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Annual Report 1974-75



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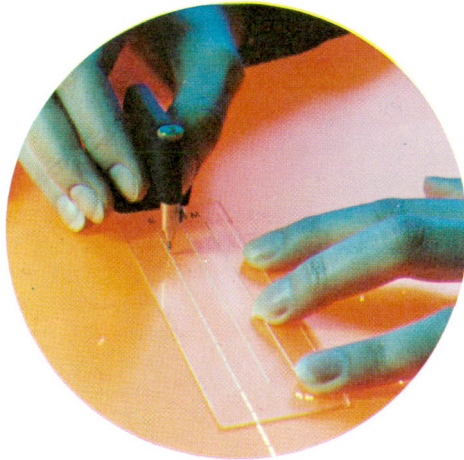
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Introduction



Throughout fiscal year 1974-75, one economic consideration more than any other dominated the deliberations of governments and the reports of the news media in all parts of the world—energy, the sources of its supply and its price. This was the case in Canada as elsewhere, and because of the nature of the topic and the responsibility of the Department of Energy, Mines and Resources to maintain up-to-date data and provide policy advice on the subject to the Government of Canada, energy was a prime concern for EMR during the year.

The price of Canadian oil remained at the \$6.50 a barrel agreed to at the First Ministers' Conference in 1974, but there was strong pressure to increase this amount to a level closer to the world price, although agreement to implement this could not be reached at a subsequent First Ministers' Conference in 1975. The price of natural gas for export to the United States, however, was increased from an average of 60 cents to \$1 a thousand cubic feet from January 1, 1975.

Another high-profile subject also in the energy field in the latter part of 1974 was the future of the Syncrude project in the Athabasca Oil Sands in Alberta as a result of the withdrawal of one of the original members of the consortium. Eventually, after intensive discussions between industry and federal and provincial governments, an agreement was reached whereby the federal government would share in the huge project to the extent of 15 per cent, with Alberta and Ontario undertaking 10 and 5 per cent of the venture respectively. A Bill was introduced in the House of Commons to authorize the setting up of a crown corporation, Petro-Canada, both to administer the federal government's participation in Syncrude and become involved in other aspects of the petroleum industry such as exploration.

An indication of EMR's involvement in the energy situation is that the budget for the department for the year more than doubled, but more than four-fifths of the total, an amount of \$467 million, was accounted for by oil subsidies.

With its responsibility to act as adviser to the Minister of Energy, Mines and Resources on all matters pertaining to the developing, processing and export or import of Canada's mineral resources (other than fuel), the Mineral Development Sector is concerned among other considerations with maintaining federal-provincial relationships in the mineral field. With this objective in view, a Canadian Ministerial Conference on Mineral Policy was set up a year ago. Towards the end of 1974 the first meeting of the Conference was held and mines ministers from both levels of government agreed to joint publication of a report entitled *Towards a Mineral Policy for Canada: Opportunities for Choice*, which sets out possible directions for future Canadian mineral policy. Another

form of joint consultation sustained by the Mineral Development Sector is the National Advisory Committee on the Mining Industry, which brings together federal government and mining industry leaders and consultants: the Committee met on three occasions in 1974.

While the Energy and Mineral Development Sectors of the department are principally concerned with policy development and advice to the Minister in those respective areas, the Science and Technology Sector supports the above sectors through provision of technical data and information, and manages a national earth sciences service program with substantial input in the above. This program is based on the systematic inventory of the Canadian landmass, its mineral and energy resources, physical properties and other phenomena, and its surface features.

The subdivision of the Science and Technology Sector reflects the scope of its involvement: Canada Centre for Mineral and Energy Technology, Geological Survey of Canada, Surveys and Mapping, Earth Physics, Canada Centre for Remote Sensing, Explosives, and Polar Continental Shelf Project. Activities include scientific and technological information, technological development, resource estimation, appraisal of natural hazards and of development on a regional basis, and cooperative logistic support of northern scientific projects. The Science and Technology Sector manages about 80 per cent of EMR's operating budget.

Many of the above units have a long record of providing data and technical information to the public and more specifically to the mining and petroleum industry at large. But the fiscal year 1974-75 saw an ever increasing effort on the part of the sector to also direct its technological activities and geoscientific surveys towards deriving information required for policy development. Consequently the interrelations of units within the sector, and between sectors are ever intensified towards producing a multifaceted and cohesive approach to national problems.

Since early in 1975, the former Mines Branch has been undergoing an indepth reorganization and changed its name to the Canada Centre for Mineral and Energy Technology (CANMET). This name change reflects more accurately the steady broadening of that branch's activities, such as current research needs in the energy field, including oil sands and petroleum technology. Among the research projects undertaken by CANMET that are of particular interest in these days of energy shortages have been several studies related to conservation of energy in industrial use, central heating applications and improved fuel combustion for automobiles.

The diversification in activity direction added to the challenges facing the Geological Survey of Canada (GSC). The systematic survey of the geology of Canada has reached a stage where such activities are focussed more and more in the frontier regions of Canada, both on land and at sea, and this is timely as frontier resources are undergoing development. Yet the need to assess Canada's mineral potential, for policy formulation and for proper management of development, demands a comprehensive overview of the country's resources, the development of reliable assessment methods, and the coordinated efforts of various governmental agencies to provide that overview, all of which made heavy demands on the GSC.

Besides resource inventories, environmental concerns and engineering feasibility studies related to resource or other developments, increasingly tended to divert attention from systematic surveys of the landmass. Thus, studies of terrain sensitivity and regional seismicity, specially in relation to pipeline and other energy developments, monitoring of sea ice and of other features demanding periodic synoptic observations by satellite, the need for proper positioning of survey stations or observational tracks, proper location of observed data, and for special maps to record and portray the resulting information also made increasing demands on the sector, including the Earth Physics, Remote Sensing, and Surveys and Mapping branches. The large seasonal deployment of departmental field parties in the Arctic, as well as an all round increase in northern activities, augmented the ever larger dependence on the coordinated logistics provided by the Polar Continental Shelf Project. Similarly the Canada Centre for Remote Sensing, originally conceived in the department as a means of providing information for national resource management, saw the scope of its interdepartmental and national cooperative service extended in kind and in volume. Proliferation in types of explosives and in their use, growing public concern for safety and security, were factors increasing the activities of the Explosives Branch in its administration of the Explosives Act. In this the branch was supported by the explosives laboratories located in CANMET.

During the year, EMR, Information Canada and the Macmillan Company of Canada Limited brought together some of the finest work available anywhere in the arts of map making and fine printing with the publication of the fourth edition of the National Atlas of Canada, which has been widely acclaimed. A total of 15,000 copies were sold to libraries, academic and government institutions and private individuals across Canada and in other parts of the world.

In the case of all of the divisions of the Department of Energy, Mines and Resources, the following pages present details of only some of the more significant projects. For those interested in more complete technical detail, reference should be made to the professional reports of each group.



Energy Development Sector

In 1974, and continuing into early 1975, the world energy situation captured the front pages of daily newspapers as well as intensive coverage on radio and TV.

Oil and gas dominated the energy scene in Canada. The decline in available resources worried the federal and provincial governments, and the public at large. No new large oil or gas fields were found in the traditional western resource base and results from exploration in the Territories, the Arctic Islands and the eastern offshore, were below expectations. However, frontier oil and gas finds made to date promise significant new production in the years ahead.

Canadian oil remained at \$6.50 a barrel, a price set at the First Ministers' Conference in March, 1974. Canadians generally pay the same price for oil from coast to coast except for differences in transportation costs and provincial taxes. An import compensation program offsets the high price of imported oil in eastern Canada so that consumers pay the same price allowed for Canadian oil. This program has been largely financed from exports of Canadian oil at world prices.

The price of natural gas has been below the comparable commodity value of other energy forms. The price of natural gas exported to the United States was raised from an average 60 cents per thousand cubic feet to \$1 per thousand cubic feet effective January 1, 1975. In the period reviewed, no large increases were announced for the domestic market, where gas remained underpriced in terms of other fuels.

Exports of oil to the United States have now been reduced. Gas shortages caused by production problems in two northern British Columbia fields resulted in some curtailment of gas exports to the northwest United States.

Western Canadian coal development and production continued to dominate the national scene but Nova Scotia increased production in 1974 for the first time in many years. Sharply higher coal prices and the inability to negotiate long-term contracts with U.S. suppliers were of concern to Ontario Hydro and the Ontario steel mills. The department continued to evaluate coal resource availability and supply capabilities for foreign and domestic markets, with increasing attention devoted to the industrial and utility requirements of central Canada.



Results of some studies on regional electrical interconnections came to a successful conclusion in 1974-75. These included the generation expansion plans on the Churchill River in Labrador and an interconnecting cable between Prince Edward Island and the mainland.

Two important policy statements on uranium and nuclear safeguards were made during the reporting year. On September 5 the government specified the need for a complete uranium resource appraisal, outlined terms on which Canadian uranium would be made available to meet future domestic nuclear requirements, and set out regulations under which uranium would be exported. On December 20 the Minister in the House of Commons reviewed the status of Canada's nuclear industry and outlined more stringent safeguards for all exports of nuclear technology, facilities and material.

Drilling activity on the Scotian Shelf and the Grand Banks on Canada's east coast decreased during the year. However, two significant discoveries of natural gas were made off the Labrador coast.

Moving from this brief summary of highlights for the year under review, the balance of this section will deal in more detail with developments affecting Canada's future in oil, gas, coal, hydro and nuclear power.

The Energy Development Sector administered the Oil Import Compensation Program until November 1, 1974, when the responsibility passed to the Energy Supplies Allocation Board. During the sector's stewardship of the program, provisional compensation payments totalling \$625 million were made to cushion the impact on Canadian consumers of sharply higher overseas oil prices. The experience of putting in place a program of this magnitude at short notice was a valuable one. However, it was gained at some expense in terms of policy development in other oil and gas areas. Transfer of this responsibility enabled staff to be concentrated more fully on policy matters.

During 1974 the National Energy Board held public hearings on the export of crude oil, which included the supply and demand situation in Canada. From these hearings the board made several recommendations to the government, one of which was the reduction of the amount of exports to the United States. This reduction was announced by the Minister on November 22, 1974. At that time he stated that exports would be reduced to a maximum of 800,000 barrels a day effective January 1, 1975. The board will identify the volume of allowable oil exports for a period of at least one year, but annual levels will be adjusted to account for immediate supply and demand factors by issuing monthly export licenses.

The Minister outlined in his statement that there would be an inevitable decline in producibility of indigenous crude oil starting in 1975 and continuing in the 1980's, when frontier oil and larger quantities of oil sands output are expected to become available. Based on the current supply and demand trends the board forecast a deficiency in supply to the domestic market served by Canadian oil in early 1982. This deficiency would reach 200,000 barrels a day by late 1983.

A similar study on the supply and demand situation for natural gas was conducted during 1974 and 1975 with the hearings being completed in February, 1975. The report was to be released later in 1975 but indications were that the situation for natural gas supply paralleled crude oil. The traditional western prairie sources were being depleted faster than new discoveries were made. Shortages of natural gas might develop in Canada before frontier discoveries could fill the gap.

In the spring of 1974 a group of specialists was assembled by the federal government to make an assessment of the application that had been submitted to the Department of Indian Affairs and Northern Development and the National Energy Board proposing the construction and operation of a natural gas pipeline from Alaska and the Mackenzie Delta to southern markets. The applications had been filed on March 21, 1974, by the Canadian Arctic Gas Pipeline Limited.

Mr. Justice Thomas R. Berger was appointed to conduct the inquiry into the social, environmental and economic impact regionally of the proposed pipeline. Mr. Berger held preliminary hearings in the summer of 1974 at Yellowknife, Inuvik, and Whitehorse. Formal hearings opened in Yellowknife on March 3, 1975. The National Energy Board hearings will start later in the year.

A second application has also been filed with the federal government by Foothills Pipeline Limited for a pipeline project that would transport Canadian gas from the Mackenzie Delta and the Beaufort Sea to points of connection with present gas pipelines in the provinces.

Progress on the Polar Gas Project included research and engineering feasibility studies on the proposed natural gas pipeline from the Arctic Islands to southern markets. The route, spanning more than 3,000 miles, would follow the west or east side of Hudson Bay.

In the fall of 1974 the future development of Canada's oil sands was shaken by the withdrawal of one partner from the Syncrude consortium, engaged in construction of the country's second oil sands plant near Fort McMurray. To ensure that this nationally important endeavor would proceed, government-industry negotiations led to the formation of a new partnership in which the federal government assumed a 15 per cent share, Alberta 10 per cent and Ontario 5 per cent. Private industry is responsible for 70 per cent. The project is slated for completion in 1979, with a production capacity of 125,000 barrels a day.

Canada has a modern refining industry which, by the end of the 1974-75 fiscal year, had a capacity in excess of two million barrels per day of crude oil. Construction of major new refineries in Newfoundland and Alberta was completed and a number of other refineries were being expanded.

The Department of Energy, Mines and Resources has been involved in many international discussions in the past year, including a number with the United States, on the future supply of crude oil and natural gas from Canadian sources. Discussions have also centred on the use of oil tankers on the west coast and the potential environmental problems for Canada in the event of a spill from a tanker carrying oil from Alaska to the United States.

Representatives from the department have participated in all the meetings of the International Energy Agency since its inception in 1974 after the worldwide oil embargo by the Organization of Petroleum Exporting Countries (OPEC).

At the end of the reporting period the department was preparing for the First Ministers' Conference on Energy which was to be held in early April.

The department is carrying out an analysis of coal supply and demand in relation to the higher prices now charged by the coal suppliers, especially those by U.S. coal companies that provide the coal for Ontario Hydro and the Ontario steel mills. These prices have, in many instances, doubled since 1973.

The federal government is concerned with the availability of future coal supplies for Ontario and studies are continuing on the feasibility of using western Canadian thermal and metallurgical coal.

Higher coal prices boosted the Nova Scotia coal industry, which stepped up production in 1974, finally checking a trend in recent years to lower output. Outlook for near-term productivity and profit has improved as the Lingan mine nears full operation.

The department continues to supervise the federal government's responsibility in the national coal inventory now under way including coal resource studies being carried out in Nova Scotia and Saskatchewan for which the federal government does the data compilation.

Developments on coal gasification are continually monitored. In 1974 a visit to West Germany, United Kingdom and Spain was organized for representatives from the federal and provincial governments and industry to examine coal conversion facilities, especially coal gasification.

Calgary attracted in 1974 the largest number of delegates ever to attend a Canadian Conference on Coal. Co-sponsored annually by the department, the conference will be held in Vancouver in 1975 and Ottawa in 1976.

Several activities related to regional electrical interconnections took place during the year. In cooperation with other federal departments and provincial authorities a detailed evaluation was made of the economic and technical aspects of developing hydroelectric energy on the lower Churchill River at Gull Island, Labrador, to meet the needs of the island of Newfoundland. After comparison of this project with alternative generation expansion plans it was concluded that the Gull Island project was the most economical source and an offer was made of financial assistance through federal loans for 50 per cent of the transmission cost to a total of \$343 million.

After more than a year of participation in studies with Prince Edward Island, approval was given for federal assistance for an interconnecting cable to tie the P.E.I. electrical system to the mainland. This in the long term will reduce the dependence on oil fuel and allow lower cost purchase of electricity from the mainland systems. A loan of up to \$9 million through the department's regional interconnection program has been provided in addition to a grant of \$18 million from the Department of Regional Economic Expansion.

Discussions took place during the year with Manitoba Hydro on the criteria for extension of the agreement under which Canada constructed the first stage of the Nelson River high voltage direct current transmission system. This first section is now operational with a design capacity of 1,060 megawatts over a 560 mile distance. No mutually acceptable basis for supplementary agreement on extensions to the system has been reached, although Manitoba Hydro has purchased equipment to extend the capacity of the system to 3,420 megawatts.

An agreement was reached with the Canadian Electrical Association to provide a federal contribution of up to \$425,000 for a research and development program. Electric utility members of the association have contributed approximately \$1 million to this joint program, which is expected to expand substantially in scope over the next five years. Initial contracts for research work have been committed.

A review was completed in September, 1974, of the prospects for tidal power development in the Bay of Fundy. A reassessment had been made of a study completed in 1969 when it was concluded that at that time, tidal power was not an economically attractive option. The review recommended further studies in four specific areas and this recommendation for additional work at a cost of \$3 million has been accepted by the governments of New Brunswick and Nova Scotia as a joint federal-provincial program over a two-year period.

The department has participated over a three-year period in the Lake Winnipeg, Churchill, Nelson River Study Board which has evaluated the environmental and social impact of the hydro development in northern Manitoba. This work is nearing completion and the report of the board will be issued during 1975.

The department played an important role in preparation of the two statements on uranium and nuclear policy announced in the latter part of 1974.

The uranium policy statement made on September 5 ensures that sufficient uranium will be available for Canadian use with utilities contracting for a minimum of 15 years supply for each reactor in service or committed for service. This will ensure that there will be sufficient domestic production capacity to meet these demands.

Export contracts, which must be approved by the Atomic Energy Control Board, will be limited under this policy to a maximum of 10 years with a contingent approval possible for an additional five years.

On December 20 the Minister reviewed the status of the Canadian nuclear industry and outlined the provisions that will be required in every safeguards arrangement. These provisions, which will be administered by the International Atomic Energy Agency or through appropriate alternative procedures, will meet the requirements of the Treaty on the Non-Proliferation of Nuclear Weapons. Contained in the safeguards arrangements will be the binding assurances that any of the Canadian supplied nuclear material, equipment and technology will not be used to produce a nuclear explosive device, whether this is stated to be for peaceful purposes or not.

Atomic Energy of Canada Limited was given encouragement and permission from the government to pursue overseas sales for the CANDU reactor with the stipulation that, as much as possible, the high technology components and services should come from Canada.

The Minister's statement also reaffirmed the position of the government towards any uranium enrichment development. Each case will be reviewed on its own merit but would only be allowed to proceed if it could be proved that it would be for the overall benefit of the country.

With the upturn in the uranium market being favorable to the producing industry several contracts were negotiated and announced. Many Canadian producers now have plans for expansion to meet the growing demand and one company is carrying out a leaching in situ experiment.

Department officials continued to participate in interdepartmental discussions, and also with the New Brunswick government, on loans to cover half of the cost of the first nuclear power plant to be built in the Maritimes. At the end of the reporting period negotiations were almost completed.

The department participated in a study on the potential application of peaceful nuclear explosions as background information for the Department of External Affairs on the Non-Proliferation Treaty review conference to be held in 1975. The department has also had considerable input in the development of research and development policies and on related nuclear work with the International Energy Agency and the OECD Nuclear Energy Agency.

Resource Management and Conservation Branch

The summer of 1974 saw two significant hydrocarbon discoveries off Canada's east coast, one of the offshore regions administered by the Resource Management and Conservation Branch. Both finds were gas, and were made in the relatively unexplored "iceberg alley" off Labrador. One discovery confirmed the results of initial indications in the Bjarni H-81 well drilled in 1973, while the second success was in the new Gudrid H-55 test, 80 miles to the southeast. Operations were carried out by the dynamically-positioned drill-ship "Pelican", which has been specially designed for a quick move off a well-site in case of an approaching iceberg. Drilling at the Gudrid location began on July 12, and after the well had been successfully tested, the drill-ship moved to the Bjarni site to complete the testing of this well before leaving the Labrador Sea on October 25.

Drilling activity on the Scotian Shelf south of Nova Scotia decreased during the reporting year as one of two semi-submersibles working the area departed for South America in late 1974. This unit had been active off the east coast since 1970. The second drilling unit moved to the Bay of Fundy where a well was started in early March.

One semi-submersible unit working on the Grand Banks left in January, 1975, and is now drilling in the Mediterranean Sea off Spain. The reduction in the number of drilling units on the Scotian Shelf and Grand Banks is attributable to lack of positive results in these areas to date. Such is not the case off Labrador. As the result of the two promising discoveries made in the Labrador Sea, the only three drilling units in the world that are capable of working in these deep, iceberg-infested waters are expected to be operating there during the summer of 1975.

Two wells were drilled in Hudson Bay by the ice-strengthened semi-submersible *Pentagone 82* during the summer of 1974. Both wells were plugged and abandoned, as was the *Walrus A-71* which had been suspended in 1969. There will be seismic activity in the Bay in 1975 but no drilling is anticipated.

Exploratory drilling expenditures during 1974 totalled \$65 million and \$13 million was spent on seismic and other geophysical surveys, representing a small reduction from 1973. Twenty thousand miles of seismic work was carried out off the east coast and 5,500 miles in Hudson Bay. There was no significant activity off the west coast.



Work has been progressing on new drilling regulations for both offshore and inland areas. Joint industry-government discussions have been held to review technical content, and the regulations are now in the final drafting stage.

A first draft of new production regulations had been completed and is being reviewed with other departments, primarily Indian Affairs and Northern Development. Following this preliminary review, industry will be given an opportunity to comment on the regulations before they are promulgated.

No Canada Oil and Gas Permits were issued during the fiscal year 1974-75 as the issuance of permits was suspended March 21, 1972. Five hundred permits comprising 39 million acres were returned to the Crown during the year, including 384 deep water permits covering 30 million acres off the Grand Banks and Labrador Shelf. As of March 31, 1975, the branch administered 3,979 permits covering 287 million acres, of which 85 per cent was off the east coast, the region of the greatest exploration activity.

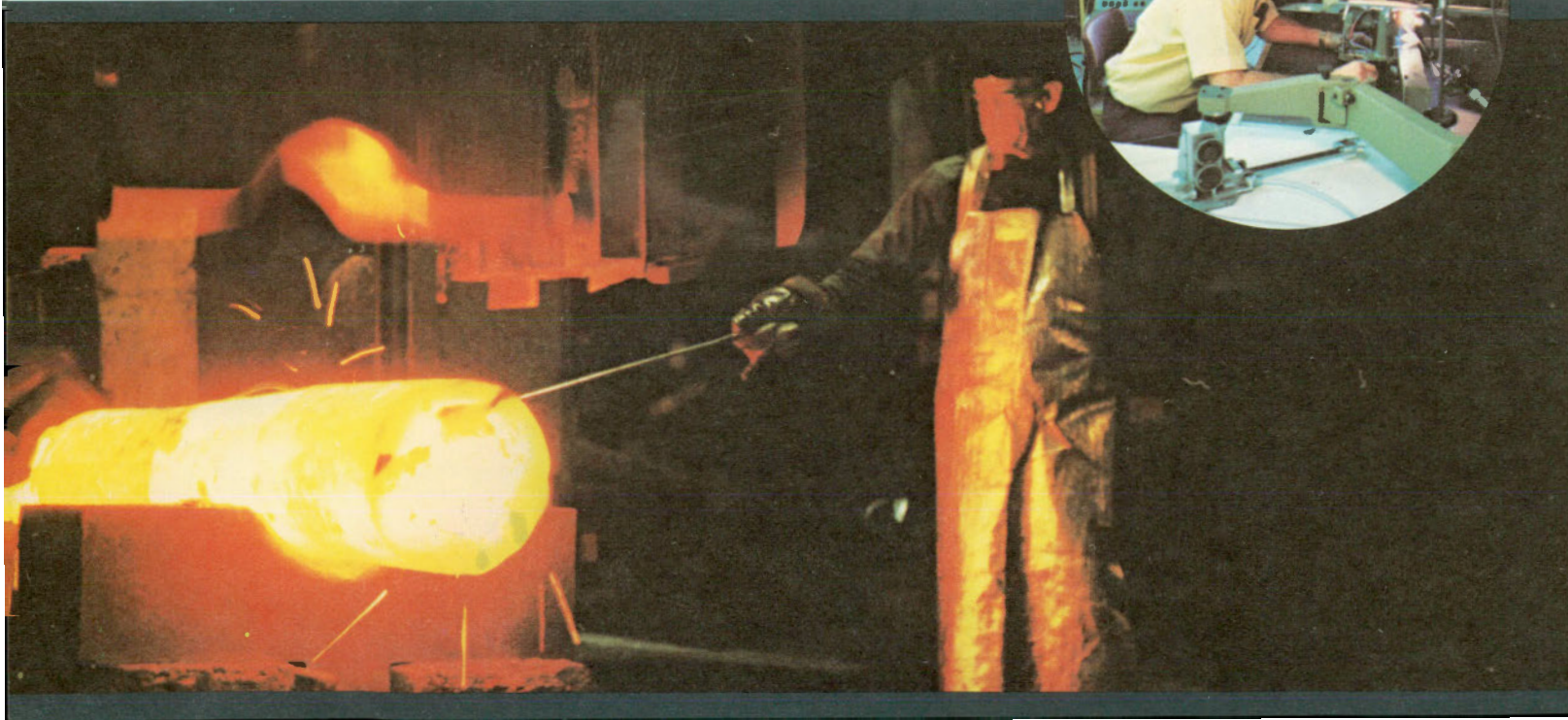
Revenue from "offshore lands" totalled about \$401,000, a decrease of 44 per cent from 1973-74. Revenue from federal leases in the provinces was \$759,000, largely from production royalties. This constituted an increase of 72 per cent over 1973-74.

During the year, work has proceeded on a comprehensive review of the Canada Oil and Gas Regulations governing administration of oil and gas rights on federal lands outside provincial boundaries. It is anticipated that during the next fiscal year legislation will be submitted to Parliament designed to effect a complete overhaul of the federal mineral resource management system.

The branch continued to provide departmental representation to the Third Law of the Sea Conference, the first substantive session of which was held at Caracas, Venezuela, in July-August, 1974. The issues of primary importance to the department at the conference include, firstly, the definition of the seaward limit of coastal jurisdiction over seabed mineral resources and, secondly, the nature of the international regime and the administrative machinery to govern seabed resource activities beyond this limit.

As regards the first issue, Canada is negotiating for confirmation of her sovereign rights to mineral resources over the whole of her continental margin, including that significant portion extending beyond 200 nautical miles, the jurisdictional limit supported by the majority of States. Concerning the second issue, Canada is striving to seek a formula for an international seabed regime that will be acceptable to the majority of States and yet meet her own requirements, that is, allow access to seabed mining activities by Canadian companies, and at the same time provide safeguards against the possible adverse effects of seabed mining on domestic mineral development.

The second session of the Conference opened in Geneva in mid-March 1975 and was to continue until early May.



Energy Conservation

The Office of Energy Conservation has been in existence a little over a year. Focussing mainly on the demand side, its purpose is to identify ways to conserve energy in Canada by reducing rates of energy consumption and by improving the efficiency with which energy is consumed in specific uses.

One of the principal tasks carried out by the Office of Energy Conservation during the year was the development of a recommended national policy on energy conservation which the Minister presented to the House of Commons on February 6, 1975. Two important phases of the policy were inaugurated and under way before the end of the fiscal year: the federal government in-house conservation program and the public information and advertising campaign. Under the former, a departmental conservation committee was formed and made recommendations particularly in the areas of more efficient use of public buildings, economies in the use of paper and more economical operation of government vehicles. The advertising campaign began with full-page advertisements in daily newspapers across the country, backed up by TV and radio spots. Work also proceeded on publications aimed at special interest groups—homeowners, automobile drivers and high school students.

The Mineral Development Sector

The Mineral Development Sector is charged with developing federal policies for Canada's mineral resources with the exception of mineral fuels. To achieve this objective, sector staff carries out detailed analyses of problems and opportunities related to Canadian minerals. On a day-to-day basis the sector serves as mineral economic adviser to the Minister of Energy, Mines and Resources, and to federal and provincial departments and agencies concerned with mineral development. Sector studies and activities embrace broad mineral issues as well as specific mineral commodity problems and opportunities. The sector provides alternate viewpoints on how specific policies—governing trade, taxation, or regional development, for example—might enhance or impede the contribution of the mineral sector to the overall development of Canada.

The sector is organized into four economic-technical divisions with a supporting Information Systems Division. The functions of each division and some of its major activities are briefly outlined below.

Any federal agency concerned with mineral development maintains vital ties with its counterpart departments and officials in the provinces across Canada, and with the Department of Indian and Northern Affairs, which has authority over minerals in the Yukon and Northwest Territories.



Over the years, the federal-provincial relationship has been sustained by federal representation at the annual Provincial Mines Ministers Conference, and was recently strengthened by the creation in 1973 of the Canadian Ministerial Conference on Mineral Policy (CMCMP). The Conference provides a forum for consultations on issues that affect all regions and provinces. Consultations take place at the levels of both Ministers and their Deputies.

At the first meeting of the Conference in late 1974, federal and provincial mines ministers reviewed and agreed to joint publication of a document proposing directions for Canadian mineral policy. Entitled *Towards a Mineral Policy for Canada: Opportunities for Choice*, the federal-provincial document was issued to the public early in 1975. It follows an earlier publication that defined mineral policy objectives. *Towards a Mineral Policy* identifies directions future policy strategies could take, such as diversifying regional and national economies through further processing and fabrication of minerals. The challenge is to increase mineral processing and financial returns while ensuring that other objectives are met, among them resource sufficiency for domestic needs, environmental quality, social stability, domestic control, and international obligations.

In another forum, the National Advisory Committee on the Mining Industry (NACOMI), the Minister of EMR meets with representatives from industry. Membership in NACOMI consists of leaders of major Canadian mining companies and other prominent consultants who are asked to contribute their specialized knowledge and advice. During 1974, NACOMI met on three occasions to exchange views on federal mineral policy proposals.

In relation to evolving a national mineral policy, studies were begun in the sector on major mineral commodities and other key factors related to mineral development in Canada. These studies will form the basis for the next step in policy formulation—identifying appropriate strategies to attain the mineral policy objectives already defined by the federal government and the provinces.

Mining Industry Financial and Corporate Analysis

In 1974, a re-organization of responsibilities within the sector resulted in the creation of the Mining Industry Financial and Corporate Analysis Division. Its sphere of interest includes the existing patterns of sharing the revenues generated by the mining industry; the effects on the industry of new mining regulations and taxation provisions; the economic viability of new mining ventures, especially where some form of direct government aid may be involved; and the extent to which the mining industry is owned and controlled by Canadian interests. The division will also study significant issues in the fields of mining finance and investment in relation to the development and implementation of mineral policies.

As required, division staff will give advice and assistance to the Department of Finance in the area of fiscal policy affecting the mining industry; to Revenue Canada in administration of the Income Tax Act as it applies to the mining; and to the Foreign Investment Review Agency. (FIRA screens applications for new industrial acquisitions by non-Canadian interests.) On request the division lends its technical expertise to the provinces in the review and analysis of new mining tax and royalty systems.

Minerals and Metals

The Minerals and Metals Division analyzes current trends in all phases of mineral development, from exploration through to production, processing and marketing. On this knowledge base, supplemented by specific commodity studies, advice is provided to the Minister and to other government departments. Officers of the division also represent EMR in inter-departmental and international committees relating to Canada's trade commitments in minerals and metals.

On the heels of the energy crisis of 1973-74, considerable attention in international forums focussed on minerals supply and demand. Existing commodity producer groups (copper, iron ore) improved their control over prices and others came into being (bauxite, mercury).

In April, 1974, a special session of the United Nations General Assembly was based on the theme "Raw Materials and Development". The Canadian delegation reiterated Canada's policy preference for commodity arrangements that involve both producers and consumers. In keeping with this policy Canada attended, as an observer only, several meetings of producer associations including those for iron ore and copper.

In the current round of multilateral negotiations under the General Agreement on Tariffs and Trade (GATT), the issue of further processing is of special importance to Canada. Now trade barriers tend to be substantially higher for processed than for unprocessed raw materials, including mineral products. The GATT negotiations call for a reduction of tariff barriers and a removal of non-tariff obstacles to trade. Hence the negotiations offer an important opportunity for Canada to obtain freer access to foreign markets for processed mineral exports. During 1974-75, officers from the Mineral Development Sector represented EMR in interdepartmental work preceding GATT meetings.

The results of sector analyses of the trends in mineral production and trade are published in a monthly review of the industry, in the annual Canadian Mineral Survey, and in more detail in the Canadian Minerals Yearbook. Of particular interest in 1974 were the sharp changes in demand and price for many minerals, especially for copper, potash and sulphur. Copper prices declined drastically toward the end of 1974, after having reached an all-time high in mid-year.

Potash demand surged with the rapid increase in demand for fertilizers throughout the world. The turnaround in the sulphur market was particularly dramatic as the glut of the past three or more years was replaced by a shortage of supply in 1974. This supply shortage was again due to worldwide fertilizer demand as well as transportation difficulties in moving the supplies from Canada's large Prairie stockpiles (derived as a by-product of sour natural gas production) to world markets. The Canadian transportation problem emphasized Canada's influence as the world's largest supplier of sulphur.

Resources and Development

The Resources and Development Division has broad responsibility for planning mineral development programs in conjunction with provincial and other federal government departments. The division is also concerned with determining the magnitude of Canada's mineral resource base.

Regions of the country are not equally endowed with minerals, and the pattern and pace of economic development varies amongst regions. To identify regional development problems and opportunities related to mineral reserves, federal and provincial governments have undertaken a number of joint cost-shared programs.

At the federal level, the planning and management of such development work is generally undertaken by the division in conjunction with the Department of Regional Economic Expansion. Since these programs were begun in 1970, projects have been carried out in several provinces, with greatest attention to regions in need of a broader economic base and areas where there are opportunities for expansion based on mineral reserves.

Program costs have varied from \$500,000 to over \$11 million, and are implemented over two- to six-year periods. In 1974, new federal-provincial mineral agreements were undertaken with Nova Scotia, Alberta and Saskatchewan. Other programs for Manitoba, Quebec, New Brunswick, Ontario and British Columbia were under negotiation or in the planning stages. All projects in the Newfoundland program, begun in 1971 and funded equally by EMR and DREE, were completed.

Because of Newfoundland's late entry into Confederation, the province has had considerable catching up to do in geological mapping. Mineral occurrence maps produced under the program have helped to fill the gap, and mineral inventory work will be continued. Other wide-reaching results include reform of the provincial land tenure system where long-term concessions had been preventing effective exploration. Also, an inquiry was held to investigate provincial mining taxation. Increasing exploration and development activity in the province attests to the success of this relatively modest program.

With a view to broadening the industrial base of the Atlantic provinces, investigations were carried out on the feasibility of zinc processing plants in New Brunswick and Newfoundland, based on ore resources from local and northern deposits. The possibility of establishing a zinc smelter in the Yukon is also undergoing extensive study.

The division provided extensive economic analyses on the feasibility of the recently established Strathcona Sound lead-zinc mine on the northern tip of Baffin Island. This is the first mine in the Canadian Arctic Islands and is a joint venture between the Government of Canada, which owns an 18 per cent interest, and private industry. Studies are also being carried out on a company proposal to establish a lead-zinc mine on Little Cornwallis Island.

The Mineral Area Planning Study (MAPS), initiated in 1972, was completed and readied for publication in late 1975. The study provides a framework for decisions on regional mineral development by examining production of key mineral commodities in relation to future domestic needs and foreign demand.

The division compiled an interim manual of mineral resource and reserve definitions for use within EMR and for circulation to provincial governments, as well as to other appropriate national and international agencies. The aim is to ensure that all those engaged in estimating and describing mineral resources use a standard technical language.

Mineral Economics

The Mineral Economics Division analyzes and recommends alternative policies for minerals. This entails identifying mineral industry opportunities and problems, and economic and social effects that may arise from mineral development.

The division is concerned with three main subject areas: mineral-based industries in relation to Canada's total economy and export markets; economic development, including the international role of minerals; and the social impact of mineral development.

During 1974-75, projects included measurement of the impact of Canada's mineral industry on the economy as a whole. An economic model developed by Statistics Canada was used to provide a detailed picture of the mineral industry within the economy as both a purchaser of goods, and as a supplier of raw materials to other industries.

Using CANDIDE, the econometric model of the total economy developed by the Economic Council of Canada, work continued on the analysis of mining industry investment. One project is investigating the benefits to Canada that could be derived from further processing of particular minerals, or from investing in different segments of the mineral industry. The study will examine the structure of individual commodity systems, that is, the interrelationships between the series of activities bringing a particular mineral from mine to market, and the relationship of these activities to other sectors of the economy.

The division is also concerned with the social impact of the mineral industry in Canada. Areas of investigation include pollution and land-use problems, as well as labor shortage and turnover in the mining industry. An in-depth survey of 20 representative mining communities across the country led to the conclusion that the design of any new mining community must take into account human, social and cultural values along with financial, economic and technological objectives if manpower instability is to be reduced. The study also identified the possible changes which, if implemented, would improve the quality of life in existing mining communities.

A preliminary study on minerals and the environment is under way, focussing on such issues as: the environmental consequences resulting from mineral activities; health and safety within the working environment; mineral conservation; and the economics of pollution control.

The division also maintains close contact with the academic community, bringing together research related to mineral economics. In this realm, the Centre for Resource Studies, sponsored jointly by the Mining Association of Canada and EMR and administered by Queen's University, began its first year of operation. Its purpose is to provide a nucleus for independent, high calibre economic research on important issues of mineral resource development and mineral policy. In 1974-75, a basic research program entitled "Impact of the Mineral Industry" was initiated, and at the end of the fiscal year the first applications and research proposals were being discussed.

In addition, the division administers the sector's research agreements. In 1974-75, \$31,568 in grants were awarded to researchers in various disciplines at universities across Canada, thus increasing the academic community's involvement in mineral resource problems and issues.

Information Systems

The Information Systems Division operates a statistical group, a resource economics library, a technical records centre, and the National Mineral Inventory. The division centralizes the collection, storage, manipulation, retrieval and dissemination of mineral industry information that has multiple applications and frequent use. Computerized data files, using the facilities of the department's Computer Science Centre, provide the link through which statistical and descriptive data are provided to management and researchers. In addition to serving the sector and department, the division provides information to other federal departments, the provinces, industry and the public.



Science and Technology Sector

Surveys and Mapping Branch

Providing up to date map information and accurate survey measurements for public use, particularly in the Arctic and northern Canada where the growing importance of exploration and development of natural resources requires these services, is the important responsibility of the Surveys and Mapping Branch. During the fiscal year 1974-75, the branch investigated several methods for facilitating this task.

The major products of the Surveys and Mapping Branch are accurate topographic maps, aerial photographs and data from a national network of survey control points precisely established and maintained by government geodesists. These are basic tools for the development of Canada's resources and have always been essential for many industrial, scientific, educational, legal, engineering and tourist-industry purposes.

Total budget for the Surveys and Mapping Branch during 1974-75 was \$20,940,000. Of that \$6,016,000 was spent on control and legal surveys, \$6,161,000 on mapping services, and \$3,690,000 on distribution of technical information, with \$2,100,000 being recovered through the sale of maps and air photographs. A sum of \$70,000 was allocated for feasibility studies and contract management of external aid projects for the Canadian International Development Agency (CIDA) and the balance of the budget went for administration.

Inertial surveying equipment with potential to change the face of surveying in Canada in the near future was acquired for assessment early in 1975 by the Geodetic Survey of Canada—the agency in charge of establishing horizontal control (latitude and longitude) and vertical control (exact height above sea level) of selected points across the nation. The equipment, an outcome of the United States space program, is capable of providing, at the push of a button, precise figures of latitude, longitude and elevation of any point. A survey line can be run at the speed of the vehicle carrying the equipment. Such equipment will save the time now needed for traditional measuring by angles and lengths in many areas of Canada.

Over the past few years, geodesists have found that there are definite distortions in the national network of horizontal control because measurements made by the new high-accuracy instruments do not conform with data from older surveys. To correct this, a complete readjustment of the national network has become necessary and data gathering for this task began in 1974 with the establishment of 52 Doppler Stations in the Arctic, Quebec and Greenland. The method of establishing horizontal control points on the ground by measuring the Doppler frequency shift of satellites whose exact positions are known at all times is now being used extensively for geodetic work. The Doppler stations will act as an anchoring framework for the mathematical adjustment of existing coordinates of control because the satellites pass over the whole country, providing a uniform surveying reference for Canada and a system that is modern and accurate and to which other geodetic control points can be related for correction. The Doppler survey of Canada, to be completed in two years, is accompanied by similar programs in the United States and Mexico. All will help develop a more uniform survey datum for the whole of North America.

The readjustment program also includes extra surveying to strengthen weak parts of the network and resurveying in regions where older surveys exist, followed by computer readjustment of all data for homogeneity of the system. During 1974-75, the branch extended a first-order traverse from Yarmouth to Liverpool, N.S., and from Stewart, B.C. northward to the Alaska highway near Watson Lake to complete surveying in these areas. This is the second year the branch has used a first-order traverse which involves measuring the distance between two points by using electronic distance-measuring devices and angular measurements—a departure from the time-consuming method of calculating distance by triangulation. Another surveying operation in the Arctic Islands, Keewatin District, N.W.T., and northern Quebec resulted in 2,870 miles of second-order traversing and the establishment of 202 new monumented stations to be used as data in production of maps at 1:50,000. The branch also provided a special survey of northern Manitoba to prepare the way for provincial development in the region.

Accurate and adequate local surveying networks are necessary for coordinated and orderly growth of Canada's urban areas. During 1974, in response to this need, the branch commenced a program of cooperation with municipalities in densifying the local survey control networks. The biggest project provided more horizontal control points around Kitchener-Waterloo, Ont. following a request from the municipality. Another project supplied precise levelling (height above sea level figures) for Winnipeg that will be of special use in urban engineering.

Under the metrication program the branch drew 87 new topographic maps with metric contours. Metrication will continue until all maps of the National Topographic System have height information in metres. The change-over will be slow but steady because of the long revision cycle for most Arctic areas (up to 25 years) and because about 10,000 sheets are now published with foot contours. The branch hopes to complete the changeover by 1990.

Photographs from satellites have proven to be an important quick updating tool for mapping and the branch continued to develop this potential in 1974-75. ERTS imagery is particularly useful for wilderness areas where exploration and development are bringing fast and important changes. During the year the photography was used to locate and plot such features as new roads, pipelines, power transmission lines and man-made lakes behind new dams and to correct features previously shown as islands in the Arctic which were in fact areas of sea ice. Specially flown satellite photography was also obtained from Skylab's unique metric cameras over a few areas of southern Canada in the spring of 1974. The branch tested this experimental imagery for use in supplementation of horizontal control for 1:250,000 mapping and provisional 1:50,000 mapping. This photography can be enlarged several times without significant loss of detail because of the relatively high resolution.

During 1974 the branch published the first cadastral photomaps for federal lands. This was an experimental project in Peigan Indian Reserve in Alberta. Further cadastral photomaps are now in preparation for eight more Indian Reserves in five provinces and for the St. Lawrence Islands National Park. Cadastral photomaps help administrators of such government lands as Indian Reserves and National Parks to identify lots, land parcels, political boundaries and buildings in their territory because these cadastral items are superimposed on aerial photographs that also show such landmarks as trees, hedges, fields, roads and waterways.

Surveyors, engaged by the Surveyor General, completed surveys for eight large new Indian Reserves around Big Trout Lake in northern Ontario in time for the June, 1974, meeting between the Indians and the Ontario government.

In 1974, Parliament passed the Alberta-British Columbia Boundary Act which provides for the creation of a boundary commission. This Commission has authority to resurvey the mountain portions of the boundary between the two provinces, to maintain the boundary and to deal with any problems relating to the whole boundary without further reference to Parliament.

The International Boundary Commission built new monuments for 74 stations along the 141st meridian between Canada and Alaska. The new marks, made up of copper clad steel rods drilled three to four feet into rock or permafrost with a bronze tablet on top, replace the old stone cairns, many of which have been destroyed. Such permanent marks are necessary because the stations are used more and more as reference points by those doing surveys for resource development in the area. The Commission also inspected 113 monuments along the boundary between Quebec and the United States west of Lake Champlain on the 45th parallel, upgrading surveys and replacing 27 monuments with permanent markers going five feet into the ground. Rights to the Lambert Tower, a light-weight tower for precise traversing and triangulation invented and developed by the Commission, were given to a private firm and put into commercial production in 1974.

The publication of a bound version of the fourth edition of the National Atlas of Canada by the Macmillan Company of Canada Limited in association with the Department of Energy, Mines and Resources and Information Canada in 1974 marked a first as far as cooperative publishing ventures between the government and private firms goes. The government provided the geographic research, cartographic design and printing plates while the private firm accepted the responsibility of printing and marketing the product. The 15,000 copies published have been distributed across Canada and abroad. Production of the National Atlas is a permanent branch project with each edition providing an up to date graphic summary of Canada's physical setting, human geography, resources and economy that depicts the nation's growth. Plans for the fifth edition were launched in October 1974 with a meeting of the Advisory Committee on the National Atlas of Canada attended by 17 geographers and cartographers from universities and government agencies across Canada.

Safety in airport areas used by both visual and instrument flight traffic is the objective behind the design of a new series of detailed terminal area aeronautical charts produced by the branch in 1974-75 for pilots navigating by visual flight rules. The additional detail deals with air traffic control of visual flying, and will allow the pilot to safely navigate areas of congested traffic. The Vancouver chart, first of the series of 10 at a scale of 1:250,000, was available in March, 1975, and was soon followed by charts for Toronto, Winnipeg and Montreal.

The Canadian Permanent Committee on Geographical Names published new editions of the Alberta and Ontario volumes of the Gazetteer of Canada series and completed verification of names now on record and collection of new ones for a book on geographical names of Nova Scotia. This book will be similar to those already published for Prince Edward Island and New Brunswick. Information is being gathered for books on geographical names of the Northwest Territories and names of under sea features.

The hook-up of the Geological Survey of Canada with the Surveys and Mapping Branch's automated cartography system in 1974 now allows the branch to produce geological maps by computer-assisted cartography. This connection is the first with an agency outside the Surveys and Mapping Branch. Plans for other hook-up stations include one with the Ontario government to enable the exchange of mapping information between federal and provincial map makers in a matter of seconds.

Converting maps from one projection (the mathematical representation of the curved earth as a flat map) to another is the topic of a new branch publication "An Integrated Approach to Map Projections and Plane Coordinates" of special application to computer programming.

Surveys and Mapping Branch products in 1974-75 included a new edition of the Yukon and Northwest Territories map at a scale of 1:4,000,000 and new editions in English and French of the Map of the World at 1:35,000,000 scale. As part of its program of cartographic service to other government agencies, the branch also printed a set of 27 territorial electoral maps for the councils of the Yukon and Northwest Territories, a set of 55 maps for the National Museum of Canada and a revision of the Highways of Canada map for the Government of Canada Travel Bureau.

During 1974-75, 3,777 maps were printed in 9,525,953 copies. Of these, 1,040 were of the branch's own national topographical map series and included 155 new multicolor maps and 453 revisions, 295 monochromes and 137 photomaps. In addition, 772 maps of the series were reprinted — an increase of 90 per cent over last year — to keep the branch's inventory of 10,293 map items and 18 million maps in stock complete and available to the public. During 1974-75, about 3,000,000 maps were sold through the Canada Map Office. The National Air Photo Library answered 14,093 requests for aerial photography.

In 1974-75, the National Air Photo Library Reproduction Centre began a program to produce summer and winter photomaps for the whole of Canada from ERTS photographs. By the end of April, 1975, mosaics showing summer and winter coverage of Manitoba and summer coverage of the Arctic were available. An entire coverage of Canada in 12 blocks at 1:2,500,000 and National Topographical Series map format at 1:1,000,000 was completed soon afterwards. The maps show names of major features and cities and the Universal Transverse Grid and are based on the best ERTS photographs taken over the past four years. They are of special use to oil companies, geologists and environmentalists.

Calgary is the site of the National Air Photo Library's first regional office for aerial photograph distribution, opened in March, 1975. The office has a microfilmed aerial photographic coverage of Alberta and microfiche cards from which the public can order the photographs. The office's present coverage will probably be expanded to include photography of all Canada.

In another decentralizing move, the Maritime Resources Management Service (M.R.M.S.) received 201 rolls of aerial photography covering New Brunswick, Nova Scotia and Prince Edward Island from the National Air Photo Library following the committee's decision to open a centre of distribution for these photographs in Amherst, N.S. M.R.M.S. will now take responsibility for future aerial coverage of the maritime area along with all reproduction and distribution of aerial coverage of the area done by the federal government. The federal government also loaned M.R.M.S. equipment for microfilm and microfiche viewing.

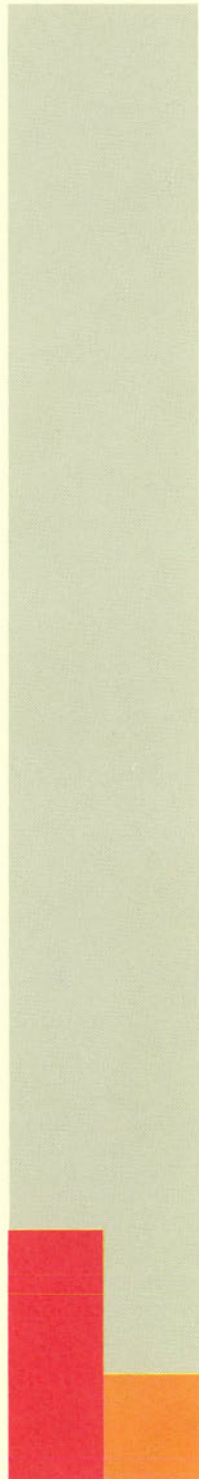


Department of Energy, Mines and Resources

ENERGY
DEVELOPMENT
SECTOR
\$ 4,997 177.2 MY

MINERAL
DEVELOPMENT
SECTOR
\$ 3,805 165.2 MY

SCIENCE AND
TECHNOLOGY
SECTOR
\$71,998 2,956.5 MY



CANADA CENTRE
FOR MINERAL AND
ENERGY TECHNOLOGY
\$14,821 713.8 MY

ASSISTANT
DEPUTY MINISTER,
SCIENCE AND
TECHNOLOGY
\$302 11.6 MY

EXPLOSIVES
\$ 426 22.3 MY

GEOLOGICAL SURVEY
OF CANADA
\$21,531 797.5 MY

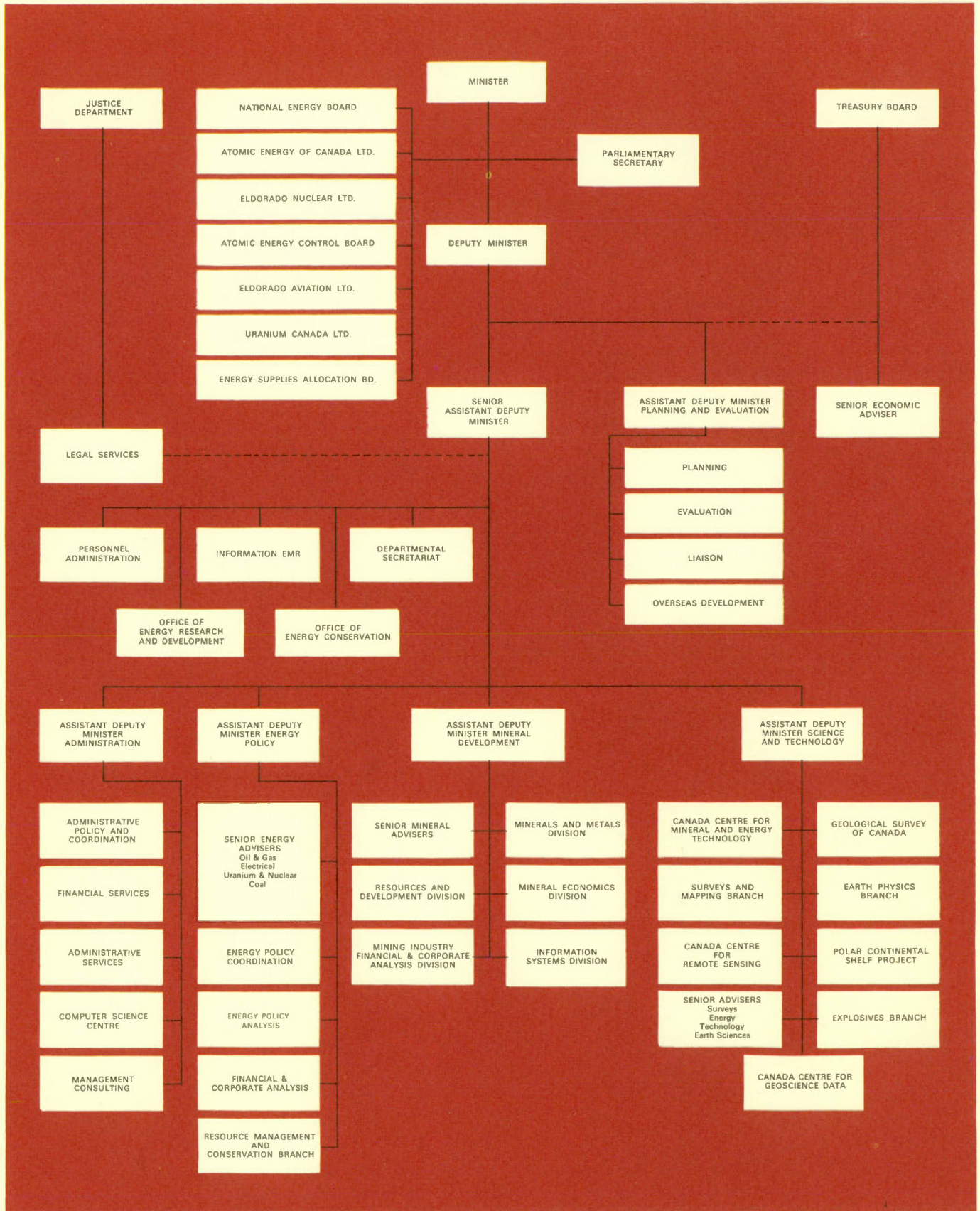
1974-75 Expenditures in thousands of dollars and man years

DEPARTMENTAL TOTAL: \$557,722*
3,750,5 MAN YEARS

*Oil subsidies \$467,213



Department of Energy, Mines and Resources



Geological Survey of Canada

For the Geological Survey of Canada, 1974-75 marked still greater involvement in the search for a broader and more secure resource base for Canada, an effort that is spurred on (and complicated) by the deteriorating energy situation and the increasingly evident need to conserve the natural environment.

Along with the studies aimed more or less directly at uncovering more abundant sources of energy and of raw materials, the Geological Survey also expanded its terrain investigations to provide planners with a better appreciation of the capacity of various terrain types — especially in the Arctic — to support exploration, transportation routes, and new communities.

Such field studies rely heavily on the continuing imaginative support of laboratory investigations at the Survey's three main establishments — Ottawa, Calgary, and Dartmouth.

The total budget allotted to the Geological Survey in fiscal year 1974-75 was \$21,744,000, of which approximately \$5 million was spent on field work. A major share was also taken up by the Federal-Provincial Aeromagnetic Surveys, a cooperative project supervised by the Survey for a number of years. In 1974-75, the federal amount spent on these surveys was \$1,275,000.

Probably the most significant new project launched by the Survey in 1974, again in cooperation with the provinces, is the Federal-Provincial Uranium Reconnaissance Program. This program was agreed to in principle in December, 1974, by the Canadian Ministerial Conference on Mineral Policy, provided that agreements are negotiated with each province individually.

The program is a response to the growing demand for uranium, both for domestic consumption and for export. Recent forecasts show that total world demand will outstrip production of this reactor fuel from present producers in the early 1980's, possibly by 1980. There is a lead time of about eight years between the discovery of a uranium deposit and production from it, and it is evident that the uranium reserves of Canada should be expanded without delay.

The objective of the program is to provide the exploration industry with high-quality reconnaissance data, and to provide governments with nationally consistent systematic information for the appraisal of Canada's uranium potential.



Although much of Canada has been explored for uranium, the methods used were often lacking in sensitivity and uniformity. Modern equipment and data-processing machinery are expected to produce much more accurate and meaningful results.

Two main methods will be used in the uranium program, which is expected to last approximately 10 years. Instruments installed in aircraft will measure gamma-ray spectra over those parts of the country that are relatively flat, with some outcrop and relatively thin overburden. This would be the case over much of the Canadian Shield. Geochemical studies on the ground will be carried out in mountainous terrain (where low-level flying is impractical) and in areas of thick sedimentary cover, as in the Prairies.

It is expected that much of the field work will be contracted out. The preliminary federal expenditure on the uranium program for the fiscal year under review was approximately \$110,000, with an additional outlay of \$315,000 for the gamma-ray spectrometry studies (this latter expenditure is included in the \$5 million already mentioned for field work). The total amount expected to be spent on the uranium program in 1975-76 is approximately \$1,545,000.

Another interesting project undertaken during the year by a Geological Survey team was a study of breccias, facies changes, and mineralization in Devonian rocks of the northern Rocky Mountains in northeastern British Columbia. Discovery of zinc and lead deposits in brecciated Middle Devonian carbonate rocks at Robb Lake, B.C., similar to those at Pine Point, N.W.T., caused speculation on the possible existence of a northern Rocky Mountain lead-zinc belt. Considerably more exploration and detailed geological work are required before these speculations are adequately tested.

The approach followed by the survey group is to try to determine for both the Robb Lake area in the mountains and the Pine Point-Great Slave Lake area in the plains what the history of the host sedimentary rocks has been. Such studies collectively make up what is known as sedimentary basin analysis, and are of outstanding importance to exploration for petroleum or base metals and for assessment of the rocks of the basin as hosts for these resources. Of particular interest in the study of the British Columbia breccias is the fact that exploration geology in the region was originally started and conceived in the 1950's for petroleum exploration, but has now turned out to be of vital interest in the search for strata-bound base metals. Thus basic geological exploration, properly carried out, has a permanent value and may serve several purposes.

A project to investigate the processes and effects of coastal erosion and sedimentation under Arctic conditions was commenced in the Sound between Byam Martin and Melville Islands in the District of Franklin, N.W.T., above latitude 75°N. Such geoscientific information is needed to assess the feasibility of inter-island gas pipeline routes. In addition, the work should elucidate the recent geological history of the area and provide Arctic sedimentary facies models. Particular attention was paid to the hazards to pipelines of scouring by "keels" of ice, particularly at the interface between land and sea.

A discovery of particular interest arising from this study was the effect on the frost table of sedimentary deposits. Well-developed beaches were found to be common along much of the coastline; in areas where beach sediments were composed of finer material and well-sorted sand, the frost table tended to lower to depth of up to 2 m (6' 6''), whereas in the poorly sorted sand and fine gravel of the beaches its depth was no more than about 0.5 m (20''). Ice push may play an important role in contributing new sediment to the beach. It was also observed that offshore ice push may be a mechanism for originating new beach and lagoon systems — all of which could have a bearing on selecting the location for pipelines.

Recent oil and gas exploration in the Arctic has created the need for detailed information on the unconsolidated deposits, landforms, permafrost, ground ice, organic cover and the geomorphic processes responsible for terrain modification. To meet these needs a surficial geology inventory of Banks Island, District of Franklin, in the Western Arctic has been undertaken. The project was designed to obtain data that would aid in the implementation of territorial land-use regulations and be pertinent to engineering construction, petroleum exploration and related activities such as construction of overland pipelines. Field work during the 1974 season on this project was concerned with identifying and obtaining general information on the various unconsolidated lithological and stratigraphic units in the area, gathering quantitative data at critical sites, and attempting to understand the recent geological history of the island. Research was also undertaken to identify and describe the various processes acting on the geology of the region under study, and classifying its vegetation.

By studies such as this terrain inventory mapping can be carried out to determine the nature of the surficial deposits as a basis for "zoning" the land for future use, with emphasis on the environmental protection of the delicate permafrost.

Once again, *CSS Hudson* steamed out from the Bedford Institute of Oceanography in Dartmouth, N.S. to undertake marine geological studies for the Geological Survey. The primary purposes of this latest expedition were to undertake detailed studies of Lancaster Sound between the north of Baffin Island and Devon Island with particular reference to the rich sedimentary deposits, some of which may be oil-bearing. In the same area, a joint venture was undertaken with industry to evaluate the use of the Bedford Institute rock core drill in the Arctic environment and to carry out a program of bedrock drilling — some useful cores were obtained. Another project, undertaken in cooperation with the Polar Gas Consortium, resulted in seismic measurements being made in Barrow Strait to evaluate possible pipeline routes. Extended studies in the Labrador Sea — Davis Strait area increased knowledge of the marine terrain and tended to confirm the drifting apart of Greenland and Baffin Island.



Canada Centre for Mineral and Energy Technology

The Mines Branch, a research laboratory and pilot-plant complex, underwent a massive reorganization during 1974-75 and has changed its name to the Canada Centre for Mineral and Energy Technology (CANMET). The new name is designed to highlight its research in the energy field and to reflect its wide range of mining and mineral interests.

The former Mines Branch divisions and research centres were reorganized into four main laboratories — energy, mining, mineral sciences, and physical metallurgy. They attack major problems faced by the mineral industry to ensure the effective extraction and utilization of Canada's minerals and fuels. Their activities are planned and implemented through three programs: energy research, mineral research, and minerals energy and information.

CANMET's research and development work reflects today's demands for energy conservation, new sources of energy and a clean, attractive environment. As most of Canada's high-grade and readily accessible mineral deposits are already being mined, research emphasis is placed on developing recovery techniques for ores characterized by low-grade and complex mineral composition. CANMET includes about 700 scientists, technicians and support staff and last year operated on a budget of \$14,779,000.

In 1974-75, fuels research was accelerated in efforts to extend existing reserves and to discover new sources of energy. Fuels research includes comprehensive evaluation of Canada's fossil fuels and the examination of refining methods for the low-grade petroleum of the Athabasca oil sands. The enormous potential of the sands cannot be tapped on a large scale until more efficient, economical techniques are developed for separating the oil from the sand and upgrading it for commercial use.

According to a report from the Alberta Energy Resources Conservation Board, Alberta's conventional crude oil reserves, representing the bulk of proved domestic oil supplies, contain less than 13 years' supply at present rates of consumption. This disclosure stresses once again the necessity of developing Canada's low-grade oil resources.

The refining of these resources is complicated by the presence of unwanted minerals, metals and sulphur. CANMET fuel experts have developed a thermal "hydrocracking" process that removes virtually all of the minerals and metals, reduces sulphur content, eliminates the production of waste coke, produces a high-quality distillate oil and increases the fuel yield by about 10 to 15 per cent. A proposal has been made to have Great Canadian Oil Sands test the hydro-cracking process in the near future.

Growing energy needs, coupled with rising prices of oil and natural gas, have made coal an important future source of thermal power, especially in the coal-rich western provinces. CANMET is working on a federal-provincial project to determine the amount and quality of lignite coal in the Ravenscrag formation of Saskatchewan. About 3,000 samples have been analyzed and the results could mean development of a vast, alternate source of energy.

CANMET fuel experts are also exploring the feasibility of producing synthetic natural gas from coal, especially in regions of Canada that are short of natural gas but rich in coal resources. So far, researchers have estimated the lowest cost of producing natural gas from coal using existing technology. This estimate will be used to determine whether the production of synthetic natural gas is an economical alternative to other energy forms.

In efforts to promote the use of combustible wastes as an alternate source of energy, CANMET has given technical advice to the Ottawa Master Plan Study, headed by the Department of Public Works which is investigating ways of using municipal garbage as fuel to heat government buildings. CANMET staff are also providing expertise to a Canadian consortium that is proposing a plant fueled partly by municipal refuse to supply a paper mill with electricity and process steam. In addition, CANMET experts are participating in Canadian and international committees to promote the use of waste heat from thermal power stations for residential and commercial heating via district heating systems.

Apart from developing new sources of fuel for the future, CANMET is also engaged in a program to make more effective use of Canada's finite oil reserves. To aid in the more efficient use of home-heating fuel oil, CANMET developed a "blue-flame" oil-furnace burner. It is designed to reduce fuel consumption by about 10 per cent and is virtually non-polluting. Researchers are also monitoring furnaces to study the effects of conservation measures such as thermostat cutback, increased operating time and heat reclaimers. One experimental device that automatically closes off the chimney when the burner is not operating promises a substantial fuel saving.

Transporting liquid fuels through pipelines is another area of CANMET expertise. In future, much of Canada's oil and natural gas will come from the Arctic and pipelines able to withstand abuse from severe cold will be a necessity. CANMET metallurgists are testing pipeline metals for strength, weldability, corrosion, cracking, brittleness, and ductility to select the best materials for the job. Their evaluations will be used to determine the structural soundness of proposed pipelines for use in the harsh Arctic environment.

Mining research is aimed at maximizing ore production with minimum cost and environmental disturbance. In 1975, the third year of a five-year, \$4-million project to optimize the design of rock slopes in open-pit mines was completed. The project is designed to reduce the excavation of waste rock from open-pit mines by more than ten per cent a year—a reduction of some 35 million tons that could save the mining industry up to \$50 million annually. Now that the field work is almost finished, CANMET is assessing the data and is compiling an engineering manual on rock-slope design and maintenance.

Over the years, CANMET has conducted much of its mining research in cooperation with industry. One such venture has resulted in the design and manufacture of a lightweight, portable, diamond drill capable of drilling down to 1,000 feet. The entire rig can be dismantled, loaded aboard a Twin-Otter aircraft, unloaded and put together in less than four hours. This new type of drill assembly will reduce the cost of dismantling and reassembling equipment and of moving from one spot to another. The rig will also improve the efficiency of a drilling operation by eliminating much of the back-breaking labor of moving conventional rigs onto and around a site.

In another research project, CANMET teamed up with a major Canadian steel company to test a modified "shaft-electric furnace" under industrial conditions. The trials indicate that this novel smelting process lowers energy needs by about 30 per cent, alleviates pollution problems, increases output, and allows the use of coal as a source of carbon instead of the more expensive coke required for blast-furnace smelting. Energy needs are reduced in this process because the off-gases from the furnace are used within the overall smelting process. Since the furnace can be operated economically in smaller units than is possible with blast furnaces, it can be used in small or medium-size steel plants located in areas where the population is too small to support a large, integrated steel works.

Other significant research related to steelmaking is aimed at finding substitutes for expensive and increasingly-scarce imported coking coal—an essential ingredient in the making of steel. Western Canadian coal could provide a major supply of coking coal but there are problems in transporting it economically to major steel producers in the East. One solution is to ship the coal in an oil slurry through a pipeline. In this way, thermal coal for use in electric generating stations and coking coal could be transported over long distances. CANMET researchers are studying methods for separating coal from such coal-oil slurries without deterioration of its coking characteristics.

In another area of endeavor, CANMET has launched a joint program with the U.S. Bureau of Mines to determine the feasibility of producing aluminum from sources other than bauxite. Research indicates that a variety of raw materials such as anorthosite hold promise of freeing the Canadian aluminum industry from its dependence on expensive foreign supplies of bauxite.

Mine safety is a major and growing concern of CANMET and efforts have been stepped up to create an acceptable working environment free from dust, radiation, noxious gases, noise and excessive heat. At CANMET laboratories in Ottawa and Elliot Lake, scientists are testing a variety of techniques to measure and control the harmful components of mine air. In cooperation with the Mines Accident Prevention Association of Ontario, the Elliot Lake laboratory has modified a dust sampler to give a more accurate reading of dust levels in metal mines. These instruments are being tested in several mines.

Particulate emissions from diesel engines used in underground mining are also being studied to determine the effectiveness of water scrubbers and afterburners in removing harmful carbon particulates. Test results will be used to improve mine-ventilation design. CANMET scientists are also experimenting with thermal-infrared scanning devices for an early-warning detection system to prevent explosions.



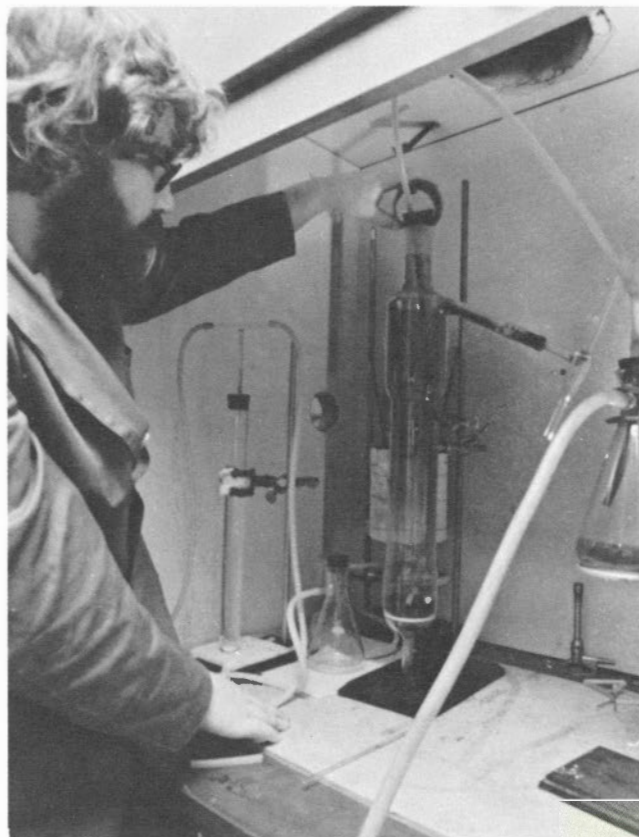
In the field of mineral sciences, a wide range of studies are being carried out to determine mineral characteristics important to the extraction and processing of ores. CANMET researchers are using a sophisticated, image-analyzing microscope to assess rapidly and accurately the proportion of each mineral in an ore sample and the size distribution of these minerals. Tasks that were formerly complicated and time-consuming to perform have become routine with the "image-analyzer". In one project, it was used to determine the quality of the Peace River iron ore deposits in northern Alberta. The results of these investigations will help to determine whether a steel mill is established at the site.

More than 30 per cent of CANMET's research budget is assigned to various projects related to environmental improvement. One of the goals of the Centre is to develop new methods of processing and recovering mineral resources to reduce environmental problems. In 1974-75, research continued on hydrometallurgical methods of processing sulphide ores that avoid the sulphur-dioxide pollution caused by conventional smelting processes.

CANMET metallurgists have developed hydrometallurgical processes for extracting copper, nickel and cobalt from complex sulphide concentrates to produce crude or refined metals. The sulphur produced as a by-product is non-polluting and has commercial potential. Such processes could prove especially useful when the size of an ore deposit is too small to justify the cost of building a conventional smelting complex. A plant using hydrometallurgical processing could be built at the mine site.

In another area of environmental research, studies are continuing on converting mineral wastes into useful products. Processes have been developed for: the manufacture of foamed insulation from waste glass, the production of fertilizer from cement-kiln dust and lime tailings, the production of wood fibre and filler clay from the waste sludge of paper plants, the production of mineral-wool insulation from asbestos tailings, the manufacture of dry-pressed brick from iron-mine tailings and the production of calcium-silicate building bricks from the residues of magnesium-metal production. CANMET scientists are also studying methods of recycling cans from municipal waste to reclaim tin and steel components.

Unfortunately, most mineral wastes cannot be converted into useful products. To minimize the environmental effects of these wastes, CANMET researchers are studying a variety of methods for removing harmful substances from mine effluents and tailing ponds before they enter drainage systems. Tests have been conducted in northwestern Quebec on the contamination of water by tailings from ore processing mills. Tests have also been carried out on the tendency of certain clays to absorb polluting traces of metal from mine waste waters. During the year research continued on the revegetation of mine wastes to restore spoiled areas to their natural state. Revegetation prevents erosion by wind and water and reduces the polluting effects of airborne dust and seepage water. Field studies have been conducted on acidic mine tailings in the Elliot Lake area to determine the most suitable vegetation and fertilizers for soil and weather conditions.





Earth Physics Branch

The Earth Physics Branch during 1974-75 continued to employ the most modern automatic techniques to further develop a quick and efficient data gathering and relaying system for a variety of geophysical information. Emphasis was on projects for regions of resource exploration and development in Canada.

The branch studies the seismic, gravitational, geothermal, geodynamic and geomagnetic properties of the Canadian landmass and their relationship to similar data from around the world. These basic geoscience services provide key information for resource development, energy transportation, navigation, telecommunications and national defence and contribute to knowledge of the geological evolution of Canada and geological hazards such as earthquakes. As part of its routine work the branch also maintains a network of seismic, geomagnetic and earth motion observatories across Canada and produces maps of the gravity and geomagnetic fields.

During 1974-75, the branch operated on a budget of \$5,490,000, of which \$1,628,000 went to the Gravity Division; \$1,524,000 to the Division of Geomagnetism; \$1,635,000 to the Seismology Division and \$703,000 to administration.

The Seismology Division began operating the Eastern Canadian Telemetered Network during 1974-75 with outstations at Manic 5 (Lac Manicouagan), Montreal, Maniwaki and Ottawa. Seismic signals, detected by the network, are transmitted to the Ottawa data laboratory in digital format over telephone lines. The network records seismic events in eastern and northern Canada, concentrating on the Ottawa and St. Lawrence valleys. In Ottawa, a computer analyzes all the data transmitted and, if the event is above a set intensity, stores it for future use. Ottawa will also now receive and store via a new telephone hook-up the date, time, period and amplitude of seismic events detected by CANSAM Canadian Seismic Array Monitor (CANSAM) in Yellowknife, N.W.T. The Yellowknife array is designed to aid in research on the capability to monitor and discriminate seismic events of a natural or nuclear nature from around the world.

A special study, by branch seismologists, of the La Malbaie area on the north shore of the St. Lawrence River in 1974-75, produced important data that will help outline the seismic patterns between Quebec City and La Malbaie and serve the continuing need to understand the physics of earthquakes. The site, a large meteorite crater, is the location of the highest seismicity and largest earthquakes recorded in Canada. Thirty events were detected in the project.

Drilling for studies of geothermal energy at Meager Creek near Lillooet, B.C. in 1974-75 revealed water under pressure and at a temperature of 60 degrees C. The site is well known as a source of many regional hot springs. Scientists hope to eventually outline the hydrology of the area, determine the cycle of temperature changes and, ultimately, find the source of the hot water.

Scientists studying permafrost in Canada's Arctic have managed to preserve the most northerly exploration well in the world—the Gulf-Neil well north of Greely Fiord, western Ellesmere Island. The well, first developed as a wildcat oil well, was preserved by inserting a cement plug down to permafrost and replacing the drilling mud with non-freezing fluid. The initial log, taken in 1974, showed that the permafrost depth at the site was 365 metres and logs taken over the next three years will show how the area settles back to thermal equilibrium following the disruption of the permafrost area around the drill site. In other permafrost work, researchers completed drilling studies to show a profile of permafrost on the shore line and offshore from Little Cornwallis Island. The data will be of use to mining companies in the area as permafrost provides an effective seal against sea water seepage and is an important factor in environment protection.

The Gravity Division last year began a program of analyzing subsidence patterns within several large North American sedimentary basins that will lead to a better understanding of general basin development. Initial results from the first study, conducted for the Sverdrup basin in the Canadian Arctic Islands, indicate that basin evolution may be broken into a series of cycles, each beginning with high subsidence rates accompanied by thick deposits of sediments and tapering off until interrupted by the start of the next cycle of subsidence. The periods of high subsidence rates at the beginning of each cycle appear to be contemporary with the uplift of areas around the basin perimeter. The uplifted region seems to migrate several kilometres toward the basin centre during the ensuing 10-30 million year period of the cycle.

During 1974-75, the Gravity Division program of mapping the Beaufort Sea at six kilometre intervals neared completion. This long-term project has produced reconnaissance gravity data of use as a framework from which exploration firms, particularly those searching for oil, can select areas for more concentrated study and from which models of the geological structure of the area can be constructed. The division also began a 10-year survey of James and Hudson bays under the same program of mapping Canada's gravity field. This is a cooperative program with the Canadian Hydrographic Service, Department of the Environment.

A new automated geomagnetic observatory at Yellowknife, N.W.T., began operation under the Division of Geomagnetism, in July, 1974, bringing the number of stations observing variations in the geomagnetic field across Canada to 11. Yellowknife lies under the auroral zone where the greatest number of variations in the external geomagnetic field occur.

Paleomagnetic studies from 1974-75 indicate that the Grenville geological province, which makes up the eastern section of the exposed Canadian Shield, may at one time have evolved separately from the rest of the Precambrian landmass. The orientation of the earth's magnetic forces is constantly changing and paleomagnetism—the study of this orientation in ancient time—is an important clue to geologic time and landform evolution. The alignment of magnetic particles in the ancient rocks of Grenville province is different from the rest of the Precambrian landmass, indicating that plate-style motions may have caused the sea to open and close, separating the two landmasses from 1,250 to 1,000 million years ago. In other paleomagnetic studies, the path of the magnetic pole (which appears to wander owing to the changes in geomagnetic orientation) 2,200 to 1,800 million years ago was established and an analysis of geomagnetic polarity for the Phanerozoic was completed.



In the early spring of 1974, the Division of Geomagnetism operated six recording magnetometers simultaneously in a line extending from Banks Island west 270 km into the Beaufort Sea, over the continental shelf and slope to the deep ocean. This area contains a remarkably widespread anomaly in the earth's magnetic field, and scientists hope that further analysis of the data will provide a reasonable explanation for this. The division has been concerned about the area since 1962 when the first records received from the region's main observatory at Mould Bay on Prince Patrick Island were so unusual that researchers suspected something was wrong with the instruments. Even during magnetic storms, when other Arctic observatories recorded rapid changes in all elements of the geomagnetic field, the trace of the vertical component at Mould Bay remained smooth. Different types of instruments showed the same effect leading to the conclusion that rapid changes in the vertical component of the magnetic field are cancelled here, to a large extent, by electric currents induced in some highly conductive body in the earth's crust below the Mould Bay observatory. Between 1963 and 1970, temporary magnetic recording stations on other islands of the Arctic Archipelago showed that the anomaly of suppressed magnetic variations was not limited to the Mould Bay region but covered an area of at least 600 km north to south and 300 km east to west. A preliminary analysis of the 1974 records indicates no sharp western boundary of the anomaly and no clear relationship to the continental shelf.

An airborne magnetic survey was completed by the division over Manitoba, Ontario, Keewatin, Hudson Bay and Western Quebec in 1974. Total distance was 50,000 line-miles and data will be used to keep magnetic maps and charts up to date. Similar data, gathered during the past few years for western Canada, have been used to delineate major magnetic regions for this area and, in addition, to construct a special model interpreting a large-scale anomaly near Fort Nelson, B.C.





Canada Centre for Remote Sensing

The Canada Centre for Remote Sensing (CCRS) coordinates airborne and satellite remote sensing in Canada and promotes its use among other government bodies, universities and industry. Operating on a budget of \$6,674,000, the Centre carries out research in remote sensing technology, develops applications for remotely-sensed data with other agencies, and makes the results available to users for the management of Canada's environment and natural resources.

Early in 1975, the CCRS awarded a major contract valued at \$1.4 million to MacDonald Dettwiler Associates of Vancouver to build and install ground data-handling equipment at a new satellite receiving station at Shoe Cove, Nfld. Beginning in June 1976, the station will receive, record, process and distribute satellite imagery of Newfoundland and a large segment of the North Atlantic Ocean.

By virtue of an agreement between the CCRS and the National Aeronautics and Space Administration (NASA), the station will acquire imagery from three NASA satellites: the Earth Resources Technology Satellite (ERTS), launched in 1972 and now called LANDSAT-1; NOAA-3, a weather satellite launched in 1973; and LANDSAT-2, the second of a series of earth resources satellites, launched on January 22, 1975. Once the station in Shoe Cove becomes operational, it will supplement the services provided by the station in Prince Albert, Sask., which receives imagery for all of Canada except for the extreme Arctic and Newfoundland.

The airborne arm of the CCRS' flew over 131 missions during 1974-75 for a total of more than 22,000 line-miles. Requests for the projects emanated from federal and provincial-government agencies, universities and private industry. Airborne imagery was sold to users at a cost per line-mile ranging from \$5.50 for the first-time user to \$14 for federal government users.

The fleet of four aircraft operated by the Centre includes two DC-3's, a Falcon Fanjet and a Convair 580. The interior of the Falcon was redesigned during 1974-75 to improve operating conditions and to eliminate power failures. Excess wiring, equipment racks, original seating and a bulky film printer and cooling system were removed and replaced by two new equipment racks and seating that allows three technicians to operate the entire sensor package. An infrared line scanner was fitted into the nose of the aircraft and each operator position was equipped with improved telecommunications facilities and a closed-circuit television screen.

The Convair 580 was purchased early in 1975 to satisfy the growing need for aerial surveys of the Arctic and Canada's coastal areas. The aircraft will be extensively modified during the year to accommodate current remote sensors and those of the future with all-weather capabilities. The aircraft should be at the disposal of users late in 1975.

The Centre also acquired an Airborne Data Acquisition System that was installed in one of the DC-3's. This computerized device monitors and records information from various sensors and navigational systems on magnetic tape. A "quick look" system on the ground is used for playback, display, and preliminary analysis of information from the system.

In keeping with its policy of encouraging the development of a commercial remote sensing enterprise in Canada, the Centre issued a three-year contract valued at \$2.5 million to Innotech Aviation of Montreal to operate and maintain the aircraft used for airborne remote sensing—services formerly provided by the Canadian Forces Airborne Sensing Unit. Interra Environmental Consultants Limited of Calgary, MacDonald Dettwiler Associates of Vancouver and Lavolin Associates of Montreal will work with Innotech as subcontractors. These companies eventually will provide the full range of remote sensing services from the acquisition of airborne imagery to its processing and analysis.

An important part of the Centre's function is to determine the benefits of remote sensing for Canada and to assist users in implementing remote sensing methods that are beyond the research stage but are still not commonly used. One of the most promising uses of satellite imagery that emerged during 1974-75 was in the field of Arctic navigation. A "quick-look" facility attached to the satellite receiving station in Prince Albert, Sask., provides black and white photographs of Arctic sea-ice within 20 minutes of LANDSAT's pass over Canada. The photographs are then relayed to Ice Forecasting Central, a division of the Department of the Environment in Ottawa, which updates its ice charts the same day and transmits the information to ships. In this way, ships can circumvent the ice, avoid costly delays and save thousands of dollars.

Geophysical Service, a company doing seismic work in the Arctic as a preliminary step in the search for oil, equipped two of its ships on an experimental basis to receive the "quick-look" imagery directly from Prince Albert. The Canadian Navy followed suit with one of its ships. The satellite imagery gives a general picture of sea-ice conditions and is used to supplement the visual observations made from aircraft patrols.

LANDSAT imagery is also a practical, inexpensive method of locating and monitoring new forest fires and burned-out areas and assessing the damage to vegetation. In 1975, 45 forest fires were located in the isolated regions of northern Saskatchewan using LANDSAT imagery. In one burned-out area near Stoney Rapids, Sask., it was estimated that about 10 hours of flying time by helicopter would have been necessary to map the damaged area. LANDSAT imagery provided the information within minutes.

A study conducted during 1974-75 of Yellowknife, N.W.T. demonstrated that the least expensive method of mapping forest fires was by transferring the satellite data in print format to an existing map. The researchers concluded that \$10,000 and six man-months would be required to map and monitor this area using LANDSAT imagery.

The mapping of areas susceptible to landslides is another field that can benefit from airborne remote sensing. During 1974, researchers at CCRS studied a region of eastern Ontario covered by leda clay, a porous soil that is extremely sensitive to natural or artificial disturbances. They discovered that aerial photographs of the area spanning decades were valuable for monitoring environmental changes that could provide clues as to the present and future status of the land. Information about the environment could be extracted from remotely sensed data to determine the area's susceptibility to landslides. In fact, the researchers concluded that landslide inventories and susceptibility mapping could be achieved practically and economically only by employing remote sensing techniques. Landslide inventory maps can be used by regional planners to direct high-density settlement away from these areas, to route traffic corridors through safer districts and to plan reforestation projects that will stabilize such terrain.

Remote sensing is a highly-automated, complex technology that is constantly being modified to meet the needs of users across the country. One sensor being evaluated by the CCRS is a laser fluorosensor. It is a device used at night for identifying and mapping the distribution of oil spills, water pollution, chlorophyll, algae and tracer dyes. It operates by exciting these substances with an ultra-violet laser and detecting their fluorescence. The laser's intensity can be altered so that the sensor also can determine water depth over clear or shallow lakes, rivers or coastal waters by measuring the time interval between pulses reflected from the surface and bottom.

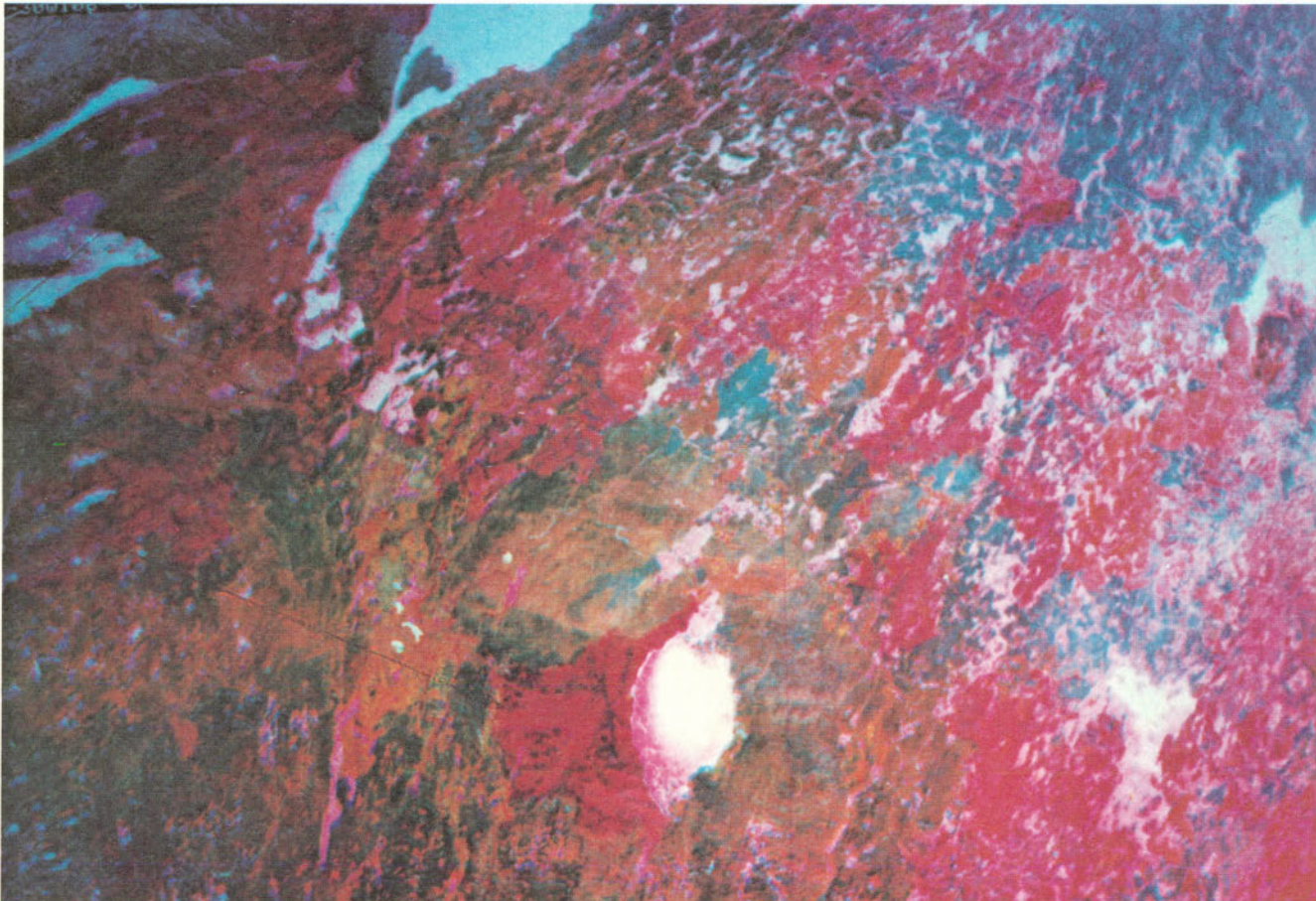
Another sensor undergoing extensive testing is a microwave scatterometer that emits microwaves and measures their "backscatter" from the ground at different angles. It provides information about sea state and ice type that can be used to infer ice thickness. Such information could be transmitted to ships in the ice-infested waters of the North to reduce the hazards of Arctic navigation.

Evaluating new equipment for more efficient processing and analysis of satellite imagery is another concern of the CCRS. The Image 100 system, acquired in April 1974, has swept the Centre into a new era of LANDSAT imagery analysis. This system automatically analyzes a LANDSAT image line by line and point by point and categorizes its content according to a classification scheme devised by the interpreter.

For example, from a digital tape an interpreter might select a portion of a scene, magnified or reduced, that he wishes to investigate. He then instructs the machine to show the image on its color television screen. Using carefully selected ground truth, the op-

erator tells the machine that certain areas are fallow fields. Once it is fed this information, the machine instantaneously classifies the rest of the image. The fallow fields might appear yellow in contrast to the remainder of the screen. In this way, different types of vegetation, water and land use are distinguished and the classified images can be used to produce accurate topographic maps. The Image 100 also makes possible quick and accurate assessments of environmental change in specific areas over periods of time.

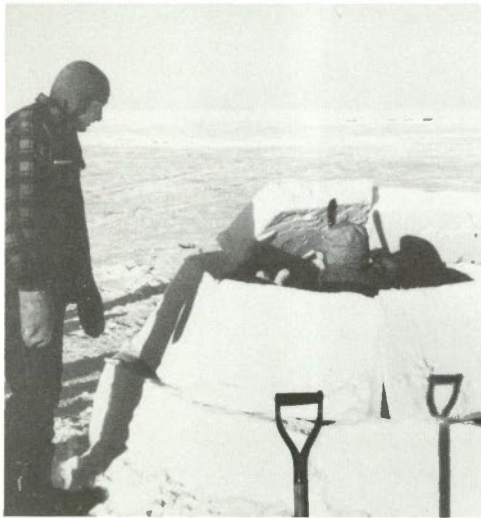
The CCRS also has modified a laser beam image recorder (LBIR), developed by the University of Toronto's Institute of Aerospace. This device is designed to produce satellite imagery in color more efficiently than the conventional method of producing satellite imagery from electron beam image recorders. During 1975, Canadian Aviation Electronics Ltd., of Montreal will complete engineering and installation of the LBIR and the Centre will tie the instrument into its computer system.





Polar Continental Shelf Project

Polar Continental Shelf Project (PCSP) continued to provide program coordination and support logistics to scientific researchers carrying out field activities in the Canadian Arctic; in the past season the expeditions supported ran the gamut from Archaeology to zoology. Although most of these field activities were on behalf of EMR and other government departments such as Indian Affairs and Northern Development, and Environment Canada, PCSP gave assistance also to scientific parties from 10 Canadian universities and to such far-flung foreign institutions as the Universities of Washington, Liège, Hokkaido and Uppsala.



For the 1974-75 fiscal year, the total budget of the PCSP was \$3.2 million. Once again the base camps were maintained at Tuktoyaktuk on the North Shore and at Resolute Bay on Cornwallis Island. Field work was carried out between mid-February and mid-October.

In addition to the total of 73 regular Polar Continental Shelf projects of considerable diversity, PCSP supported 32 projects under the cooperative Industry Government Program in the Beaufort Sea. At times, unfavorable ice conditions kept scientific parties on shore, which taxed the facilities of the base camp at Tuk to capacity. The major field program efforts were concentrated in the hydrographic survey of Eureka Sound and adjacent fjords and the gravity survey of southern and eastern Amundsen Gulf. Permafrost and sea ice studies both received considerable support in the Beaufort Sea and Resolute areas.

The biological sciences were very well supported in 1974. Arctic fauna studied included whales, greater snow geese, caribou and muskox, polar and grizzly bears, and ringed seals. Other areas of interest included glacier physics, climatology, vegetation and marine biology.



Explosives Branch

The Explosives Branch administers the Canada Explosives Act and regulates all factories that produce commercial blasting explosives, military explosives, blasting accessories, gun-powder, sporting ammunition, and fireworks. The quality and safety of these products, as well as their road transportation, storage, sale and importation are controlled by a licensing system supported by inspections of division members. All licences are issued from the Ottawa office.

During 1974-75, the number of factories licenced to manufacture explosives dropped from 66 to 64. They produced 231,000,000 kilograms of commercial blasting explosives—an increase of 16,000,000 kilograms over 1973-74. The production of fireworks, ammunition and blasting accessories also increased but not to the same degree as commercial blasting explosives.

A bill to amend the Explosives Act was introduced in the Senate in November, 1974, and was passed to the House of Commons for clause by clause examination. The aim of the bill is to tighten control over the sale, purchase, possession and security of explosives, to reduce the incidents of abandoned explosives and to make the abandonment of an explosive an offence. The amendment also will result in stiffer penalties for infractions under the Act. It is expected that the bill soon will become law.

Since 1973, the Explosives Branch has provided courses to qualify candidates as "Fireworks Supervisors". During 1974-75 about 2,600 persons attended courses at centres across Canada.

Research Agreements

Through its program of research agreements, the department funds extramural research and development projects that are directly related to EMR's areas of concern. Organizations not directly managed by the federal government can apply for aid on behalf of research in the natural, physical and social sciences.

By means of research agreements, advice to government and information of value to other interested parties can be based on the research of expert specialists from a wide variety of fields, who frequently use a multidisciplinary approach. Assessment of proposals and follow-up on the progress of projects is the responsibility of the branch or branches of EMR whose disciplinary orientation relates most closely to the subject of the research.

Agreements are made for the next fiscal year. During 1975-76, 36 Canadian institutions will share funds totalling \$882,670. The largest portion of this amount, \$819,170, will go to 111 researchers who are members of university faculties; the balance will go to members of provincial research councils and specific research institutions.

Typical research projects approved this year include:

in situ recovery of oil from the Alberta oil sands;

Natta-Ziegler catalyzed Fischer-Tropsch hydrogenation reactions;

improvement of energy utilization in the Canadian transportation sector;

simulation of travelling waves on high voltage direct current transmission lines;

gasification of peat in a spouted bed reactor;

laser rock breakage;

Japanese economic growth and Canadian mineral exports;

regional metallogenic analysis of Nova Scotia: a multi-disciplinary approach;

Precambrian porphyry copper and molybdenum deposits in Ontario and Saskatchewan;

evolution of a "Greenstone" belt;

radio frequency interferometry as applied to ice and permafrost sounding;

map generalization;

urban cartography;

seismotectonic studies of Newfoundland.



Administration

The Administration Sector of EMR is comprised of a policy and coordination group, personnel, financial and administrative services, a computer science centre and a management consulting group. The personnel branch is concerned with recruitment, training, staff records, language training and preparation for retirement. By the end of the fiscal year, EMR had a full-time staff of 3,232, an increase of 96 over the preceding year. The department also employed a number of term employees, among them summer students, totalling 550 man-years during the fiscal year. The total man-year utilization for the fiscal year was 3,763, an increase of only eight man-years over the previous year. Approximately 85 per cent of the staff is employed in the National Capital Region; the others are employed in about 25 locations across Canada.

The department is strongly oriented toward the scientific, engineering and technical fields, with about 30 per cent in the scientific and professional category and a further 33 per cent in the technical category. About 1,200 or 37 per cent of the staff hold university degrees, of whom some 225 have master's degrees and 375 have Ph.D. degrees. This educational requirement in highly specialized fields makes the recruitment of staff a more than normally difficult process.

The department as a whole made considerable progress during the year in its ability to provide services to and to communicate with employees and the public in the official language of their choice, as a result of intensive language training programs and the recruitment of bilingually qualified personnel. By March, 1975, the number of qualified incumbents in bilingual positions was 406, which represented an increase of 52 per cent in bilingual capability over the previous year. To enable employees to retain and increase their capability in French the department is carrying on active monitoring and tutoring programs. Progress was achieved in the department's ability to make "work instruments" available to employees in either official language. New forms were published in both languages and considerable headway was made in translating unilingual documents into French.

The department's ratio of participation by members of the anglophone and francophone communities is 82 per cent anglophone to 18 per cent francophone, and plans are underway, in cooperation with the Public Service Commission, to give even greater emphasis in recruiting to the French-speaking scientific and professional communities. One of the programs is a cooperative program with the University of Sherbrooke involving the rotational assignment of French-speaking undergraduates between EMR and the university.

Financial Services provides financial advice to the whole department, develops accounting policy and procedures, coordinates submission of financial plans to Treasury Board, and carries out control and reporting functions. EMR's financial services differ from those of many other federal government departments in that they administer not only a headquarters but also an extensive field surveys budget; last year alone some 325 field accounts were operated in all parts of Canada, including the Far North. In addition the group also handles some of the financial matters for other agencies which report to Parliament through the Minister of Energy, Mines and Resources, such as Atomic Energy of Canada Ltd., Eldorado Nuclear Ltd. and Uranium Canada Ltd.

The most significant undertaking by Administrative Services during 1974-75, in addition to its day-to-day administration functions, was the move of employees into the new EMR Tower building at 580 Booth Street in Ottawa in the Fall of 1974. Close to 800 employees were moved in from various locations in different parts of the city, and others were relocated within the Booth Street complex. Administrative Services also looks after Technical Field Support Services, providing support for all EMR activities in the field. The inventory of vehicles numbers about 500, valued at over \$5 million, and ranges anywhere from skidoos to all-terrain motorcycles, other supplies include scientific instruments, sleeping bags and emergency freeze-dried food rations—everything required to sustain an expedition in the field. Administrative Services also arrange for the chartering of aircraft and helicopters of all types, the annual outlay for which by all EMR branches is in the neighborhood of \$6 million.

A central in-house management consulting service is provided, on request, to all areas of the department. Major projects carried out during the year were the development of an order processing system for the Canada Map Office, reorganization of publication distribution at Vancouver, and a workload analysis study at the Calgary Institute of Sedimentary and Petroleum Geology.

The gross budget of the EMR Computer Science Centre for 1974-75, which is operated on a cost-recovery basis with direct charges to users, was \$2.8 million. The Centre performs systems analysis and programming, with related data manipulation and display functions. These services are offered to any government department that needs them; during the fiscal year under review, about 25 per cent of the work load was on behalf of departments other than EMR, who availed themselves, among other services, of a plotting facility which is unavailable at most other computer centres.



