiries about the project's outcome have been received by the Ministry of Energy, Mines and Petroleum Resources from sources in Ontario and Alberta. Proposals are under consideration to study zeolites for water effluent treatment and other industrial uses.

**OUTPUTS**

**Fieldwork Articles**


**Open Files**


**Other**


**Talks**

A presentation was made at the 1990 Joint Meeting of the Geological Association of Canada and the Mining Association of Canada, Vancouver, British Columbia.

---

A four year study identified zeolite, kaolin, bentonite, perlite, volcanic glass and diatomaceous earth occurrences in the Tertiary basins of southern B.C.
**Project name** | PHOSPHATE
---|---
**MDA expenditures** | $152,379 (1987-1989)
**Principal researcher(s)** | S. BUTRENCHUK
**Supervising agency** | B.C. GEOLOGICAL SURVEY BRANCH
**Project location** | SOUTHEAST AND NORTH-EAST B.C.

**OBJECTIVES**
To stimulate industry interest in the economic potential of phosphate in British Columbia. This objective was to be achieved by identifying the most promising areas for developing phosphate deposits in the province and by compiling a resource potential for phosphate.

**ACHIEVEMENTS**
Geological investigations identified several stratigraphic horizons containing sedimentary phosphate deposits. Of these, the Fernie Formation and Sulphur Mountain Formations were identified as affording the best potential for developing a commercial phosphate deposit in British Columbia. The Fernie Formation was estimated to have a resource potential of 57 to 340 million tonnes and the Sulphur Mountain Formation, an estimated 19 to 113 million tonnes. Also, the Aley carbonatite was recognized as possibly providing an alternative source of phosphate in the province.

**IMPACT**
Due to poor fertilizer markets and an oversupply of phosphate worldwide, private sector interest in exploring for phosphate has been relatively low. The project, however, identified yttrium values in the Fernie phosphate which has resulted in two field programs by Formosa Resources to date. Westroc Resources has also staked some ground. As well, in research at the University of Guelph the Fernie phosphate is being used to develop a low cost, slow release fertilizer. Industry interest in the project was sufficiently high that all Open File publications on phosphate were sold out.

**OUTPUTS**

**Fieldwork Articles**


**Open Files**

**Other**

**Talks**

Presentations were also made at the following:

**Project name** | ALEY CARBONATITE
---|---
**MDA expenditures** | $5,100 (1987)
**Principal researcher(s)** | U. MADER
**Supervising agency** | B.C. GEOLOGICAL SURVEY BRANCH AND THE UNIVERSITY OF BRITISH COLUMBIA
**Project location** | NORTHEAST B.C.

**OBJECTIVES**
To stimulate industry interest in carbonatites and kimberlites in British Columbia by describing the geology and mineralogy of the Aley carbonatite. This project was intended to contribute to the larger study being undertaken on carbonatites and kimberlite related diatremes.

**ACHIEVEMENTS**
The geological study identified economic minerals present in the deposit, contents of thorium in selected samples and identified rare earth elements in the individual phases of the carbonatite plug and associated dykes.

**IMPACT**
This project resulted in increased industry awareness of the economic potential of carbonatites and related ultra-alkaline rocks in British Columbia. As a result, one company, Teck Corporation, carried out work in the Wicheeda Lake area north of Prince George and on REN claims at Perry River. Also, activities in the Kechika River area have been in part inspired by this project.
OUTPUTS

Fieldwork Articles

PROJECTS

Project name: PEAT INVENTORY

MDA expenditures: $12,641 (1988)
Principal researcher(s): D. MAYNARD
Supervising agency: B.C. GEOLOGICAL SURVEY BRANCH
Project location: PROVINCE-WIDE

OBJECTIVES
To assess the economic potential of British Columbia peatlands in order to provide guidance to investors interested in developing a viable peat industry. This was to be achieved by compiling information on the distribution and quality of peat resources in the province.

ACHIEVEMENTS
A total of 73 map sheets at a scale of 1:250 000 were produced to display information on distributions of peat deposits. The report identified three peatland resource areas: central and north coast, central Interior Plateau and northeastern Great Plains. The potential for horticultural peat was identified for both the northeastern and the northwestern part of the province. Fuel peat potential was identified for all three main regions. Agricultural uses of peatlands were found to be common in the Fraser Valley, eastern Vancouver Island, the central Interior and Peace River area. Environmental concerns of developing a peatland were also considered.

IMPACT
The project stimulated industry interest in the peat resources of British Columbia. Two private companies, both from out of province, requested preliminary information on the project’s conclusions. Also, the Provincial Ministries of Agriculture and Environment were interested in the project outcome and final report.

OUTPUTS

Open Files

Fieldwork Articles

OUTPUTS

Project name: KYANITE AND GARNET

MDA expenditures: $17,278 (1988)
Principal researcher(s): J. PELL
Supervising agency: B.C. GEOLOGICAL SURVEY BRANCH
Project location: PROVINCE-WIDE

OBJECTIVES
To assist industry by identifying exploration targets for kyanite and garnet in schists and other related environments in central British Columbia.

ACHIEVEMENTS
An extensive literature search identified areas of high grade garnet and kyanite. Ten 1:250 000 geological maps were compiled of areas underlain by greater than 15% kyanite or greater than 25% garnet host rocks. A comprehensive bibliography on garnet, kyanite, andalusite and sillimanite in British Columbia was prepared.

IMPACT
This project has generated interest from prospectors and industry, particularly regarding garnet. One company is currently in the process of developing a garnet deposit near Penticton. Exploration and drilling have been undertaken near Revelstoke. Two other areas have also been considered for exploration. As well, a potential garnet resource on Vancouver Island is being evaluated.

OUTPUTS

Fieldwork Articles

Open Files

OUTPUTS

Project name: TALC ASSESSMENT

MDA expenditures: $10,417 (1988)
Principal researcher(s): M. MACLEAN
Supervising agency: B.C. GEOLOGICAL SURVEY BRANCH
Project location: PROVINCE-WIDE

OBJECTIVES
To aid prospectors and industry in the discovery and development of British Columbia talc to replace the imported product that is widely used in the province’s pulp and paper industry. This objective was to be achieved by compiling an inventory of known talc
occurrences in British Columbia and providing information and references to act as useful guides to exploration.

ACHIEVEMENTS A report documenting 38 talc occurrences and 4 pyrophyllite occurrences was prepared. A map was compiled demonstrating the distribution of occurrences classified on the basis of host lithology. The majority of occurrences were found to be associated with schists and ultramafics of Mississippian to Triassic and Cambrian to Mississippian formations (Cache Creek, Anarchist, Sylvester, Antler and Larderel). Two properties recently studied in detail were identified as having commercial quality talc.

IMPACT Considerable industry interest was stimulated by this project and a number of copies of the report were sold. One company, Pacific Talc Incorporated, is currently preparing plans to bring its Nahatlach River deposit to the production stage. Pacific Talc’s activities brought inquiries from major talc producers in North America: Talc Luzenac Incorporated, Cyprus Minerals, US Borax, Montana Talc, and ECC International.

OUTPUTS

Open Files

Project name FLUORSPAR POTENTIAL
MDA expenditures $51,310 (1989)
Principal researcher(s) Z.D. HORA
Supervising agency B. C. GEOLOGICAL SURVEY BRANCH
Project location PROVINCE-WIDE

OBJECTIVES To encourage and stimulate private sector exploration for fluorspar resources in British Columbia. This objective was to be accomplished by compiling a database of fluorspar resources in the province and identifying areas favourable for exploration and development. The project also intended to examine the potential of using fluorine as a pathfinder for high-tech elements, such as rare earth elements, beryllium, yttrium, and zircon.

ACHIEVEMENTS This project identified several of the criteria for distribution of fluorspar deposits in the British Columbia Cordillera Region. Geochemical studies were undertaken which used fluorine anomalies as pathfinders for high-tech elements. The potential of fluorspar deposits in British Columbia was assessed and benchmark deposit types described.

IMPACT As a result of this project, two junior companies independently assessed the potential of the Rexspar deposit. As well, the Mineral Policy Branch of Energy, Mines and Resources Canada is currently studying the feasibility of developing a British Columbia fluorspar resource for use in the Pacific northwest aluminum industry.

OUTPUTS

Project name LIMESTONE AND DOLOMITE
MDA expenditures $23,456 (1990)
Principal researcher(s) P. FISCHL
Supervising agency B. C. GEOLOGICAL SURVEY BRANCH
Project location PROVINCE-WIDE

OBJECTIVES To promote the development of limestone and dolomite resources by compiling an inventory of present and past producers and geological units with favourable potential.

ACHIEVEMENTS This project produced the first comprehensive inventory of limestone resources in British Columbia. Geological units with limestone and dolomite resources were described and data on their chemical composition was compiled.

IMPACT Several potential gold producers have used the preliminary data from this project to search for limestone sources for use in neutralizing mine waste waters. Three major companies: Asarco Incorporated, J.M. Huber Corporation, and Ash Grove Cement West Incorporated, are using the study results to look for opportunities to open new quarries. As well, smaller groups, mainly from Alberta and Eastern Canada, have used the information to assess the feasibility of developing a new lime production facility.

Fieldwork Articles


Talks
A presentation was made on high-tech elements potential in British Columbia to the Kootenay Exploration and Mining Conference, in Nelson, British Columbia, 1989.

Project name
LIMESTONE AND DOLOMITE
MDA expenditures
$23,456 (1990)
Principal researcher(s)
P. FISCHL
Supervising agency
B. C. GEOLOGICAL SURVEY BRANCH
Project location
PROVINCE-WIDE

OBJECTIVES
To promote the development of limestone and dolomite resources by compiling an inventory of present and past producers and geological units with favourable potential.

ACHIEVEMENTS
This project produced the first comprehensive inventory of limestone resources in British Columbia. Geological units with limestone and dolomite resources were described and data on their chemical composition was compiled.

IMPACT
Several potential gold producers have used the preliminary data from this project to search for limestone sources for use in neutralizing mine waste waters. Three major companies: Asarco Incorporated, J.M. Huber Corporation, and Ash Grove Cement West Incorporated, are using the study results to look for opportunities to open new quarries. As well, smaller groups, mainly from Alberta and Eastern Canada, have used the information to assess the feasibility of developing a new lime production facility.
### 1.1.5 Geophysics

Geophysical Surveys - surveys wherein local variations in specific geophysical parameters, such as the earth's magnetism, are measured in a systematic manner to determine distributions that may be interpreted to locate subsurface geological features, including ore deposits.

<table>
<thead>
<tr>
<th>Project name</th>
<th>AEROMAGNETIC SURVEYS</th>
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<tr>
<td>MDA expenditures</td>
<td>$625,000 (1987-1989)</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>GEOLOGICAL SERVICES OF CANADA, GEOPHYSICS DIVISION, AEROMAGNETIC SURVEYS</td>
</tr>
<tr>
<td>Project location</td>
<td>STRAIT OF GEORGIA, CENTRAL VANCOUVER ISLAND, CENTRAL B.C.</td>
</tr>
</tbody>
</table>

#### OBJECTIVES
To aid geological field mapping and mineral exploration in British Columbia by undertaking aeromagnetic surveys and producing data sets to complement existing coverage.

#### ACHIEVEMENTS
MDA funding complemented Geological Survey of Canada funding to conduct aeromagnetic surveys at constant elevation in three areas of British Columbia. Fixed-wing aircraft and inboard systems were primarily used for the task. Flight path recovery and navigation were carried out using a combination of visual (photographic) and electronic systems such as Loran 'C', doppler, inertial guidance and, in central British Columbia, the Global Positioning System. Use of these systems resulted in high precision surveys with a positional accuracy estimated to be approximately 50 metres in most areas.

The results of these surveys were released in both map and digital format. For the Strait of Georgia (NTS 92E, F, G, K, L, & M), 52 maps were produced at 1:50 000 scale and six maps at 1:250 000 scale. For the Taseko Lakes area (NTS 92O & P), 12 maps were produced at 1:50 000 scale and 2 maps at 1:250 000 scale. Ten maps at 1:50 000 scale and 2 maps at 1:250 000 scale were produced for the Williams Lake area (NTS 93A, H).

#### IMPACT
In the Queen Charlotte Sound area, magnetic patterns have helped to define the boundary between the Alexander and upper Jurassic Wrangellian terranes. This boundary has economic importance as it contains important source rocks for hydrocarbon reserves. For central Vancouver Island, the data has been used to complement recently collected seismic data, which will better define the deep structure of the crust and upper mantle, as part of the Canadian Lithoprobe program.

The data collected during this project will prove useful for mapping geological units such as mafic volcanics and...
intrusions, and contacts between units, and thus will help to define areas of high potential for mineral exploration. Subsequent to the release of these data, the GSC has demonstrated improved geological definition through digital correction of terrain clearance.

### 1.2 Geoscience Data Systems

High quality and accessible mineral deposit data are important building blocks for modern exploration. Under this component of the Agreement, MDA funding contributed towards the expansion and redesign of computer files of coal and mineral deposits in order to improve access for industry and government resource managers.

MDA expenditures on the three geoscience data systems projects were $418,000. The majority of funding was directed towards the reinstatement and continued updating of MINFILE, the province’s computer inventory of mineral occurrences.

Industry use of MINFILE has increased as a result of this project. By the end of 1991, about 75 percent of the known mineral occurrences in the province will have been investigated and included in MINFILE.

MINFILE data is sold on a commercial basis in hard copy as maps and printouts and in computer format as floppy diskettes for use with MINFILE/pc. MINFILE/pc is a menu-driven search-and-report program for IBM-PC compatible computers. This program is able to efficiently and easily search, sort and manipulate information in the database in response to specific queries and has twelve search screens allowing interrogation of description areas. MINFILE information can be plotted using computer aided drafting systems and integrated with conventional geographic information systems.
Geoscience Data Systems - MINFILE

**Project name** MINFILE

**MDA expenditures**

- $2,747 (Budgeted, 1991)

**Principal researcher(s)** L. JONES AND A. WILCOX

**Supervising agency** B.C. GEOLOGICAL SURVEY BRANCH

**Project location** PROVINCE-WIDE

**OBJECTIVES** To stimulate increased and more efficient exploration activity by providing accurate and up-to-date information on mineral deposits in the province. This was to be achieved by updating the Ministry of Energy, Mines and Petroleum Resource's computer inventory of provincial mineral occurrences, known as MINFILE.

**ACHIEVEMENTS** This project provided part of the funding for the reinstatement and continued updating of MINFILE. Under the MDA, the system was upgraded to contain 18 more field elements. As well, existing geological data were enhanced.

By the end of 1991, about 75 percent of the known mineral occurrences in the province will have been investigated and included in MINFILE. Of this, approximately 58 percent have been or will be released to the public at a 1:250 000 scale for use with MINFILE/pc.

Under the MINFILE project, a magnesite and silica Open File were published and a uranium and thorium Open File were prepared for release.

**IMPACT** MINFILE has helped to provide solutions to mineral exploration, land-use and mineral resource management problems. Industry use of MINFILE has increased as a result of this project. Over 300 clients are now accessing the system and both the number of MINFILE sales and enquiries are up dramatically. The list of interested clients now includes representatives from 9 provinces, 9 U.S. states, New Zealand, England, Switzerland, China and several African countries. It is anticipated that increased circulation of geoscience data pertaining to British Columbia will serve to attract investment dollars to the province in the years ahead.

MINFILE will ultimately be used as an underlying database for Geographical Information Systems and Expert System technology.

**OUTPUTS**

**Fieldwork Articles**


**Open Files**


**MINFILE Releases**

48 MINFILE areas released since 1986.

**Talks and Displays**

Presentations were made at the following:


**MINFILE**

MINFILE, the province's computer inventory of mineral occurrences, is widely available in hard copy as maps and printouts and in computer format as floppy diskettes.

<table>
<thead>
<tr>
<th>Project name</th>
<th>COMPUTER FILE – RADIO METRIC AGE DATES</th>
</tr>
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<tbody>
<tr>
<td>MDA expenditures</td>
<td>$3,625 (1986)</td>
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<td>Principal researcher(s)</td>
<td>A. BENTZEN</td>
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<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Project location</td>
<td>VANCOUVER</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To provide support to the exploration industry by compiling a computer database file of radiometric dates for British Columbia.

**ACHIEVEMENTS** Approximately 3,000 radiometric dates from British Columbia geological sites were entered into a computer to produce a master database accessible by modem/diskette/and 9 track tape. The British Columbia Ministry of Energy, Mines and Petroleum Resources received a master copy of the database on diskette and computer tape as well as updates of all dates added later.
**IMPACT**  Geologists in government and industry have been provided with access to this valuable database which has proved of assistance in mapping and exploration.

**OUTPUTS**

**Fieldwork Articles**


---

**Project name**  LITHCHEM

**MDA expenditures**  $9,600 (1987)

**Principal researcher(s)**  A. SINCLAIR

**Supervising agency**  B.C. GEOLOGICAL SURVEY BRANCH AND THE UNIVERSITY OF BRITISH COLUMBIA

**Project location**  UBC

**OBJECTIVES**  To assist the exploration industry by constructing a rapid evaluation (computer-based) system for whole rock chemical analyses of volcanic rocks in British Columbia. The project intended to produce a system that would be of use both for theoretical and applied studies.

**ACHIEVEMENTS**  A software system was developed to permit data entry, data selection and data display with a variety of two-dimensional graphs to assist recognizing magmatic trends and superimposed alterations. An extensive file of more than 2200 chemical analyses of volcanic rocks from the Canadian Cordillera was input and integrated with supplementary geological information on age and classification.

**IMPACT**  This project has produced a chemical database for mesozoic volcanic rocks. Although the information has not been well publicized, it has been well received by those aware of it.

**OUTPUTS**

**Fieldwork Articles**


1.3 Market, Technical and Feasibility Studies

Under this component, studies were carried out to assess British Columbia’s future mineral supply, collect and analyze mineral economic data, identify market potential for selected industrial mineral commodities and examine the feasibility of introducing new techniques and technologies in mineral development. In 1988, a new program was added, which funded research into industry-wide problems, such as acid mine drainage.

Many of the projects were initiated by industry and carried out on a cost-shared basis.

Project outputs that are currently publicly available are marked with an ** and are listed in Appendix B. Most cost-shared project reports will become available in the future as limited periods of confidentiality expire.

Activities were divided into four sub-components: Mineral Economic Data Development, Mineral Opportunities, Mineral Supply Forecasting and Research and Development.

MINERAL ECONOMIC DATA DEVELOPMENT

MDA expenditures under the Mineral Economic Data Development sub-component were approximately $128,000. Seven projects were supported which provided industry and government with new mineral economic data to support policy work and decision making. The majority of funding was directed towards the design and implementation of a computer database of mineral sector data, the Mine Profile System. Other studies looked at the relative tax burden imposed on new mine developments in jurisdictions across Canada, the impact of upcoming mine closures on local communities, public attitudes towards the mining industry, native participation in mining, the development of mine-specific reclamation funds and the feasibility of establishing a custom processing facility for industrial minerals.

MINERAL OPPORTUNITIES

The two types of studies funded under the Mineral Opportunities sub-component were mineral market and technology development projects. Total MDA expenditures were about $555,000.

The purpose of the mineral market studies sub-component was to demonstrate the export market potential and import replacement opportunities for provincial industrial minerals. British Columbia currently imports a significant amount of raw and semi-manufactured products made from minerals for which the province has an abundant resource potential. Development of these resources would not only strengthen the provincial mineral sector, but also create manufacturing opportunities. Furthermore, the development of these resources would reduce the province’s reliance on imported materials and provide opportunities for increased mineral commodity exports.

Seven studies to examine the market potential for selected provincial mineral commodities were funded. Local processing and export opportunities for jade, gypsum, feldspar, talc, dimension stone, barium carbonate and garnet were analyzed. Another study assessed the costs involved in transporting industrial minerals to market. The results of these studies have proved very useful to industry and several of the commodities studied are currently being evaluated by the private sector for development.

The technology studies were designed to ensure that the province’s mining industry would be able to benefit from changing economic conditions and technologies by developing and adopting relevant technologies. This was to be achieved by providing “seed money” to stimulate research, development and demonstration work in the province by private industry in the fields of mineral exploration technology, mineral processing and recovery, coal fuel product development and utilization and mine reclamation and environmental problems. The aim was to provide incentives to companies to expand their research capabilities and to provide a focus for applied minerals and mining research.

Of the nineteen technology studies carried out, two studies addressed the issue of worker safety. Nine other studies looked at the feasibility of introducing new techniques and technologies into mineral development. Several of the applications studied have already been implemented by industry to enhance resource recovery.

Four projects addressed the environmental problems associated with mining and in particular for the prevention, treatment, monitoring and control of acid mine drainage. These projects have contributed towards a greater understanding of the issues and have worked to develop solutions.

MINERAL SUPPLY FORECASTING

MDA funding of $38,500 contributed towards the purchase of world metal market reports from the Commodity Research Unit of London, England. These reports have provided essential market intelligence information for policy analysis and planning.

RESEARCH AND DEVELOPMENT

Beginning in 1988, acid mine drainage research became a priority under the MDA. Most of the studies funded under the research and development sub-component were concerned with acid mine drainage research.

Total MDA expenditures on this sub-component were approximately $480,000. About half of the projects were cost-shared with industry and total project costs were often
several times greater than the MDA contribution. The projects funded entirely by the MDA were of a more generic nature. The information produced had broad applications which was relevant to both industry and regulatory agencies.

All acid mine drainage projects were recommended and approved by the British Columbia Acid Mine Drainage Task Force. The Task Force is composed of representatives of mining companies, universities, the Mining Association of British Columbia and several federal and provincial government agencies. It is recognized as a world leader in acid mine drainage research and is currently building domestic expertise that is sought after worldwide.

The achievements of the acid mine drainage research projects have been considerable. Awareness of the issue has been heightened, the best understanding of acid mine drainage available has been collected together in a technical guide and published, alternative waste disposal and treatment methods have been evaluated and a computer program to predict the potential for acid generation has been developed. Acid mine drainage research is a relatively new science and the outcomes of the MDA projects will provide valuable information for future studies.

### 1.3.1 Mineral Economic Data Development

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<th>Project name</th>
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</tr>
</thead>
<tbody>
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<tr>
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<td>B. W. MACKENZIE</td>
</tr>
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<td>Supervising agency</td>
<td>B.C. MINERAL POLICY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>QUEEN'S UNIVERSITY CENTRE FOR RESOURCE STUDIES</td>
</tr>
<tr>
<td>Project location</td>
<td>QUEEN'S UNIVERSITY</td>
</tr>
</tbody>
</table>

**OBJECTIVES**

To design and implement a computer database of British Columbia mineral sector data in order to support government policy work and data dissemination.

**ACHIEVEMENTS**

A consultant was hired to design an interactive database composed of several modules. Appropriate hardware was selected and purchased. Data on geology, reserves, grades, mine plans, capital and operating costs, ownership, personnel, contracts, labour unions, for all current mines in the province were compiled and input. Significant numbers of historical producers were researched and entered in the system, as well as selected potential producers. Although the mine module and company module are the most complete, there is also a commodity module which contains information on contracts.

**IMPACT**

The project produced an in-house database of the British Columbia mineral sector that has enhanced government's ability to respond to enquiries and issues affecting the industry. Use to date, however, has been limited due primarily to staffing constraints.

**OUTPUTS**

A customized computer software system was specially developed for the Mineral Policy Branch of the Ministry of Energy, Mines and Petroleum Resources - the 'Mine Profile System.'

**Project name**

- MINE PROFILE SYSTEM

**MDA expenditures**

- $72,752 (1986-1988)

**Principal researcher(s)**

- CONSOLIDATED COMPUTER MANAGEMENT INCORPORATED

**Supervising agency**

- B.C. MINERAL POLICY BRANCH

**Project location**

- VICTORIA

to maintain employment and incomes in the face of anticipated closures or reduced operations at mines in British Columbia. Many of the report's recommendations were adopted by the Task Force.

**OUTPUTS**


---

**Project name** | **PUBLIC ATTITUDE SURVEY**
---|---
**MDA expenditures** | $10,000 (1989)
**Total project cost** | >$20,000
**Principal researcher(s)** | MARKTREND MARKETING RESEARCH INC.
**Supervising agency** | MINING ASSOCIATION OF BRITISH COLUMBIA
**Other participating agencies** | B.C. MINERAL POLICY BRANCH
**Project location** | PROVINCE-WIDE

**OBJECTIVES**

To survey public attitudes in British Columbia towards the mining industry, in order to obtain and report on information that would assist government and industry in the development of appropriate strategies for an improved public image.

**ACHIEVEMENTS**

A report was produced which documented the results of the public opinion survey. A total of 663 telephone interviews were conducted with residents throughout the province. Questions focused on the following: 1. Determining the level of public understanding and appreciation of the economic impact of mining; 2. Identifying concerns surrounding mining that are most important to British Columbians; 3. Ascertaining the level of public understanding on land use issues affecting the mining industry, and what attitudes are held by the public; and 4. Determining how these findings differ among various segments of the population. Recommendations on future communication strategies for the Mining Association were also provided.

**IMPACT**

This project led to the development of an expanded communications program by the Mining Association of British Columbia with a view to educating the general public on the economic impact of the mining industry in British Columbia. In particular, the Association concentrated on communication strategies which emphasized the environmental impacts of mining, the Mine Development Review Process, careers in mining and safety in the mining industry. Communications with communities throughout the province were also opened up.
Also, the Ministry of Energy, Mines and Petroleum Resources used the results of this study as input into decision making regarding their communications strategy.

OUTPUTS

Marktrend Marketing Research Incorporated (1989): Presentation of *Attitudes to Mining in British Columbia* to a Joint Meeting of the Mining Association of British Columbia and British Columbia and Yukon Chamber of Mines Luncheon Meeting, 1989.

Project name: INDUSTRIAL MINERALS CUSTOM MILLING
MDA expenditures: $5,000 (1989)
Principal researcher(s): AINSWORTH-JENKINS HOLDINGS INC.
Supervising agency: B.C. GEOLOGICAL SURVEY BRANCH
Project location: VANCOUVER AND EUROPE

OBJECTIVES To coordinate and prepare an interprovincial report on native participation in the mining industry. This project intended to provide government with information that would help future decisions regarding native participation in existing and developing mining operations.

ACHIEVEMENTS A report was prepared which examined the issue of native participation in the Canadian mining industry. The following information was presented: a collection of "best" case studies; a listing of government programs/policies that natives and/or companies could access to increase native participation; a preliminary evaluation of the opportunities available and the feasibility of establishing a custom processing facility for industrial minerals in British Columbia.

ACHIEVEMENTS A report was prepared which describes the history and economics of three successful custom processing plants that were visited in Europe. Based on the experiences of these operations, the limitations and potential for custom processing in a British Columbia location are described. Recommendations are also made as to the types of minerals/products that may be economically viable and the markets that are potentially accessible to British Columbia producers. Factors cited that make British Columbia an attractive location for a industrial mineral custom processing facility are: its wealth of industrial minerals, its reputation as a reliable and competent trading partner, and its proximity to Pacific Rim nations. The report suggests that British Columbia could export processed materials in empty container ships returning to industrialized Pacific Rim countries. The possibility of joint ventures with European or American custom processors is also discussed.

IMPACT Industry interest in the report has been high, with approximately 30 copies sold between May 1989 and January 1990.

OUTPUTS

Project name: NATIVE PARTICIPATION IN MINING
MDA expenditures: $8,125 (1990)
Total project cost: >$16,000
Principal researcher(s): B. JANKE
Supervising agency: B.C. MINERAL POLICY BRANCH
Project location: VICTORIA

OBJECTIVES To supply government and industry with a preliminary evaluation of the opportunities available and the feasibility of establishing a custom processing facility for industrial minerals in British Columbia.

ACHIEVEMENTS A report was produced which examined the issue of native participation in the Canadian mining industry. This project intended to provide government with information that would help future decisions regarding native participation in existing and developing mining operations.

IMPACT The project produced a comprehensive source of information on native involvement in mining which will be helpful to governments in British Columbia and other jurisdictions when deciding on proposed mine developments and potential community impacts.

OUTPUTS


1.3.2 Mineral Opportunity Market Studies

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<thead>
<tr>
<th>Project name</th>
<th>MOHAWK JADE TILE PRODUCTION STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$25,000 (1987)</td>
</tr>
<tr>
<td>Total project cost</td>
<td>&gt;$50,000</td>
</tr>
<tr>
<td>Principal researcher(s)</td>
<td>M. WALDER AND E. PLANK</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B. C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>MOHAWK OIL COMPANY LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

OBJECTIVES To promote local processing of British Columbia’s jade resources by examining and reporting on the feasibility of constructing a local facility to process sub-gem quality jade into decorative tiles.

ACHIEVEMENTS A study was done of current stone cutting technology and its potential application to jade, given jade’s unique toughness and texture characteristics. Pilot scale tests were made by selected equipment manufacturers and based on these tests, equipment was selected and flowsheets developed. Capital and operating costs were calculated to determine the cost of the final product and to ensure an adequate projected rate of return. A site selection survey identified the southwest mainland of the province as the optimal location for the processing facility.

IMPACT Due to difficulties in securing marketing arrangements, progress in developing a jade tile processing facility has not gone beyond the conceptual stage.

OUTPUT
sidered to be a constraint to development were to be prioritized. The information from this project was intended to assist Ministry staff and the Industrial Minerals Advisory Group in developing future industrial minerals studies.

**ACHIEVEMENTS** A report was prepared that ranked British Columbia's industrial minerals in order of priority for market studies and developed a design for the Industrial Minerals Market Studies Series. It was suggested that each future study include the following information: a geological description of the mineral; a general overview of end-uses and further processing of the mineral; a map or description of known deposits or occurrences within British Columbia; a review of relevant historical producers; a description of present producers and consumers; and an analysis of potential producers and consumers.

**IMPACT** The outline has helped Ministry staff and the Industrial Minerals Advisory Group develop guidelines for further industrial mineral studies.

**OUTPUTS**


A presentation was made in Vancouver, British Columbia, to the Industrial Mineral Advisory Group in 1986.

<table>
<thead>
<tr>
<th>Project name</th>
<th>GYPSUM MARKET STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$15,000 (1987)</td>
</tr>
<tr>
<td>Total project cost</td>
<td>$30,000</td>
</tr>
<tr>
<td>Principal researcher(s)</td>
<td>KING, MURPHY, LAVALIN CONSULTANTS</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY AND MINERAL POLICY BRANCHES</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>QUEENSTAKE RESOURCES LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To encourage the development of British Columbia gypsum resources by providing information on the eastern Pacific Rim market potential for British Columbia gypsum and developing a marketing scenario. The project also intended to identify gypsum specifications needed for each segment of the market, including prices, production and consumption volumes.

**ACHIEVEMENTS** A study was carried out in joint cooperation with Queenstake Resources Limited, a publicly-owned Canadian mining company. A detailed description of gypsum and its role in today's industrial world was provided. Marketing opportunities for British Columbia gypsum in the North American "Pacific Northwest" area were outlined. The report suggested the best opportunities for British Columbia's gypsum were in the supply of crude gypsum to the wallboard and cement plants located in the Vancouver port area and in Seattle and Tacoma.

**IMPACT** Industry interest in the project has been high and over 30 copies of the report have been sold. The output of the study was used in a feasibility assessment of the Haines Gypsum project in northwestern British Columbia.

**OUTPUTS**


### FELDSPAR MARKET STUDY

<table>
<thead>
<tr>
<th>Project name</th>
<th>FELDSPAR MARKET STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal researcher(s)</td>
<td>MINERAL MARKETING INCORPORATED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY AND MINERAL POLICY BRANCHES</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To promote the development of feldspar, nepheline syenite and other feldspathic materials in British Columbia. This goal was to be achieved by evaluating the market potential and identifying the uses and specifications of these minerals in West Coast and Pacific Rim glass and ceramics plant.

**ACHIEVEMENTS** A report was produced which described the physical characteristics and industrial uses of feldspar, nepheline syenite and other feldspathic materials. Information was provided on world production, supply, international trade and prices. Ten potential production sites in British Columbia were briefly evaluated. It was found that a producer of feldspar or nepheline syenite in British Columbia would enjoy a freight advantage in western markets over eastern producers of both materials and also over southern California or Mexican suppliers of feldspar. Depending on the nature of the deposit, transportation costs and the effectiveness of sales and marketing efforts, the potential market for British Columbia producers was projected to range from 25,000 to 100,000 tonnes annually. The primary markets were identified as glass and ceramics plants in the Western Provinces, the Pacific Northwest, Northern California and Pacific Rim countries.

**IMPACT** Industry interest in the report was high; it was one of the best selling reports produced under the MDA. As a result of the project, one privately funded follow-up market study was carried out and two feldspar deposits were studied for development. As well, the nepheline syenite deposit at Trident Mountain was staked and evaluated for development.
**OUTPUTS**


Feldspar Resources Report (in preparation).

Presentations were made at the following:

<table>
<thead>
<tr>
<th>Project name</th>
<th>MARKET STUDY: MODIFIED TALC</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$1,518 (1989)</td>
</tr>
<tr>
<td>Total project cost</td>
<td>$2,000</td>
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<tr>
<td>Principal researcher(s)</td>
<td>TEMANEX CONSULTING INCORPORATED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>PACIFIC TALC LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To identify market opportunities and project market sizes for modified talc in British Columbia by analyzing the West Coast papermaking industry and its near term growth potential and assessing papermaking mineral pigments markets and trends.

**ACHIEVEMENTS** A report was produced that analyzed West Coast mineral pigment market trends with regards to talc’s potential and limitations in the papermaking industry. Talc’s current usage was found to be limited and primarily for pitch control rather than for paper filling and coating. The major inhibiting factors to greater usage of talc were found to be twofold: in British Columbia kaolin has been traditionally used as a low-cost alternative; and, the hydrophobic nature of talc’s surface is such that it results in a high dusting tendency in offset printing, which is the dominant printing process in North America. The report concluded that if the offset dusting problem were solved and talc was competitively priced, it might be possible for talc to capture roughly a 20% share of the West Coast papermaking pigments market over the next five to ten years.

**IMPACT** The results of this study were very useful to Pacific Talc Limited and have helped the company get one step closer to actual production from their deposit near Boston Bar.

<table>
<thead>
<tr>
<th>Project name</th>
<th>DIMENSION STONE MARKET STUDY</th>
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</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$15,143 (1989)</td>
</tr>
<tr>
<td>Principal researcher(s)</td>
<td>J. PAGE/BEATY GEOLOGICAL SERVICES</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To diversify the province’s mineral industry by identifying market opportunities for British Columbia dimension stone which would lead to import replacement and new export opportunities.

**ACHIEVEMENTS** A market study was undertaken which identified opportunities for British Columbia dimension stone. Premium quality colored granites were found to provide the best market opportunities. Fabricated grey colored granites also appeared to have good market potential. Competitiveness was cited as the most important factor to developing a British Columbia dimension stone industry.

MDA studies advanced local processing and export opportunities for jade, gypsum, feldspar, talc, dimension stone, barium carbonate and garnet.
IMPACT This project and the dimension stone assessment project have generated considerable industry interest. Numerous requests for information have been received by the Ministry of Energy, Mines and Petroleum Resources. Plans are currently underway to develop two new quarries and three quarries have started production since these projects were originally undertaken. A mapping project to identify potential exploration targets has been proposed and will be undertaken in 1990.

OUTPUTS


A presentation of the report was made to the Industrial Minerals Advisory Committee in the spring of 1989.

<table>
<thead>
<tr>
<th>Project name</th>
<th>BARIUM CARBONATE MARKET STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$10,000 (1990)</td>
</tr>
<tr>
<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>PRODUCTIVE CONSULTANTS COMPANY</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
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</tbody>
</table>

OBJECTIVES To identify North American market conditions for barium products and the economic outlook for the barium chemical manufacturing facility proposed by Mountain Minerals Company Limited.

ACHIEVEMENTS A report was produced that identified the following: the size of the North American market, supply and demand patterns, economics, major barium chemical uses, market growth potential, competitive forces and Mountain Minerals Company Limited’s distinct advantages. A list of industrial consumers was supplied in the Appendix. The report concluded that the marketing climate was very favourable and recommended that Mountain Minerals proceed with the barium chemicals project.

IMPACT This study is being used by Mountain Minerals Company Limited to assess whether or not the company will enter the barium carbonate production business.

OUTPUTS


<table>
<thead>
<tr>
<th>Project name</th>
<th>GARNET MARKET STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
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<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>HEBB RESOURCES INTERNATIONAL INCORPORATED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>POLESTAR EXPLORATION INCORPORATED</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

OBJECTIVES To promote the development of high-quality British Columbia garnet by analyzing supply and demand factors, market trends, product specifications, new uses, and by forecasting a strategy for penetrating existing or anticipated markets.

ACHIEVEMENTS A report was prepared that described current world-wide sources and industrial demand for garnet. The most promising market for garnet was found to be as an abrasive blast cleaner. Garnet’s ability to win market share to date was seen as limited by two factors: relatively high price and limited availability. A strategy for British Columbia garnet producers to penetrate these markets was identified. Both demand and price outlook for British Columbia garnet products was regarded as very positive.

IMPACT This study is being used by Polestar Exploration Incorporated to help assess whether or not the company will develop a garnet-bearing skarn deposit at Crystal Peak, in the Hedley area of British Columbia, for abrasive garnet production.

OUTPUTS


<table>
<thead>
<tr>
<th>Project name</th>
<th>STRATEGIC PLAN, INDUSTRIAL MINERALS</th>
</tr>
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<tbody>
<tr>
<td>MDA expenditures</td>
<td>$9,222 (1990)</td>
</tr>
<tr>
<td>Principal researcher(s)</td>
<td>H. MCVEY</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

OBJECTIVES To stimulate the development of industrial minerals in British Columbia by producing a five- to ten-year strategic plan of geological, process development,
marketing and promotional programs that would be used as the basis for an Industrial Minerals Program under a renewed Economic and Regional Development Agreement.

**ACHIEVEMENTS** A report was prepared that examined anticipated trends in consumption and production of industrial minerals and assessed British Columbia's advantages and disadvantages with respect to future development. The potential for growth and importance of industrial minerals was emphasized. The structure and activities of the Industrial Minerals Subsection of the British Columbia Ministry of Energy, Mines and Petroleum Resources were analyzed and compared with those of competing jurisdictions in the Pacific Northwest. Recommendations were made regarding a five-to ten-year strategic plan for an Industrial Minerals Program which would allow British Columbia to maintain its achieved advantages.

**IMPACT** This report is being used by government policy makers to assist in planning.

### OUTPUTS


<table>
<thead>
<tr>
<th>Project name</th>
<th>INDUSTRIAL MINERALS TRANSPORTATION STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$20,000 (1990)</td>
</tr>
<tr>
<td>Principal researcher(s)</td>
<td>TRANSMODE CONSULTANTS INCORPORATED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. MINERAL POLICY AND GEOLOGICAL SURVEY BRANCHES</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To promote the development of industrial minerals in British Columbia by producing estimates of the costs of transporting industrial minerals to selected markets in North America and overseas countries. The intent of this project was to provide policy makers and potential producers with a "pre-feasibility" assessment of development potential.

**ACHIEVEMENTS** Frequently the cost of transporting an industrial commodity to market exceeds the cost of mining and processing. Thus, the transportation cost is a critical factor in evaluating the economics of an industrial mineral deposit. This project produced a report that analyzed the cost of transporting 12 industrial minerals from 19 deposit or production sites in British Columbia to potential markets. Nearly 80 different transportation routes were considered in the analysis, each linking a mineral deposit with a potential market in North America or in Pacific Rim countries. The study concluded that for most of the selected sites and markets, the favourable or only possible mode of transportation was by truck. Opportunities to recoup some of the transportation costs by taking advantage of backhaul rates were found to depend on location within the province and the standard of service required. Highway load restrictions in the U.S. were cited as a factor that increased the cost of trucking to U.S. markets. The cost advantages of shipping large volumes of bulk product versus small volumes of palletized or containerized product were determined to be significant.

**IMPACT** The report was released in August, 1990. While industry has not had time to act on the report, it has been used by the British Columbia Ministry of Regional and Economic Development.

### OUTPUTS


#### 1.3.3 Mineral Opportunities Technology Development

<table>
<thead>
<tr>
<th>Project name</th>
<th>MINE DUMP RESLOPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
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<tr>
<td>Principal researcher(s)</td>
<td>NORECOL ENVIRONMENTAL CONSULTANTS LIMITED, THURBER CONSULTANTS LIMITED, POLSTER ENVIRONMENTAL SERVICES AND WRIGHT ENGINEERS</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. ENGINEERING &amp; INSPECTION BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>FORDING COAL LIMITED, WESTAR MINING LIMITED, MINING ASSOCIATION OF B.C. AND B.C. MINISTRY OF THE ENVIRONMENT</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To help industry develop new methodology by examining current mine-waste dump management practices and problems. The project's aim was to develop criteria for the management of existing and future mine waste rock dumps in British Columbia, with a particular emphasis on dump face resloping.

**ACHIEVEMENTS** The project team conducted an extensive literature review to determine the state of the art of mine-waste dump reclamation techniques to meet safety,
stability, end-use productivity and drainage requirements. Questionnaires were completed by 15 mining companies to supplement the literature review, followed by interviews. The data were analyzed to identify the advantages and disadvantages, including costs, of different dump management strategies. The major criteria for costs and end land use objectives were identified and suggestions were made on how these criteria should be weighted. The findings were summarized in a report.

**IMPACT** The project highlighted issues related to mine waste dump resloping. It facilitated communication and cooperation between the industry and regulatory agencies and pointed out areas requiring further study. The project report has been an important reference for government policies related to resloping.

**OUTPUTS**

<table>
<thead>
<tr>
<th>Project name</th>
<th>PORTABLE MODULAR MILLS</th>
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</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$19,935 (1986)</td>
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<tr>
<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>TRM ENGINEERING LIMITED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>TRADER RESOURCE CORPORATION AND FLEET DEVELOPMENT</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To promote the development of new technology in British Columbia's mineral industry by examining the feasibility of constructing portable concentrating facilities. The project had two components. The first involved identifying prospects in coastal areas of the prov-
ince with known or inferred precious metal reserves that might be made economic by the availability of a portable concentrating facility. The second was the design of a cost-effective modular constructed facility capable of servicing these deposits.

**ACHIEVEMENTS** A resource assessment was conducted that identified 8 properties with good potential and 36 properties with moderate potential to become economic with the availability of an appropriately-designed portable mill. Several concentrator (mill) designs were developed to handle the specific through-put and metallurgical requirements of these deposits. The designs included both barge-mounted and trailer-mounted modular units that would permit application at either tidewater or inland sites. Capital and operating costs were calculated for three barge-mounted designs and tables were provided for the calculation of costs of trailer-mounted mills based on required components. A report detailing the results of the project was produced.

**IMPACT** Industry was very interested in the results of the study. Portable modular mills are being considered for at least two of the deposits identified by the resource assessment. Neither deposit, however, has yet reached a production decision.

**OUTPUTS**


<table>
<thead>
<tr>
<th>Project name</th>
<th>HEAP LEACH PRE-FEASIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$3,000 (1987)</td>
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<tr>
<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>KILBORN ENGINEERING (B.C.) LIMITED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>ENERGEX MINERALS LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>NORTH CENTRAL B.C.</td>
</tr>
</tbody>
</table>

It was found that at gold prices of (US$) $345 per troy ounce, a positive cash flow would be generated by the treatment of ore grading in excess of 0.21 ounces of gold per ton.

**IMPACT** This project defined parameters under which seasonal heap leaching of gold ore might be economic in northern regions of the province. The report has been popular with industry, although no northern operations have yet adopted the technology.

**OUTPUTS**


<table>
<thead>
<tr>
<th>Project name</th>
<th>ROCK DRAINS SYMPOSIUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$10,000 (1987)</td>
</tr>
<tr>
<td>Total project cost</td>
<td>&gt;$20,000</td>
</tr>
<tr>
<td>Principal researcher(s)</td>
<td>B.C. TECHNICAL &amp; RESEARCH COMMITTEE ON RECLAMATION</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. ENGINEERING &amp; INSPECTION BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>B.C. MINISTRY OF ENVIRONMENT, MINING ASSOCIATION OF B.C., CROWS NEST BRANCH OF THE CANADIAN INSTITUTE OF MINING AND METALLURGY, BYRON CREEK COLLIERIES, CROWS NEST RESOURCES LIMITED, FORDING COAL LIMITED AND WESTAR MINING LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>CRANBROOK</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To promote new mining technology by investigating the economic viability of heap leaching for operators of numerous potentially leachable gold prospects in the unique climatic conditions in the northern regions of the province. This objective was to be accomplished by examining the feasibility of operating a gold ore heap leach in the Toodoggone area of north central British Columbia.

**ACHIEVEMENTS** A study was undertaken and a report prepared that examined the economics of operating a 30,000 tonne gold ore heap leach in the Toodoggone area.
Market, Technical and Feasibility Studies – Mineral Opportunities Technology Development

IMPACT The report and video have received limited use to date, due in part to technical difficulties. The introduction of new software developments in the future and rapidly decreasing hardware costs may allow for a broader range of applications.

OUTPUTS

A report and video presentation were prepared.

<table>
<thead>
<tr>
<th>Project name</th>
<th>MINE RESEARCH AND DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$7,016 (1988)</td>
</tr>
<tr>
<td>Total project cost</td>
<td>&gt;$14,000</td>
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<tr>
<td>Principal researcher(s)</td>
<td>BAPTY RESEARCH LIMITED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. MINERAL POLICY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>MINING ASSOCIATION OF B.C.</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

OBJECTIVES To assist industry exploration and development efforts by investigating the state of mining research and development (R&D) in British Columbia.

ACHIEVEMENTS A survey of six mines in the province was undertaken to determine levels of R&D funding. Based on the results of the survey, it was concluded that R&D was underfunded in British Columbia. A report was prepared which documented the results of the survey, identified areas for additional research, and recommended the formation of a central organization to receive and endorse R&D projects, arrange funding and coordinate activities. The report also noted that facilities and expertise available from the University of British Columbia were under-utilized.

IMPACT This project highlighted the need for R&D at mine sites that would increase profits and decrease costs. It was an important factor in the creation of two new positions: the Science/Research Coordinator position at the Mining Association of British Columbia and a Vancouver-based CANMET position.

OUTPUTS

A report was prepared by Bapty Research Limited for use by the Ministry of Energy, Mines and Petroleum Resources and the Mining Association of British Columbia.
**OUTPUTS**

Advertisements were placed in the Northern Miner newspaper.

Exhibits were displayed at major national meetings.

<table>
<thead>
<tr>
<th>Project name</th>
<th>EXTENDED WORK HOURS</th>
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</thead>
<tbody>
<tr>
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<tr>
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<tr>
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<td>U.S. BUREAU OF MINES, WESTMIN RESOURCES LIMITED, SIMON FRASER UNIVERSITY INSTITUTE FOR HUMAN PERFORMANCE AND CANMET</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. ENGINEERING AND INSPECTION BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>U.S. BUREAU OF MINES, WESTMIN RESOURCES LIMITED AND CANMET</td>
</tr>
<tr>
<td>Project location</td>
<td>VANCOUVER ISLAND</td>
</tr>
</tbody>
</table>

**OBJECTIVES**

To provide information to the mining industry on the potential safety, fatigue and health effects caused by employees working extended hours at Westmin’s Myra Falls underground mining operation on Vancouver Island.

**ACHIEVEMENTS**

A two phase study is being conducted that will monitor workers and working conditions for 24 hours a day over a period of 16 days at Westmin’s Myra Falls underground mine. During Phase I, workers were monitored for 8 consecutive days while working 8 hour shifts. A variety of health and safety tests were performed. During Phase II, these same tests will be repeated over 8 consecutive days, after workers have completed 12 hour shifts for a number of months. Comparisons will be made between the 8 hour versus 12 hour shift effects, pre-shift versus post-shift effects and changes over shift period (first day versus last day). A report will be produced which will summarize the results of the study.

**IMPACT**

This study will be used by Westmin Resources, as well as other mining companies and unions, to provide input into decision making regarding the effects of longer shift hours in underground mines.

<table>
<thead>
<tr>
<th>Project name</th>
<th>FRESH AIR BASE</th>
</tr>
</thead>
<tbody>
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<tr>
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<tr>
<td>Principal researcher(s)</td>
<td>ROCBORE LIMITED</td>
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<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>ROCBORE LIMITED/ J.S. REDPATH LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>KAMLOOPS</td>
</tr>
</tbody>
</table>

**OBJECTIVES**

To improve underground mine safety by providing assistance for the development of a portable, reusable Mobile Safety Base for underground mines.

**ACHIEVEMENTS**

An airtight, reinforced and fire resistant fibreglass shelter was developed to be used as a refuge station in remote areas of mines, in the event of a sudden loss of air quality. This Mobile Safety Base was designed to be linked to the mine’s compressed air, water, power and communications systems to provide life support in an emergency. Its compact design allowed it to be portable within most mines. Small dimensions and the ability to nest major components permitted it to be transported by air to remote locations.

**IMPACT**

This project resulted in the manufacture of a portable, re-usable refuge station.

*Development of a fresh air base for underground miners was one of the many ways the MDA supported worker safety.*
### Project name: COAL WASTE DUMP STABILITY

<table>
<thead>
<tr>
<th>Project name</th>
<th>COAL WASTE DUMP STABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$30,000 (1987)</td>
</tr>
<tr>
<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>GOLDER ASSOCIATES LIMITED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. ENGINEERING AND INSPECTION BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>FEDERAL PANEL ON ENERGY RESEARCH AND DEVELOPMENT, CANMET, BULLMOOSE OPERATING CORPORATION, BYRON CREEK COLLIERIES, CROWS NEST RESOURCES LIMITED, FORDING COAL LIMITED, QUINTETTE COAL LIMITED, WESTAR MINING LIMITED AND MINING ASSOCIATION OF B.C.</td>
</tr>
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### Project name: WESTAR SPIRAL TEST

<table>
<thead>
<tr>
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<th>WESTAR SPIRAL TEST</th>
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<td>MDA expenditures</td>
<td>$10,000 (1987)</td>
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<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>CANMET</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. ENGINEERING AND INSPECTION BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>CANMET'S COAL RESEARCH LABORATORIES</td>
</tr>
<tr>
<td>Project location</td>
<td>SOUTHEAST B.C.</td>
</tr>
</tbody>
</table>

**OBJECTIVES**

To increase productivity in the coal mining industry by assessing the performance of spiral concentrators for the recovery of clean coal from refuse and intermediate products at Westar Mining Limited's Elkview coal preparation plant.

**ACHIEVEMENTS**

CANMET's Coal Research Laboratories at Devon, Alberta were commissioned to undertake a total of 16 tests on 3 samples from the Elkview plant to determine the quality of products, operating variables and separation efficiency. These tests led to the conclusion that the addition of spirals to the Elkview plant would improve the recovery of fine coal and produce refuse with an acceptable high ash content.

**IMPACT**

The project demonstrated that spiral concentrators could be used to upgrade fine coal recovery in a southeastern British Columbia coal preparation plant. Westar subsequently installed spirals at its Balmer plant. Eventually the use of spirals may lead to better utilization of mined coal at other sites, thus increasing the productivity and life of the province's coal mines.

**OUTPUTS**


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**OBJECTIVES**

To improve industry and government decision-making and planning by providing a better understanding of the factors that affect coal mining waste dump failures. By developing more accurate predictions of the risk of failure, this project intended to contribute towards the creation of more equitable regulation of coal waste dumps and more cost-effective, safer dump management techniques.

**ACHIEVEMENTS**

A study was undertaken and a report prepared that reviewed experiences with past waste dumps at seven coal mines in British Columbia and one in Alberta. Data on failures, behaviour and operating practices were analyzed to identify patterns, correlations and unusual circumstances. Rates of failure were found to have increased markedly in the 1980's corresponding to an increased number of operations and less favourable conditions. Among the variables found to affect the risk of failure were: waste rock quality; rates of dumping; excess precipitation; steep foundation toe slopes; poor drainage, rapid loading of foundation soils and direction of crest advance. The existence of complex inter-relationships and incomplete data sets made it impossible to develop a mathematical model to simulate the relative importance of the various factors or conclude that any particular factor had become more dominant in recent years. Comments and recommendations on future monitoring procedures were included, as well as suggestions for further study.

**IMPACT**

This study made important contributions to the understanding of factors that affect the stability of coal mine waste dumps. These waste dumps are among the largest man made structures in the world and are under increasing scrutiny because of the potential environmental
impacts of failures. The report has been a key reference for follow-up projects in 1990 to establish operating standards for waste dumps and to define critical design criteria.

OUTPUTS


Presentations were made at the following:

<table>
<thead>
<tr>
<th>Project name</th>
<th>COAL FINES AGGLOMERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$25,000 (1988)</td>
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<tr>
<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>PAL SHARMA, WESTAR MINING LIMITED, B.C. RESEARCH, FERRO-TECH LABORATORIES, CANMET, ALLIS-HALMERS LABORATORY AND KAISER ENGINEERS</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>WESTAR MINING LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>SOUTHEAST B.C.</td>
</tr>
</tbody>
</table>

OBJECTIVES

To improve marketability and reduce the handling problems associated with coal from southeastern British Columbia coal mines by developing appropriate and cost-effective coal fines agglomeration technology.

ACHIEVEMENTS

A comprehensive technology study was undertaken on the binding of fine coal particles from Westar's southeastern British Columbia coal operations. Laboratory tests were done by B.C. Research on agglomeration technologies and binders. Pilot scale tests were undertaken at the Ferro-Tech Laboratory in Michigan. Coking tests were done by CANMET and compacting feasibility tests by the Allis-Chalmers Laboratory in Wisconsin. The study developed a quick fix method to improve the handling characteristics of fine coal and made recommendations on a permanent solution. Also included as an additional note in the report was a description of the patented process developed by Kaiser Engineers for heavy oils application to coal fines.

IMPACT

The results of this study were very useful to Westar. The coal agglomeration process developed has already been used at the Greenhills operation. It's application, however, has been minimal because of the costs involved and poor coal market conditions.

A final report was prepared that fully documented the findings of the study. Under the terms of the agreement with Westar, this report will be kept confidential until 1993.

<table>
<thead>
<tr>
<th>Project name</th>
<th>COAL TAILINGS AGGLOMERATE</th>
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<tbody>
<tr>
<td>MDA expenditures</td>
<td>$26,500 (1988)</td>
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<td>Total project cost</td>
<td>&gt;$53,000</td>
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<tr>
<td>Principal researcher(s)</td>
<td>NATIONAL RESEARCH COUNCIL, CORPORATE AND TECHNICAL SERVICES AND THE EXSHAW PLANT OF CANADA CEMENT LA FARGE INCORPORATED IN ALBERTA</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. GEOLOGICAL SURVEY BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>CANADA CEMENT LA FARGE</td>
</tr>
<tr>
<td>Project location</td>
<td>SOUTHEAST B.C.</td>
</tr>
</tbody>
</table>

ACHIEVEMENTS

A pilot scale test was conducted which produced a total of 115 tonnes of agglomerated coal tailings (ACT) from Westar's Elkview coal preparation plant near Sparwood, British Columbia. This project was the second phase of a larger project designed to determine if a consistent and economical agglomerated product could be produced from coal tailings for use in the cement industry as kiln fuel.

IMPACT

The currently depressed price of domestic natural gas precluded further development of an agglomerated coal tailings product. The excellent potential of the NRC agglomeration process was demonstrated, however, and in the future, western Canadian coal producers may benefit by utilizing this process. The NRC process has since been tested at the Quintette mine.
OUTPUTS


ACHIEVEMENTS

Washability tests were done using trench samples from a number of seams at different pit locations at the Crows Nest Line Creek operation in southeastern British Columbia. These samples were analyzed and compared against conventional washability tests and plant performance. The results were documented in a report. The study concluded that while this method would never replace the need for a full washability test or test plant washing of a seam, it might provide useful preliminary information for very little cost or effort.

IMPACT

The tests are performed on exploration samples. It is expected that in appropriate situations the results will help in the development of more detailed coal quality analysis programs. In the past year, the test has been used on exploration samples at the Line Creek coal mine in southeastern British Columbia. As well, it has received some preliminary use at other coal mining operations.

OUTPUTS

Crows Nest Resources Limited (1990): Predicting Plant Recoveries from Small Samples.

OBJECTIVES

To improve the efficiency of British Columbia's coal mines by developing an inexpensive and quick procedure for estimating the relative plant washing characteristics of different coal seams using trench samples. This project intended to produce a fast semi-quantitative test for screening samples.

National Research Council's mobile coal agglomeration facility.
70 - Promotion of B.C. Mineral Potential

<table>
<thead>
<tr>
<th>Project name</th>
<th>Foothills Surface Geophysics</th>
<th>Project name</th>
<th>Westmin Acid Mine Drainage and Waste Rock Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
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<td>MDA expenditures</td>
<td>$84,590 (1988-1990)</td>
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<td>Principal researcher(s)</td>
<td>Crows Nest Resources Limited, Geo-Physi-Con Company Limited and Coal Mining Research Company</td>
<td>Principal researcher(s)</td>
<td>Northwest Geochem and Westmin Resources Limited</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. Geological Survey Branch</td>
<td>Supervising agencies</td>
<td>B.C. Acid Mine Drainage Task Force and B.C. Engineering and Inspection Branch</td>
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<tr>
<td>Other participating agencies</td>
<td>Crows Nest Resources Limited, Alberta Office of Coal Research and Technology, Quintette Coal Limited, Smoky River Coal Limited, Luscar Sterco Limited and Manalta Coal Limited</td>
<td>Other participating agencies</td>
<td>Westmin Resources Limited</td>
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<tr>
<td>Project location</td>
<td>Northwest B.C.</td>
<td>Project location</td>
<td>Vancouver Island</td>
</tr>
</tbody>
</table>

**OBJECTIVES**

To assist the coal industry by testing, evaluating and improving on the application of surface geophysical techniques for use in coal exploration in topographically and structurally complex areas.

**ACHIEVEMENTS**

This project was conducted on Crows Nest Resources Limited’s Telkwa coal licence block in northwestern British Columbia. It contributed to the Phase II work of a larger project that examined geophysical techniques in the foothills and mountains of British Columbia and western Alberta. During this study, a reflection seismic program was conducted at the Telkwa site and seismic profiles were developed. The study found that the seismic profiles successfully identified large and moderate-sized discontinuities, and confirmed prior concepts of faulting style and fault locations. As well, the profiles improved the definition of areas of non-deposition of coal. Further work, however, was identified as necessary to successfully delineate the geometry of thin, near-surface coal seams. The Phase III report will evaluate the results of all the studies undertaken in British Columbia and Alberta.

**IMPACT**

The project has acquainted company geologists with shallow reflection seismic surveys, and has demonstrated the viability of this exploration tool in some situations. If further exploration is required on the Telkwa coal licence block, there is a good chance that they will incorporate this exploration method.

**OUTPUTS**


Pilot scale waste dump and monitoring systems, Westmin Resources Ltd.
the use of bactericides to reduce the activity of the acid generating bacteria, \textit{Thiobacillus ferroxidans}. Early tests, however, indicated that in this case the application of bactericides would be ineffective for long-term control of AMD. The other approach looked at the use of solidification techniques to cover waste rock dumps, so as to minimize moisture and air transfer and thereby hinder acid generation. Field trials of these methods produced encouraging results. The most promising control approach involved the development of a cementitious solidification mixture incorporating mine waste materials for use as a waste rock dump surface sealant and grouting matrix. Reports were prepared which presented the results of the various phases of the program. Work is continuing on this project and final results will be produced in 1991.

**IMPACT** Industry interest in this project has been high. There is currently very little information available on AMD generation in waste rock dumps and this research is helping to fill the void. This project is providing a good insight into what is happening in waste dumps and interest in the use of solidifying covers has been generated.

**OUTPUTS**


<table>
<thead>
<tr>
<th>Project name</th>
<th>KUTCHO CREEK AMD - BLENDING AND SEGREGATION</th>
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<tbody>
<tr>
<td>MDA expenditures</td>
<td>$55,000 (1989-1990)</td>
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<td>$10,000 (Budgeted, 1991)</td>
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<tr>
<td>Principal researcher(s)</td>
<td>RESCAN ENVIRONMENTAL CONSULTANTS</td>
</tr>
<tr>
<td>Supervising agencies</td>
<td>B.C. ENGINEERING AND INSPECTION BRANCH AND B.C. ACID MINE DRAINAGE TASK FORCE</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>ESSO MINERALS CANADA, SUMAC MINES</td>
</tr>
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<td>Project location</td>
<td>NORTHWEST B.C.</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To assist industry in mine development by investigating means of preventing and minimizing acid generation in waste rock at the Kutcho Creek deposit in northwestern British Columbia. The intent of this three year project was to determine if careful blending of waste-rock dumps would be a viable means to control AMD through the interaction of carbonate (acid consuming) and sulphide-rich (acid generating) materials.

**ACHIEVEMENTS** This project was conducted in three phases. During Phase I, a general reconnaissance survey of the exploration adit was done for evidence of acid generation. Representative samples of rock were collected from inside the adit and humidity cell tests were carried out on twenty samples. Phase II testing involved the construction and implementation of 3 twenty-tonne field test plots to examine whether blending acid-generating footwall wastes with acid-consuming wastes would prevent acid generation from occurring in field-scale waste dumps. Further humidity cell testwork and acid base accounting tests were also performed. Detailed monitoring of the field test plots was done in Phase III, including sampling of drainage water and collection of climatic data. Preliminary results from the laboratory humidity tests suggest that blending over the short term may minimize acid generation. From the acid base accounting tests, it was discovered that in the early stages of mine development, it may be necessary to mix limestone with the waste rock piles to increase the overall neutralization potential. Final results will be published when the study is complete.

**IMPACT** Industry interest in this project has been high. The blending and segregation concept is relatively new and there has not been much prior research in the area. Results from this project have already been referred to in planning for the Windy Craggy mine project in northwestern British Columbia.

As well, a very effective humidity cell was designed during the first phase of the project to test the acid-gen
ating characteristics of the waste rock on a laboratory scale and this technique has applications in other research.

**OUTPUTS**


Rescan Environmental Services Limited (1990): Kutcho Creek Property: Acid Generation Testwork Phase II.

<table>
<thead>
<tr>
<th>Project name</th>
<th>WASTE DUMP HYDROGEOCHEMISTRY</th>
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<tbody>
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<tr>
<td>Principal researcher(s)</td>
<td>DR. G. POLING AND M. LI</td>
</tr>
<tr>
<td>Supervising agencies</td>
<td>B.C. ENGINEERING AND INSPECTION BRANCH AND B.C. ACID MINE DRAINAGE TASK FORCE</td>
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<td>Other participating agencies</td>
<td>BHP-UTAH MINES LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>NORTHERN VANCOUVER ISLAND</td>
</tr>
</tbody>
</table>

**OBJECTIVES**

To gain information on the treatment and control of acid mine drainage (AMD) by studying the waste dump hydrogeochemistry at BHP Utah’s Island Copper mine on Vancouver Island. This project intended to determine the hydrogeochemistry of a waste dump through dump drilling, sampling, geochemical analysis, instrumentation and monitoring of water quality.

**ACHIEVEMENTS**

The northwest waste dump of BHP Utah’s open pit Island Copper mine was studied by means of a drilling program and using acid-base accounting and (kinetic) humidity cell testing. The interaction of rock mineralogy, bacteria population, oxygen transfer and water infiltration were monitored. Preliminary monitoring data revealed the following: the dump has probably reached a steady state; temperature changes are solely due to changes in surrounding temperatures; where oxygen concentration increases or carbon dioxide concentration decreases, Acid Producing Potential (APP) very likely increases; the dump material has a high heat preserving capacity; the dump temperature may be affected by some diffusive or convective cold air current travelling along the interface of the dump and the original ground; heat generated by sulfide oxidation contributed to the increase in the dump temperature; and, a correlation between oxygen concentration, carbon dioxide concentration and APP exists. The results were documented in a report.

**IMPACT**

Through this project, a better understanding of the hydrogeochemistry of waste dumps was achieved. BHP Utah and government regulators were provided with information that will guide them in future reclamation efforts.

**OUTPUTS**

BHP - Utah Mines (1990): Island Copper Mine: Dump Investigation Project.

Li, M.: Final Report, which will take the form of a Master’s Thesis from the University of British Columbia, is in preparation.

<table>
<thead>
<tr>
<th>Project name</th>
<th>CYANIDE IN GROUNDWATER</th>
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<tr>
<td>MDA expenditures</td>
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<td>Principal researcher(s)</td>
<td>L. BROUGHTON</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. MINERAL POLICY BRANCH</td>
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<tr>
<td>Other participating agencies</td>
<td>KLOHN LEONOFF CON- SULTING ENGINEERS, COASTECH RESEARCH INCORPORATED</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
</tr>
</tbody>
</table>

**OBJECTIVES**

To provide practical information to the mining industry and regulatory authorities regarding the fate and persistence of cyanide in groundwater. This project intended to develop a standard test procedure for determining the behavior of cyanide in different soils and using this procedure, to test the attenuation capabilities of soils typical in British Columbia at specific sites.

**ACHIEVEMENTS**

A summary report documenting current research and knowledge about the behavior of cyanide in the environment was prepared. Selected soil samples were collected from Corona’s Nickel Plate mine, Cheni-Corporation’s Lawyer’s mine and Sumac Venture’s Grand Forks Heap Leach operation. These sites were chosen because they represent three different types of gold milling and cyanide solution containment facilities. Laboratory soil characterization and column testing were done on the samples to determine the attenuation capabilities of the soils. The final report will document the results of the study.

**IMPACT**

Identification of the major factors that affect the behavior of cyanide in groundwater, and definition of attenuation capacities for at least some soils within British Columbia will be useful tools both for the development of new cyanide impoundments and monitoring and remediation of existing operations.

**OUTPUTS**

### 1.3.4 Mineral Supply Forecasting

<table>
<thead>
<tr>
<th>Project name</th>
<th>COMMODITY RESEARCH UNIT REPORTS</th>
</tr>
</thead>
<tbody>
<tr>
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<td>$38,500 (1987-1989)</td>
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<td>Principal researcher(s)</td>
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<td>Supervising agency</td>
<td>B.C. MINERAL POLICY BRANCH</td>
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<td>Other participating agencies</td>
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</tr>
<tr>
<td>Project location</td>
<td>VICTORIA</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To support the Ministry’s forecasting and planning activities by purchasing regular and special reports on world metal markets from the Commodity Research Unit (CRU) of London, England.

**ACHIEVEMENTS** MDA funding contributed towards the purchase of CRU reports on the following topics: short-term and 5-year outlooks for copper, lead, zinc and molybdenum markets; production costs for North America copper mines; and an analysis of the copper concentrate trade.

**IMPACT** These reports have provided the Ministry with market intelligence information useful for policy analysis and planning. In addition to providing information relevant to daily work, the data has been particularly useful in the preparation of the Mineral Market Update and for the work of the Mine Closure Task Force.

**OUTPUTS**

Off-the-shelf metal market information is available to the Ministry in the form of hard copy reports maintained in the Mineral Policy Branch Library.

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<table>
<thead>
<tr>
<th>Project name</th>
<th>FRASER RIVER GRAVEL STUDY</th>
</tr>
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<tbody>
<tr>
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<td>Principal researcher(s)</td>
<td>NORTHWEST HYDRAULIC CONSULTANTS LIMITED</td>
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<tr>
<td>Supervising agency</td>
<td>FISHERIES &amp; OCEANS CANADA - HABITAT MANAGEMENT UNIT AND B.C. ENGINEERING AND INSPECTION BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>AGGREGATE PRODUCERS OF B.C. AND THE DISTRICT OF CHILLIWACK</td>
</tr>
<tr>
<td>Project location</td>
<td>LOWER FRASER RIVER</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To provide industry and government with a better understanding of the physical impacts of gravel mining operations on the lower Fraser River. This project intended to review and assess the impacts of past gravel mining operations near Minto Landing and comment on approaches that could be used to minimize bar scalping impacts at new operations.

**ACHIEVEMENTS** A report was produced that describes the physical characteristics of the Fraser River near Minto Landing and its evolution over the last century. Available data on past gravel mining operations and the mining methods used (either bar scalping or instream excavation) in Minto side channel are summarized. Based on this data, an assessment of past dredging operations on the river’s regime was produced. The report concludes that due to the particular site characteristics of the two ongoing scalping operations, no substantial upstream or downstream morphologic impacts have occurred. Several areas in the side channel were identified where additional bar scalping could be carried out with minimal impacts to the adjacent channel morphology. The report recommends that Fisheries and Oceans introduce the following two restrictions on gravel mining to reduce the effects of instream excavations: 1) specify a maximum allowable excavation depth and the total quantity of gravel that can be removed, and 2) re-direct operations to isolated areas of the channel.

**IMPACT** This project has provided useful information on the effects of gravel mining on the Fraser River. Additional bar scalping sites were identified, which could be developed as part of a habitat enhancement program. Along with the information from an earlier study, the Department of Fisheries and Oceans Canada now has a better understanding and a greater amount of background data available to help in assessing the impacts of future operations.

**OUTPUTS**

1.3.5 R & D Fund

Project name: ELECTRIC SHOCK HAZARD STUDY
Principal researcher(s): BENSTED, SIMPSON & ASSOCIATES LIMITED
Supervising agency: B.C. ENGINEERING AND INSPECTION BRANCH
Project location: PROVINCE-WIDE

OBJECTIVES: To increase safety in the mining industry by examining the safety problems related to the use of portable electric substations in open pit mines in British Columbia. This objective was to be achieved by studying the grounding conditions at selected mines and developing guidelines for the safe use of this type of equipment.

ACHIEVEMENTS: Field trips were made to five open pit mines in British Columbia, where a series of soil resistivity and ground system impedance measurements were carried out. Information and measurement results that had previously been obtained from another mine were also made available for this study. The field measurement data were processed; the power system information reviewed; fault level calculations carried out; and possible fault situations developed. A report was prepared which showed the results of the study and assessed the potential for shock hazard at each of the sites. Recommendations to ensure greater safety and a code of practice for the use of moveable substations at each site were also presented.

IMPACT: The results of this study are forming a basis for revisions to the Canadian Standards Association for Use of Electricity in Mines.

OUTPUTS


Project name: EXPLORATION SAFETY SEMINAR
MDA expenditures: $1,000 (1990)
Principal researcher(s): SAFETY COMMITTEE OF THE B.C. AND YUKON CHAMBER OF MINES
Supervising agency: B.C. MINERAL POLICY BRANCH
Other participating agencies: BRITISH COLUMBIA AND YUKON CHAMBER OF MINES
Project location: VANCOUVER

OBJECTIVES: To increase safety in the mining industry by producing a safety seminar for personnel involved in mineral exploration in British Columbia.

ACHIEVEMENTS: A one day safety seminar was conducted on March 20, 1990. It addressed common safety themes such as: safe vehicle practices, hypothermia, mountain and glacier travel, aircraft safety, wilderness survival and first aid, dangerous animals, safe practice in underground and surface mine workings and considerations for back and eye safety.

IMPACT: This project has resulted in increased awareness of safety procedures for individuals working in mineral exploration in British Columbia.

OBJECTIVES To provide a better understanding of the means of controlling acid mine drainage by studying and monitoring the acid mine drainage abatement techniques applied at the abandoned Mount Washington copper mine on Vancouver Island. The project intended to collect and present hydrologic, geologic and topographical information from the site.

ACHIEVEMENTS Through these projects, MDA funding contributed to the first two years of a multi-year project. During 1989, the glacial till blanket construction phase was completed, along with the construction of a 310 metre diversion ditch and the installation of fourteen piezometers. Seeding and fertilizing of the waste dump was also completed, and a program was set up to monitor the physical and chemical hydrogeology of the mine site and waste dump and to evaluate the effectiveness of the reclamation activities already undertaken. MDA funding was primarily responsible for the installation of instruments to monitor the impact of reclamation on water quality.
During the second year, site plans were produced that plotted groundwater and geochemical data. The data indicated that the effectiveness of the glacial till cover on the East Dump was not proven or disproven, due to the impact of drainage from the pit on the East Dump. The blanket of mine waste was shown to be subject to an unusually high and variable water table that was considered to have experienced a significant production of acid and metals.

**IMPACT** The results of the monitoring program provided an improved analysis of AMD generation and the impact of abatement techniques. They have been used to guide the subsequent control program. As well, the site plans and cross section generated provided a base for the design of the final control work.

**OUTPUTS**


A presentation was made at the Canadian Institute of Mining and Metallurgy Meeting in Penticton, British Columbia in 1989.

Site plans and cross-sections were produced that plotted groundwater and geochemical data.

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**Project name** | **AMD TECHNOLOGY GUIDE**
---|---
**MDA expenditures** | $70,163 (1989-1990)
**Total project cost** | $78,183
**Principal researcher(s)** | STEFFEN, ROBERTSON AND KIRSTEN (B.C.) INCORPORATED, NORECOL ENVIRONMENTAL CONSULTANTS AND GORMELY PROCESS ENGINEERING
**Supervising agency** | B. C. ACID MINE DRAINAGE TASK FORCE
**Other participating agencies** | ENERGY MINES AND RESOURCES CANADA AND ENVIRONMENT CANADA
**Project location** | PROVINCE-WIDE

**OBJECTIVES** To provide mining companies, consultants and regulatory agencies with an understanding of the process of acid mine/rock drainage (AMD) and guidance on the application of AMD abatement technology. This objective was to be achieved by producing a standard reference manual outlining the state of the art technology for prediction, prevention, treatment, control and monitoring of AMD.

**ACHIEVEMENTS** MDA funding contributed towards the production of the first volume of a two volume technical guide that describes the acid generation and metal leaching and migration processes. Current methods for prediction, prevention, treatment, control and monitoring of AMD are outlined and assessed. Recommended procedures to deal with AMD problems are presented.

**IMPACT** Awareness of acid mine/rock drainage was heightened by this project. Since the publication of the guide, two short courses based on the guide’s contents have been offered in Vancouver and one in Ontario. Other courses elsewhere in Canada and in Indonesia have used the guide as a textbook.

**OUTPUTS**


**PROJECT NAME:** UNDERWATER DISPOSAL

**MDA expenditures**
- $10,000 (Budgeted 1991)

**Total project cost** >$200,000

**Principal researcher(s)** RESCAN ENVIRONMENTAL CONSULTANTS

**Supervising agency** B.C. ACID MINE DRAINAGE TASK FORCE

**Other participating agencies** MINE ENVIRONMENT NEUTRAL DRAINAGE COMMITTEE, CANMET AND ENVIRONMENT CANADA

**Project location** VANCOUVER ISLAND

**OBJECTIVES** To gain knowledge on the prevention of acid mine drainage (AMD) by determining the criteria for environmentally safe disposal of reactive mine wastes in fresh water environments. This project intended to evaluate the effectiveness of underwater disposal methods for suppressing acid generation from mine waste rock and tailings in Buttle Lake and Benson Lake on Vancouver Island as part of a Canada-wide study through the Mine Environment Neutral Drainage Committee.

**ACHIEVEMENTS** This project represents the first detailed study of the distributions of metals in both the solid phases and interstitial waters of the abandoned tailings deposits in Buttle Lake and Benson Lake. Water quality sampling, CTD profiling and lake sediment coring for pore water analyses were conducted. The results from the first phase found that the potentially reactive mine tailings submerged in the south basin of Buttle Lake made no significant impact on the water quality of the area. Similar studies on Benson Lake are being undertaken during the 1990 season.

**IMPACT** The positive results obtained to date are confirming for the mining industry and regulatory agencies that the use of underwater disposal of mining wastes as a means to prevent the formation of AMD may be an acceptable alternative.

**OUTPUTS**

**PROJECT NAME:** PREDICTION: OPEN PITS

**MDA expenditures** $20,850 (1990)

**Total project cost** >$50,000

**Principal researcher(s)** K. MORIN/MORWIJK ENTERPRISES LIMITED

**Supervising agency** B.C. ACID MINE DRAINAGE TASK FORCE

**Other participating agencies** EQUITY SILVER MINES LIMITED

**Project location** WEST CENTRAL B.C.

**OBJECTIVES** To provide industry and government with a computer model that would simulate and predict the potential for acid drainage from mine walls in open pits following mine closure. This objective was to be achieved by analyzing a comprehensive existing data set for Equity Silver mine in west central British Columbia.

**ACHIEVEMENTS** A report was produced that consisted of a literature review; an evaluation of site data; a predictive model of acid mine drainage (AMD) during operation, flooding, and after decommissioning; and a set of recommendations for further studies and for draft criteria for pit abandonment.

As well, a computer program, MINEWALL, was developed based on conceptual models that accounted for water...
movement, acid generation, acid neutralization, and metal leaching through time within a mine. MINEWALL was applied to the Equity Silver mine and the program predicted the Main Zone Pit would remain non-acidic throughout decommissioning, except for an initial mild acid flush at the beginning of flooding.

**IMPACT** The capability to evaluate and predict the water-quality impacts of open pit mines has been greatly enhanced because of this project. Further work was indicated as necessary to more fully examine the mechanisms that control AMD production in open pits.

**OUTPUTS**


<table>
<thead>
<tr>
<th>Project name</th>
<th>GIBRALTAR AMD MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$15,140 (1990)</td>
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<tr>
<td>Total project cost</td>
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<tr>
<td>Principal researcher(s)</td>
<td>KLOHN LEONOFF LIMITED</td>
</tr>
<tr>
<td>Supervising agency</td>
<td>B.C. ACID MINE DRAIN-AGE TASK FORCE</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>GIBRALTAR MINES LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>CENTRAL B.C.</td>
</tr>
</tbody>
</table>

**OBJECTIVES** To study methods for treatment and control of acid mine drainage (AMD) by developing an AMD model that would predict the effect of commercial leaching activities on long-term water quality following mine closure. This objective was to be achieved by monitoring the effects of economic leaching activities at the Gibraltar mine in central British Columbia.

**ACHIEVEMENTS** Only the first two years of this five-year project received funding through the Mineral Development Agreement. During this phase, a literature search was conducted of other bioleach operations. Information on prediction, mineralogy, water quality and other data related to Gibraltar was reviewed and assessed. Recommendations were presented for further work to acquire additional data for long term prediction. A report documenting results to date was produced. Work during the 1990 season was based on the recommendations of the report.

**IMPACT** This project will provide important information on the long-term effects of commercial leaching of mine dumps. Possible treatment methods following economic extraction will be tested and a model of the leach process within a dump will be developed.
Project name | OPTIMUM SAMPLING FREQUENCY
---|---
MDA expenditures | $25,697 (1990)
Principal researcher(s) | E. ROBERTSON
Supervising agency | B.C. ACID MINE DRAIN-AGE TASK FORCE
Project location | PROVINCE-WIDE

OBJECTIVES To recommend the optimum sampling frequency for assessing water quality in effluent caused by acid mine drainage (AMD). This object was to be achieved by evaluating four of the most extensive water quality monitoring data sets associated with AMD in British Columbia.

ACHIEVEMENTS A review of the main literature on sampling theory was undertaken. Monitoring programs at several mine sites in British Columbia were evaluated and deficiencies in current programs identified. The project attempted to determine the number of samples necessary to reliably detect the beginning of an AMD problem, evidence of environmental damage and changes in water chemistry. Recommendations will be presented in the final report on strategies for design of monitoring programs.

IMPACT This project could change monitoring program designs throughout the industry. It will impact on monitoring requirements for permits and approvals. Improvements in program design, reliability and cost effectiveness should result.

OUTPUTS
Robertson, E. (1990): Optimum Sampling for Acid Mine Drainage Monitoring

---

Project name | AQUATIC INVERTEBRATES MONITORING
---|---
MDA expenditures | $40,000 (1990)
Total project cost | $40,000 (Budgeted, 1991)
Principals | LIMNOTEK RESEARCH & DEVELOPMENT INCORPORATED
Supervising agency | B.C. ACID MINE DRAIN-AGE TASK FORCE
Other participating agencies | LIMNOTEK RESEARCH & DEVELOPMENT INCORPORATED AND B.C. MINISTRY OF THE ENVIRONMENT
Project location | WEST CENTRAL B.C.

OBJECTIVES To evaluate the use of a trough apparatus for measuring the environmental effects of dilute acid mine drainage (AMD) on aquatic invertebrates. This project used a trough apparatus on Foxy Creek, near the Equity Silver mine site in west central British Columbia, and test it with an initial run using a preselected concentration of dilute or treated AMD. Stage II plans are to use the trough apparatus to test raw AMD at different dilutions and expose fish as well as invertebrates.

ACHIEVEMENTS An apparatus consisting of 10 flow-through troughs, suitable for invertebrate and periphytic algal colonization and growth were installed and tested on Foxy Creek. Samples were taken from 5 treated and 5 untreated troughs during and at the end of a 6 week experiment for examination of the effects of AMD additions on indices of invertebrate abundance and algal growth.
Near Equity Silver mine a trough apparatus was tested to measure the environmental impacts of mining.

Results from the first stage showed that at the operational 10% AMD dilution rate, the addition of treated AMD to Foxy Creek did not impact on aquatic insect composition and abundance. The apparatus was observed to be a powerful tool capable of accurately determining ecosystem response curves for effluent discharges during mine operations or at closure. As well, it was found to be ideal for exploring alternative AMD treatment strategies at specific sites. Stage II of the project was conducted during the summer of 1990.

IMPACT Industry interest in this project has been high. Limnotek Incorporated has already been contacted by other companies and will be using the trough apparatus to determine environmental impacts at other mine sites during 1991.

OUTPUTS
Limnotek Research and Development Incorporated (1990): The Effect of Additions of Treated Acid Mine Drainage on the Abundance and Composition of Stream Macroinvertebrates and Periphytic Algae: An In Situ Mesocosm Experiment.

---

**Project name**  | **AMD SEDIMENT MONITORING**
---|---
**MDA expenditures**  | $4,998 (1990)
**Principal researcher(s)**  | E.V.S. CONSULTANTS LIMITED
**Supervising agency**  | B.C. ACID MINE DRAINAGE TASK FORCE
**Project location**  | PROVINCE-WIDE

**OBJECTIVES** To determine the relevance and applicability of sediment monitoring techniques for measuring the impact of acid mine drainage (AMD). The intent was to undertake an extensive literature review in order to provide information and guidance on sediment contamination issues.

**ACHIEVEMENTS** A literature review of sediment monitoring techniques was conducted. A report was prepared recommending the application of the Sediment Quality Triad approach for acid mine sites. This method is an effects-based approach to evaluating and assessing pollution-induced degradation due to toxic sediments. It was developed to utilize three measures of sediment quality: sediment chemistry, which measures contamination; sediment bioassay, which measures toxicity; and biological community structure, which measures biological alteration. The Triad effectively combines the information from independent measures into an interpretive framework.

**IMPACT** This project will help to clarify the impact of AMD releases on the environment and will act as a guide for future monitoring work.

**OUTPUTS**

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**Project name**  | **DIAGENESIS IN AQUATIC TAILINGS**
---|---
**MDA expenditures**  | $4,000 (1990)
**Total project cost**  | $10,000
**Principal researcher(s)**  | K. DRYSDALE
**Supervising agency**  | B.C. ENGINEERING AND INSPECTION BRANCH AND B.C. ACID MINE DRAINAGE TASK FORCE
**Other participating agencies**  | B.C. MINISTRY OF ENERGY, MINES & PETROLEUM RESOURCES
**Project location**  | HOWE SOUND

**OBJECTIVES** To investigate the long term stability of reactive tailings in a submarine environment. This objec-
tive was to be achieved by examining the pore water composition of historical tailings derived from sulfide-rich ores at the Britannia mine when deposited in a marine environment.

**ACHIEVEMENTS** This study found surface enrichments of base metals were being diluted by natural sedimentation from the Squamish River. The oxygen diffusing into the sediment from the overlying water was completely consumed by 7 cm depth in the lower basin and by 3 cm in the upper basin. Dissolved sulfides were found to be virtually absent, despite active sulfate reduction close to the sediment/water interface. The presence of the thin oxygenated layer indicated that the bulk of the metal rich tailings deposit lay within the sulfate reducing zone, which was likely to render it generally unreactive and insoluble.

**IMPACT** The abandoned Britannia mine is a significant source of metals to Howe Sound. This study confirms that the tailings are not a significant source of this contamination and efforts can and are being concentrated on the on-land sources, such as mine waters and waste rock.

**OUTPUTS**


<table>
<thead>
<tr>
<th>Project name</th>
<th>ION SPECIATION MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$11,000 (Budgeted, 1991)</td>
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<tr>
<td>Principal researcher(s)</td>
<td>C.B. RESEARCH INTERNATIONAL CORPORATION</td>
</tr>
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<td>Supervising agency</td>
<td>B.C. ACID MINE DRAINAGE TASK FORCE</td>
</tr>
<tr>
<td>Project location</td>
<td>PROVINCE-WIDE</td>
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</table>

**OBJECTIVES** To provide a more concise understanding of the aquatic impacts of acid mine drainage by refining the ion speciation model MINEQL to include determination of metal complexes with natural organic matter substances.

**ACHIEVEMENTS** None to date. A report and a computer disk copy of the speciation model will be submitted by December 31, 1990.

**IMPACT** None to date.
2. Financial Assistance for Mine Development

The purpose of this program was to provide financial assistance on a cost-shared basis to industry for engineering design and environmental studies for mine access roads.

The provision of infrastructure was determined to be key to the development of some of the province’s more remote and potentially valuable orebodies. With the necessary infrastructure in place, several proposed projects could be developed that would generate new jobs in remote areas. As well, with the availability of road access and other facilities, additional jobs in mineral exploration and other resources industries could be stimulated.

Infrastructure assessments for six mine developments were carried out. Total expenditures under this Program reached approximately $1,100,000.

Three of the six access roads have now been constructed - to the Lawyers gold-silver mine, the Nickel Plate gold-silver mine and the Golden Bear gold-silver mine. Two other proposals are currently under review by the provincial Mine Development Steering Review Process.

**OBJECTIVES** To assist with the feasibility assessment of the Mount Klappan anthracite coal project in northwestern British Columbia by providing support for infrastructure planning. This project intended to identify and assess all potential road corridors to the mine site, make recommendations on the most practical route, and prepare preliminary route alignments and capital and maintenance cost estimates.

**ACHIEVEMENTS** An engineering and geotechnical review of road corridors was prepared. Recommendations on the most practical route were presented, based on field reconnaissance, mapping and technical reviews. Preliminary route alignments within these corridors and preliminary construction costs were estimated.

**IMPACT** This study helped to identify the optimal route to the proposed Mount Klappan mine site.

**OUTPUTS**


To further investigate the feasibility of developing the Mount Klappan anthracite coal deposit by undertaking a detailed engineering study of the previously selected road corridor, with attention given to environmental considerations, other natural resources, regional hydrology, terrain, availability of electric power and other related factors.

**ACHIEVEMENTS** Detailed engineering and environmental assessment studies were conducted of the proposed access road. Separate consultants prepared environmental impact reports for the following resources: terrain, vegetation, fluvial geomorphology, fisheries, wildlife, outdoor recreation and visual impacts, and heritage value. The characteristics of resources within an approximate 2 kilometre-wide corridor were documented. Independent assessments of the potential impacts of road development on these resources were presented and possible ways to avoid or lessen some of the initially identified environmental impacts suggested. The report concluded that there were no significant direct environmental impacts associated with the construction, operation and maintenance of the road and that the identified environmental impacts could be remedied with straightforward solutions.

**IMPACT** This project greatly assisted Gulf Canada Resources Limited with its plans for development.

**OUTPUTS**

OBJECTIVES  To assist in the development of a gold deposit in an isolated area of northwestern British Columbia. This project intended to determine the safest, most cost-effective and environmentally responsible transportation option to service the proposed Golden Bear mine site.

ACHIEVEMENTS  An overview study was prepared of transportation options for meeting the needs of the Golden Bear project. The four options reviewed were: air only, winter haul road/air support, all-weather road, and summer haul road. These options were evaluated on the basis of technical feasibility, capital and operating cost/impact on project feasibility, employee safety and convenience, and socio-economic and community impact. Based on this analysis, the report concluded that the all-weather road was the most technically feasible option. The main reasons for this choice were lack of major technical constraints, lower costs and reliability of the all-weather road option. The report further concluded that the route known as the Moosehorn route would likely be the preferred option among several from a technical, environmental and cost perspective.

IMPACT  Based on these reports the decision was made that the mine proponent should concentrate future detailed engineering and environmental design efforts on developing an acceptable final alignment in the Moosehorn corridor.

OUTPUTS
ACHIEVEMENTS A report was prepared which compared six corridor options from the following perspectives: travel time, traffic safety, engineering, geotechnical problems, and construction, operating and maintenance costs. Following this detailed review, all parties, the Mine Development Steering Committee, the Department of Fisheries and Oceans, the Tahltans, and the mining company endorsed the “Modified Lower Tahltan Route.” The Environmental Land Use Committee granted Approval in Principal to the project in early March, 1988.

IMPACT This report led to the successful resolution of outstanding routing concerns. The route was successfully constructed in the 1988-89 field season.

OUTPUTS


<table>
<thead>
<tr>
<th>Project name</th>
<th>SEREM/LAWYERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA expenditures</td>
<td>$116,762 (1986-1987)</td>
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<tr>
<td>Total project cost</td>
<td>Approximately $230,000</td>
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<td>Principal researcher(s)</td>
<td>THOMPSON &amp; ASSOCIATES LIMITED AND NORECOL ENVIRONMENTAL CONSULTANTS LIMITED</td>
</tr>
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<td>Supervising agency</td>
<td>B.C. ENGINEERING AND INSPECTION BRANCH</td>
</tr>
<tr>
<td>Other participating agencies</td>
<td>SEREM INCORPORATED (NOW CHENI GOLD MINES INCORPORATED)</td>
</tr>
<tr>
<td>Project location</td>
<td>NORTH CENTRAL B.C.</td>
</tr>
</tbody>
</table>

OBJECTIVES To assist with the development of the Lawyers gold-silver mine in the Toodogone River area of north central British Columbia by undertaking an engineering and environmental study to determine the optimal design of road access to the Lawyers property.

ACHIEVEMENTS A ground survey of the route was conducted and designs produced for a 50 kilometre/hour roadway with a 5 metre wide gravel surface. Plans/profiles, quantity estimates, stream crossing and drainage designs and reclamation plans for disturbed areas were prepared. Wildlife studies including a winter reconnaissance wildlife population inventory and fisheries studies were also undertaken. The plans for the selected road route were presented to the British Columbia Mine Development Steering Committee.

IMPACT This project led to a road design that was subsequently constructed with partial funding through a loan from the Province. The road was instrumental in the development of the Lawyers deposit and is also being used by other companies actively exploring/producing in the Toodogone River gold camp.

OUTPUTS


<table>
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<tr>
<th>Project name</th>
<th>MASCOT GOLD MINES</th>
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<tr>
<td>MDA expenditures</td>
<td>$11,500 (1986)</td>
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<td>Principal researcher(s)</td>
<td>FENCO LAVALIN CORPORATION AND KER, PRIESTMAN &amp; ASSOCIATES LIMITED</td>
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<td>B.C. ENGINEERING AND INSPECTION BRANCH</td>
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<td>Other participating agencies</td>
<td>MASCOT GOLD MINES LIMITED</td>
</tr>
<tr>
<td>Project location</td>
<td>SOUTH CENTRAL B.C.</td>
</tr>
</tbody>
</table>

OBJECTIVES To assist with the development of the Nickel Plate gold mine project in south central British Columbia by contributing towards the design of the necessary upgrading for the road west of Apex Village Ski Hill Resort to the mine property.

ACHIEVEMENTS A report was produced that looked at alignment improvements and costs to upgrade the existing mine access road to a 10 metre wide surface and a 50 kilometre per hour maximum design speed. A road survey along the existing road and several reconnaissance surveys of possible relocation routes were conducted. The report recommended improvements that included among other things, an increase in the radius of two sharp switchback curves and a widening of two gully curves. Cost estimates for the proposed and alternative alignments were presented.

Development of mine access roads has helped to curtail the high costs of alternate transportation.
IMPACT This design study ultimately led to the upgrading of 12 kilometres of mining road access from Apex Village Ski Hill Resort to Mascot Gold Mines Limited mine property (now operated by Corona Corporation).

<table>
<thead>
<tr>
<th>Project name</th>
<th>ISKUT ROAD STUDY</th>
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<tbody>
<tr>
<td>MDA expenditures</td>
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<td>Total project cost</td>
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<td>THURBER CONSULTANTS LIMITED</td>
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<td>Supervising agency</td>
<td>B.C. ENGINEERING AND INSPECTION AND MINERAL POLICY BRANCHES</td>
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<td>Other participating agencies</td>
<td>COMINCO LIMITED, SKYLINE GOLD CORPORATION, SULPHURETS GOLD CORPORATION, ECHO BAY MINES LIMITED, CONSOLIDATED SILVER STANDARD MINES LIMITED, NEWHAWK GOLD MINES LIMITED, PRIME RESOURCES CORPORATION, CALFINE RESOURCES INCORPORATED, PEZGOLD RESOURCE CORPORATION, ADRIAN RESOURCES LIMITED, TICKER TAPE RESOURCES LIMITED, CHERYL RESOURCES INCORPORATED, MAGENTA DEVELOPMENT CORPORATION, LINK RESOURCES INCORPORATED, CREST RESOURCES LIMITED, CORPTECH INDUSTRIES INCORPORATED, EQUITY SILVER MINES LIMITED, HOMESTAKE MINERAL DEVELOPMENT COMPANY AND MINGOLD RESOURCES INCORPORATED</td>
</tr>
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</table>

Project location NORTHWEST B.C.

ACHIEVEMENTS A report was produced that presented an assessment of six road corridors that could be developed. The study focussed on engineering factors, including feasibility, road alignment and costs, but also addressed environmental considerations in an overview manner. A review of previous engineering and geological reports was presented, supplemented by a detailed terrain analysis of the corridors by aerial photo interpretation. Road alignments were established on 1:10 000 scale topographic maps produced for the study and field checked for engineering aspects by helicopter reconnaissance. Construction and maintenance costs for the road were also estimated. Of the six potential corridors studied, the Iskut Valley route was determined to be preferable for economic, environmental, and regional development reasons. The study indicated that mineral, timber, and recreational values would be better utilized if a road was built into the area.

IMPACT The Iskut River Valley is resource rich but lacks road access. The economic benefits of a road would include more efficient mineral exploration, extraction and mine development, expanded forestry operations, potential new tourism opportunities and expanded markets for businesses in Stewart, Terrace and Smithers. Mining and timber companies have been lobbying the provincial government for permission to build a road and for financial assistance with the capital cost of construction. This study provided considerable information and led to a subsequent investigation to determine the relative economic advantages of a road.


OBJECTIVES To guide and stimulate resource development in the Iskut River Valley of northwestern British Columbia by identifying an approvable multi-purpose access road corridor to the developing gold mines in the Bronson Creek/Johnny Mountain area. This project intended to coordinate input by government agencies, potential industrial users of the road and qualified consultants.
alternatives was conducted, with a central focus on nine mining properties as potential beneficiaries. The two main access options considered were through the Iskut Valley to connect with the existing Highway #37 in British Columbia, and from the Iskut Valley through the Alaska Panhandle to tidewater at the head of the Bradfield Canal in Alaska. The report concludes that the Iskut Valley road is an economically viable project and would generate positive net benefits over a fairly broad range of assumptions. The Bradfield route, on the other hand, was determined not to be economically viable. With construction of the Iskut Valley Road, benefits were found to accrue not only to the mining industry, but also to the forest industry and B.C. Hydro.

**IMPACT** The positive economic benefits and regional economic impacts that were identified with the road have made its construction a priority of the government.


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**Project name** ISKUT ROAD ECONOMIC ASSESSMENT

**MDA expenditures** $44,250 (1990)

**Principal researcher(s)** CLAYTON RESOURCES LIMITED, ROBINSON CONSULTING & ASSOCIATES LIMITED AND WESTERN ECONOMIC CONSULTING LIMITED

**Supervising agency** B.C. MINERAL POLICY BRANCH

**Project location** NORTHWEST B.C.

**OBJECTIVES** To encourage economic development by determining the relative economic advantages of key transportation options to the resource-rich Iskut River Valley, and examining the distribution of these advantages, whether they be for the benefit of the mining companies, the State of Alaska or the Province of British Columbia.

**ACHIEVEMENTS** A benefit-cost analysis of road access
**Project name**  
WINDY Craggy  
ROAD STUDY

**MDA expenditures**  
$50,000 (1990)

**Total project cost**  
Approximately $98,000

**Principal researcher(s)**  
DELCAN CORPORATION,  
NORECOL ENVIRONMENTAL CONSULTANTS LIMITED AND THURBER CONSULTANTS LIMITED

**Supervising agency**  
B.C. ENGINEERING AND INSPECTION BRANCH

**Other participating agencies**  
GEDDES RESOURCES LIMITED

**Project location**  
NORTHWEST B.C.

**OBJECTIVES**  
To further the development of the Windy Craggy copper, gold, silver, cobalt deposit in northwestern British Columbia by conducting a road access planning study of the proposed route to the mine site through the Tatshenshini River basin. The study intended to focus primarily on bridge location and design, visual impacts of the bridge and road within the Tatshenshini valley and potential wilderness impacts.

**ACHIEVEMENTS**  
A report was produced that presented design criteria for the proposed access road and a preliminary layout of the horizontal and vertical alignment on 1:5000 and 1:10,000 topographical mapping. Preliminary bridge crossings and culvert locations was identified. An assessment of environmental, wilderness and geotechnical concerns were presented. A preliminary description of the route alignment and provisions for a preliminary construction schedule were also included.

**IMPACT**  
This project was designed to help the company find a route that would minimize the visual and wilderness impacts of road access to the Windy Craggy mine site. Studies are still ongoing.

**OUTPUTS**

The purpose of this program was to provide funds for management, supervision, public information and support services. Total expenditures of approximately $526,000 were spent to acquire the services of a contracted MDA administrator/manager, provide for office and travel expenditures, conduct an annual independent financial audit, fund an independent evaluation program, and undertake an information program to apprise both the public and the minerals industry of the status and results of MDA activities.

**OBJECTIVES** To carry out public information activities to make the public and the mineral industry aware of the programs and results of the Canada/British Columbia Mineral Development Agreement and to describe future plans. The emphasis for the general public was to increase public understanding of the province’s mineral resources and government’s role in promoting and managing these resources. Activities directed towards the mineral industry were primarily intended to facilitate the dissemination of geological, technical and marketing information generated by MDA activities.
ACHEIVEMENTS A variety of promotional activities were employed. These included: newsletters, brochures, displays, annual reports and the project summary report. A series of newspaper articles were produced and distributed to regional newspapers for publication. The articles documented MDA funded activities of regional significance, in particular, those research projects designed to minimize the impact of mining on the environment.

IMPACT Interest in the project displays was very high. Each issue of the newsletter was followed by a wave of enquiries regarding MDA programs and specific projects and by an increase in sales of MDA outputs. The activities undertaken to promote the MDA successfully heightened industry and public awareness of the program.

OUTPUTS


A series of newspaper articles were produced and distributed to regional newspapers throughout the province for publication.

Brochures


Canada/British Columbia Mineral Development Agreement: An Economic and Regional Development Agreement Program.

Talks


Presentations were made at the following:

Displays

Annual displays were set up at the following:

One-time displays

Project name | EVALUATION
---|---
MDA expenditures | $56,533 (1988-1990)  
$15,000 (1991)
Principal researcher(s) | DON FERRANCE AND ASSOCIATES
Supervising agency | MDA EVALUATION SUB-COMMITTEE
Project location | VANCOUVER

OBJECTIVES To carry out an independent evaluation and assessment of the effectiveness and impacts of the programs funded under the Canada/British Columbia Mineral Development Agreement.

ACHIEVEMENTS A consultant was hired to undertake a review of the various draft evaluation frameworks prepared by the Management Committee and others, recommend a workable approach and then use this method to undertake the evaluation. A preliminary evaluation was carried out in 1989-90 and a final evaluation in 1990-91. The preliminary evaluation involved 120 personal or telephone interviews with people directly involved with MDA programs and 226 mailed questionnaires with representatives of the exploration and mining industry and government. Some of the conclusions of the preliminary evaluation were: MDA funded geological survey projects have had a substantial impact; economic data development projects
have assisted the public sector in developing policies and making decisions; market studies have assisted industry in identifying opportunities and preparing development strategies for industrial minerals; through MDA funding, significant progress has been made with respect to understanding and developing possible solutions to the acid mine drainage issue; the primary impact of the environment-related projects has been on the regulatory environment; and the FAMD projects have served to increase government involvement in the planning of several controversial road developments into previously inaccessible wilderness areas. Recommendations to be considered in the planning of a subsequent MDA included the following: increased funding; a reallocation of program funding; greater industry input into design of programs and selection of projects. The overall lack of awareness by the public of the MDA program was cited and the rationale for a strong information program explained.

IMPACT The evaluation highlighted the impacts of the MDA and outlined the levels of awareness and areas of concern of many of the diverse sectors of the province's mining industry.

OUTPUTS


APPENDIX A

MDA Financial Summary
### MDA FINANCIAL SUMMARY

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<tbody>
<tr>
<td><strong>PROGRAM 1 - PROMOTION OF B.C. MINERAL POTENTIAL</strong></td>
<td></td>
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## MDA FINANCIAL SUMMARY - Continued

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| Total                               | $37,935 | $97,039 | $129,863 | $73,001 | $197,211 | $20,000          | $555,049 |

**Mineral Supply Forecasting**

| Commodity Research Unit Reports     | $20,000 | $6,500  | $12,000  |         |         |                  | $38,500 |

**R & D Fund**

| Electric Shock Hazard Study         | $32,036 |         |         |         |         |                  | $32,036 |
| Exploration Safety Seminar          | $1,000  |         |         |         |         |                  | $1,000  |
| Mount Washington Instrumentation    | 8,170   | 5,292   |         |         |         |                  | $13,462 |
| and Data Summary                    |         |         | 8,020   |         |         |                  | $16,292 |
| AMD Technology Guide                | 70,163  | 8,020   |         |         |         |                  | $78,183 |
| Underwater Disposal                 | 49,984  | 49,830  | $10,000 |         |         | $109,814         |         |
| Prediction: Open Pits               | 20,850  |         |         |         |         |                  | $20,850 |
| Gibraltar AMD Model                 | 15,140  | 10,000  |         |         |         |                  | $25,140 |
| Constructed Wetland Bell Mine       | 22,464  | 10,000  |         |         |         | $32,464          |         |
| Optimum Sampling Frequency          | 25,697  |         |         |         |         |                  | $25,697 |
| Biological Monitoring of AMD        | 20,319  |         |         |         |         |                  | $20,319 |
| Aquatic Invertebrates Monitoring    | 40,000  | 40,000  |         |         |         | $80,000          |         |
| AMD Sediment Monitoring             | 4,998   |         |         |         |         |                  | $4,998  |
| Diagenesis in Aquatic Tailings      | 4,000   |         |         |         |         |                  | $4,000  |
| Ion Speciation Model                |         |         |         |         |         |                  | $11,000 |
| Report Publication                  | 25,000  |         |         |         |         |                  | $25,000 |

| Total                               | $160,353| $217,610| $106,000| $483,963|
## PROGRAM 2 - FINANCIAL ASSISTANCE FOR MINE DEVELOPMENT

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## PROGRAM 3 - MANAGEMENT, PUBLIC INFORMATION AND EVALUATION

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APPENDIX B

Reports Available

Publications of the British Columbia Geological Survey Branch are available from:

B.C. AND YUKON CHAMBER OF MINES
840 West Hastings Street
Vancouver, British Columbia, V6C 1C8
(604) 681-5328

OR

CROWN PUBLICATIONS INC.
546 Yates Street
Victoria, British Columbia, V8V 1K8
(604) 386-4636

The reports listed below are available from:

ISLAND BLUE PRINT CO. LTD.
905 Fort Street
Victoria, British Columbia, V8V 1K3
(604) 385-9786

Resource Assessment for Coastal and Western British Columbia and the Development of a Portable Modular Mill Design.

A Preliminary Evaluation of Heap Leaching, Energex Minerals Toodogone Project.


Regional Study of Coal Mine Waste Dumps in B.C. (color version of the above report).


British Columbia Dimension Stone Market Study.

A Study of Mining Shock Hazards.

Transportation Cost Study for Industrial Mineral Deposits.

The report listed below is available from:

BITECH PUBLISHERS LTD.
903 - 580 Hornby Street
Vancouver, British Columbia, V6C 3B6
(604) 669-4280


The report listed below is available from:

CROWN PUBLICATIONS INC.
546 Yates Street
Victoria, British Columbia, V8V 1K8
(604) 386-4636


For further information contact:

Mr. Greg McKillop
Manager
Program Development and Statistics
Ministry of Energy, Mines and Petroleum Resources
Parliament Buildings
Victoria, British Columbia
V8V 1X4
(604) 356-2854

Transportation Cost Study for Industrial Mineral Deposits.