CANADA

ANNUAL REPORT

CALENDAR YEAR

1958

Department of

MINES AND TECHNICAL SURVEYS

annual report

Calendar Year 1958

Department of Mines and Technical Surveys

76101-5—1

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To His Excellency Major-General Georges P. Vanier, D.S.O., M.C., C.D.,
Governor General and Commander-in-Chief of Canada.

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honor to lay before Your Excellency the Annual Report of the Department of Mines and Technical Surveys for the calendar year 1958.

Respectfully submitted,

PAUL COMTOIS
Minister of Mines and Technical Surveys

76101-5—1½

The Honorable Paul Comtois,

Minister of Mines and Technical Surveys,

Ottawa.

SIR:

I have the honor to submit the Annual Report of the Department of Mines and Technical Surveys, covering the calendar year 1958.

Your obedient servant,

MARC BOYER

Deputy Minister

Contents

Appendices


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introduction

IN 1958 the Department of Mines and Technical Surveys carried forward its program of basic and applied research on an ever-widening plane. The immediate technological problems of the mineral industry were still an important part of the work; but many of the year's projects reflected an acute need for fundamental scientific studies. For experience has shown that research is of greatest benefit to both science and industry when, in addition to practical applications, it pursues a knowledge of basic principles.

Thus the Department's geological work gave increased emphasis to laboratory projects and special field investigations that would further the science of geology and man's knowledge of how and when the rocks of the earth's crust were formed. Research in palaeomagnetism offered new evidence on movements of the north magnetic pole and the position in which rock formations were originally laid down. The analysis of soils, stream waters and sediments proved to be a valuable scientific supplement to geological maps, and studies in biogeochemistry—involving the analysis of vegetation and micro-organisms for traces of metal—offered a promising new approach to the solution of many geological problems.*

Similarly, basic studies in physical metallurgy, undertaken in 1958, will enlarge our knowledge of the crystal structure of metals and alloys—the key to the understanding and control of their behaviour. The Department's

* A roof-top greenhouse on one of the Department's new buildings will give considerable impetus to this work.

76101-5—2

research in fuels sought to determine the basic chemical structure of oils and bituminous substances—a matter of prime importance to the development of new and improved refining techniques. And other basic projects underway during the year were laying the foundation for new and better methods of extracting metals from their ores.

Meanwhile, the Department proceeded with the construction of a radio telescope—an instrument that will open new vistas in astronomical research. It continued to take an active part in the International Geophysical Year, carrying out, among other things, a systematic study of meteors, photography of the sun's surface and the observation of artificial earth satellites. Also undertaken was a 21,000-mile geomagnetic survey over the Pacific ocean as far as Australia, the Philippines and Japan.

Much of the Department's research program in 1958 underlined the need for better analytical methods. Metallurgical investigations, in particular, depend to a large degree on rapid and accurate chemical analyses; and in this field the Department has continually sought to replace older, slower techniques by ingenious application of radioactive isotopes and various instrumental methods.* Considerable attention was given to the development of new methods for detecting uranium and thorium, and better techniques for determining the presence of rare earths in uranium concentrates. Similarly, a laboratory project in geochemistry resulted in more efficient means of determining minute quantities of lead, zinc, copper and molybdenum. This has greatly increased the speed and accuracy of geochemical field work, enabling a single operator to make as many as 100 determinations a day.

Meanwhile, the Department's program of technical surveys continued to pave the way for the development of Canada's natural resources and for her económic progress. And in 1958 the need for this work was never more apparent.

As a result the Department intensified its survey operations—geological, geographical, geodetic, topographical, hydrographic and legal—bringing to bear all the aids modern technology could provide.

For transporting men and equipment the helicopter and the Piper Super Cub made it possible to by-pass the most difficult terrain, cover vast areas in a fraction of the normal time. The use of advanced instruments such as the tellurometer was of great value in control surveys and replaced slower, more costly triangulation techniques in many parts of the country. Under study

* A good illustration is the problem of determining impurities in certain alloys. Formerly this was done by analyses which were time consuming and often inaccurate; now the use of polarographic methods with controlled potential electrodeposition has greatly simplified the work and offered more reliable results.

during the year was the possibility of using gamma rays emitted by rock formations as a means of identifying them from the air. Also being investigated was a means of applying the phenomena of nuclear magnetic resonance to geophysical work. Magnetometers based on this principle make use of the spinning nuclei of atoms to measure the magnetic field of the earth.

In 1958 the Department made its first excursion into the realm of submarine geology. This came shortly after the United Nations Conference on the Law of the Sea which established the right of a nation to exploit the resources of its continental shelf. The Department's first shelf project took the form of an aeromagnetic survey over the Gulf of St. Lawrence.

Plans were also under way, during the year, for an extended research program in the Polar Basin, involving about 1,500 miles of continental shelf along the north rim of the Arctic Islands. The program called for an advance party in the 1959 season to obtain first-hand knowledge of the polar environment, the equipment needed for a major expedition, and other possible problems. The project has introduced the Department to the study of oceanography, and other related sciences. A new ship, the C.G.S. *Hudson,* plans for which were under way during the year, will eventually provide a floating laboratory for oceanographic research and for charting northern waters.

The Department also made considerable progress on a $6,300,000 project in aerial photography involving some 500,000 square miles, of the Arctic Islands. One of the largest projects of its kind ever undertaken by the free world, it is a major step forward in the development of the Canadian north.

The geographical work of the Department was expanded in 1958, both in the field and at home. The English edition of the *Atlas of Canada* was issued late in the year with the French well under way. Its 450 maps represented an immense effort in geographical and economic research, and were hailed as a triumph in graphic arts. The cartography and printing, a matter involving many complex problems in drafting, photomechanics and lithography was undertaken by the Department's Map Compilation and Reproduction Division.

In 1958 plans for moving to the new Booth Street buildings were well in hand. In fact by the fall of the year some sections of the Department had already occupied new quarters with others to follow in short order. The modern well-equipped laboratories would provide breathing room for a host of varied projects; but as 1958 drew to a close it was plain that, with the growing need for mineral research and basic survey work, the Department would require even greater expansion in the years ahead.

76101-5—2½

surveys and mapping branch

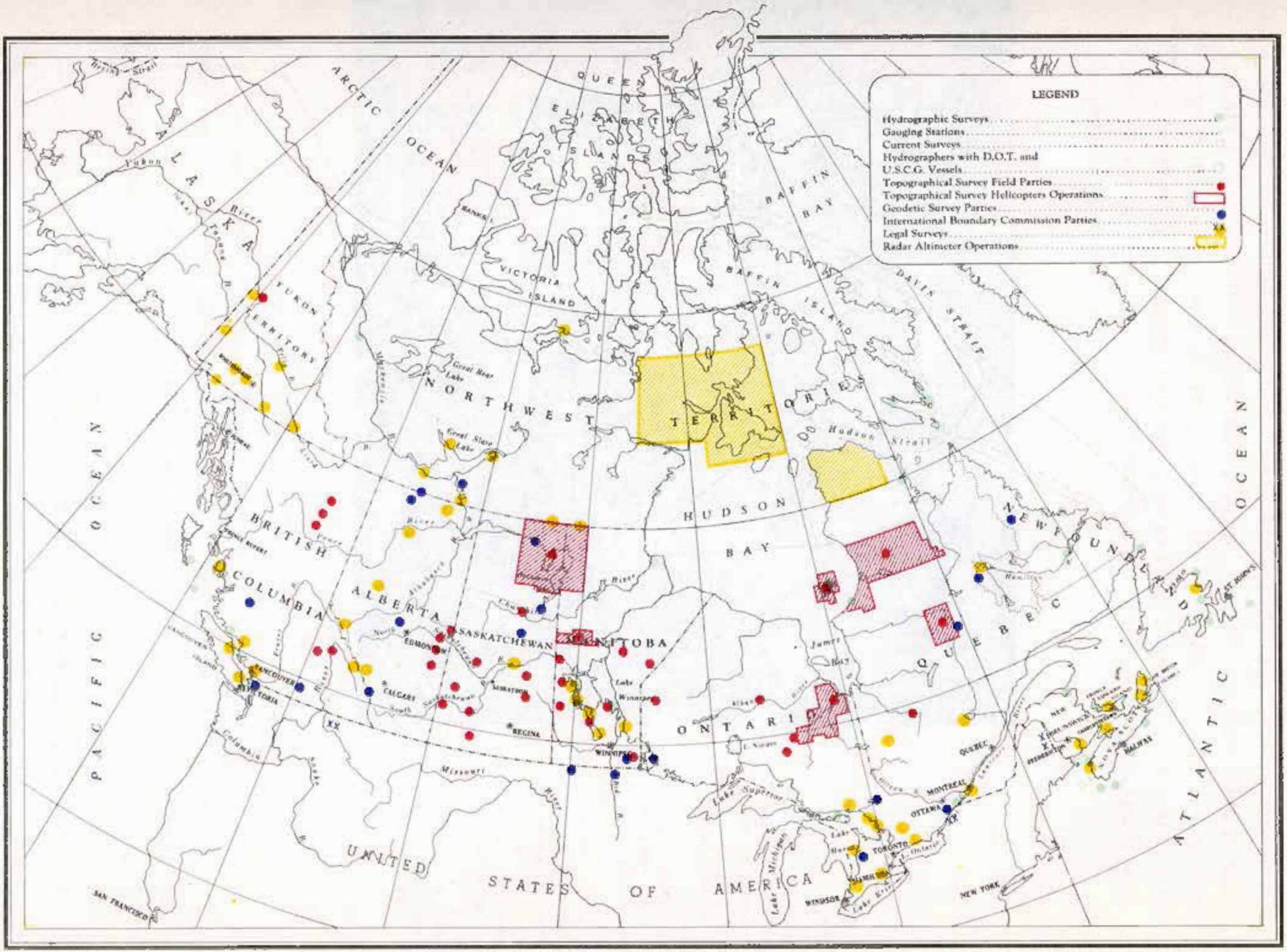
FOR the Surveys and Mapping Branch, 1958 was a productive year. In nearly every aspect of the Branch's diverse operations, the volume of work carried through exceeded that of 1957 by at least 10 per cent.

In geodetic and topographical surveys, the field season was one of the most successful, due, in no small measure, to the effective use of the aids of modern technology; for the Branch has sought constantly to develop better survey methods and; for processing the resulting data, more efficient computational techniques.

Also intensified was the charting of Canada's coastal and inland waterways. Thus the Canadian Hydrographic Service sent out more ships and parties and distributed more standard charts than in any previous year. Legal surveys, too, were in greater demand, stimulated mainly by the development of the Yukon and Northwest Territories; and projects such as the construction of the Trans-Canada Highway and the laying of natural gas pipelines.

In map compilation and reproduction, the year's production program was dominated by the *Atlas of Canada,* a project that called for an immense effort in drafting, photomechanics and lithography. The English edition was completed in time to meet a fall deadline and the French was well under way at year's end. Made available to the public late in the year, the *Atlas of Canada* was hailed in Canada and abroad, as a triumph in modern cartography and graphic arts.

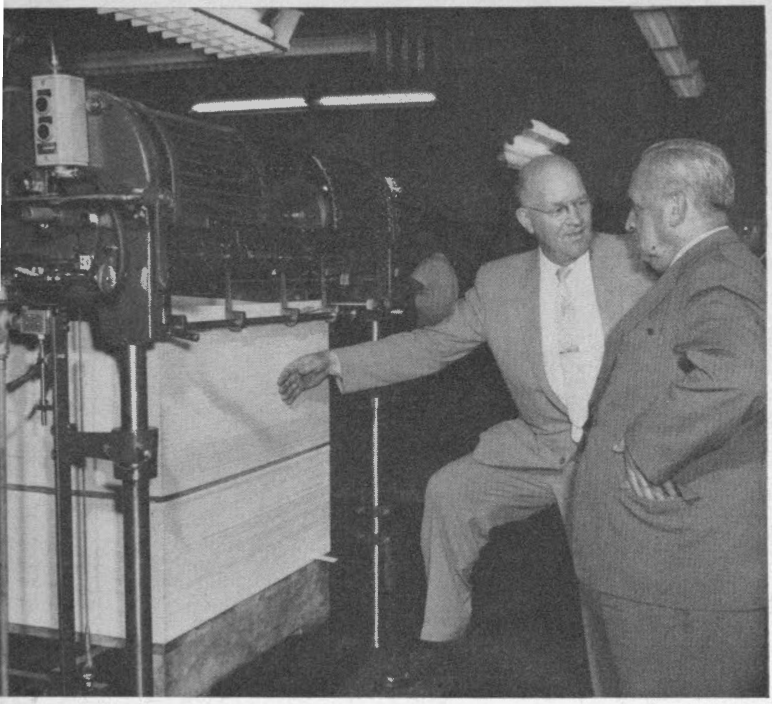
The year also brought the retirement of the Branch's director, W. H. Miller, after almost 45 years of service with the Department.



SURVEYS AND MAPPING BRANCH FIELD PARTIES, 1958.

The Geodetic Survey of Canada

The Geodetic Survey continued to extend the networks of precise horizontal and vertical control, the framework for all mapping and charting in Canada and for countless engineering projects. In 1958 fourteen field parties operated in various parts of the country. Some of the work, however, was of scientific import, leading to more precise determinations of the size and shape of the earth or to the development of improved survey methods and computational techniques.



Minister of Mines and Technical Surveys, Paul Comtois and Chief Cartographer E. D. Baldock stand beside a Mann offset press, one of many used to print the new *Atlas of Canada*. Involving an immense effort in drafting, photomechanics and lithography, the *Atlas* dominated the work of the Map Compilation and Reproduction Division in 1958.

Triangulation

Triangulation provides a basic framework of well-defined points whose positions, in terms of latitude and longitude, are determined to a high degree of accuracy. It is a means of accurately relating local surveying and mapping projects to one another.

In 1958 the Geodetic Survey of Canada extended the network of horizontal control by means of triangulation in the District of Mackenzie, Alberta, Saskatchewan, Manitoba, Quebec and Newfoundland (Labrador).

The control net along the Mackenzie Highway was completed to the northern boundary of Alberta and extended to the vicinity of Hay River in the District of Mackenzie. Reconnaissance for this arc has progressed easterly along the south shore to the vicinity of Fort Reliance.

In Saskatchewan the arc connecting Prince Albert and La Ronge was extended 110 miles northeasterly from Lac la Ronge and reconnaissance for it completed from the Reindeer Lake area to Wholdaia Lake via Black Lake.

In Manitoba, the party working southwesterly from the Ontario-Manitoba boundary (in the vicinity of the transcontinental railway lines) extended for about 100 miles the arc that will link the networks of Eastern and Western Canada.

Work on the Oskelaneo-Knob Lake arc in northern Quebec progressed from Nitchequon Lake to Kaniapiskau Lake. Despite persistently bad weather, the Nain-Knob Lake arc in Labrador was extended westward 100 miles from Nain on the Atlantic coast.

Precise Levelling

In 1958 three parties of the Geodetic Survey undertook precise levelling operations (to establish elevations above sea-level) in British Columbia, Alberta, Saskatchewan and Ontario.

In British Columbia, the Chilcotin Road line was completed from Kleena Kleene to Bella Coola. In the southern part of the province, the Pacific Great Eastern Railway extension was levelled south from Squamish to Caulfield. Relevelling of the Vancouver loop was completed and a start made on the connection between Kamloops and Merritt.

In Alberta a large loop was divided in two by connecting Green Court and Valleyview. Levelling was begun on the north trunk road between Nordegg and Cochrane to provide control for the Eastern Rockies conservation area. And in Saskatchewan a line was projected northerly from Big River to provide control for the Meadow Lake area.

The party in Ontario completed the relocation of the main level line along the north shore of the St. Lawrence River between Cornwall and Iroquois and that from New Liskeard to North Bay. The rest of the season was spent installing and connecting hydrographic gauge-control bench marks on Lakes Huron and Erie.

Base Lines

Precise base-line measurements are made at regular intervals in the triangulation network. The purpose: to control distances which are carried forward by means of triangulation. During the year a geodimeter party measured a base line in each of the following areas: Kenora, Ontario; Whitemouth, Manitoba; La Ronge, Saskatchewan; and Hay River, District of Mackenzie.

To the east of Ottawa, invar tapes were used to measure the easterly 6 miles of a projected 10-mile base line along the Canadian National Railways' right-of-way between Hawthorne and Vars. The line will serve as a test range for distance-measuring devices such as the geodimeter and the tellurometer, and as the base of a very precise triangulation scheme to be used for similar purposes.

Astronomy

Astronomical observations usually consist of recording the precise time of the passage of a star from which the latitude, longitude and azimuth of a point may be determined. They serve three functions: to control the directions of triangulation nets, to determine the positions of points in areas where triangulation control is not available, and to provide data for scientific investigations concerning the size and shape of the earth.

In 1958, four Laplace points (to control triangulation) were established—one near Hay River, one near La Ronge and two in the Knob Lake area. A triangulation station near Manning, Alberta, was occupied to provide data for determining the deflection of the plumb line.

Electronics

The Survey continued to study the use of the tellurometer, an instrument used to measure the length of a line by determining the time a radio wave takes to travel along it. To determine the procedure for using the instrument and its applications in geodetic surveying, a tellurometer party measured 35 lines in the arc of triangulation extending from Kenora, Ontario, to Whitemouth, Manitoba. At year's end an analysis of the data obtained from this operation was under way but preliminary results showed that tellurometer measurements could be used to strengthen second-order triangulation. Hence it was used in measuring 15 lines of the second-order Brandon spur net (which extends northward from the International Boundary to the vicinity of Brandon) to strengthen control in this area.

Mathematical Adjustments and Computations

An increasingly large share of the Survey's work load is undertaken in its offices where field data must be adjusted for error and countless routine mathematical computations are carried out. In 1958 the Survey continued

In 1958 the tellurometer, an electronic distance-measuring device of high accuracy, was put to good use in many parts of the country. In hydrographic work it measured distances between survey beacons; in topographical surveys it sometimes replaced slower, more costly triangulation techniques.

to develop programs for an electronic computer enabling much of the work to be carried out with greater efficiency. In fact, computational procedures were constantly scrutinized with this in mind. In addition the Survey continued its active interest in international geodetic organizations and the work of national agencies.

International Boundary Commission

Inspection

The Commissioners made a joint inspection of various points on the International Boundary from Passamaquoddy Bay to the western extremity of the 49th Parallel at Point Roberts, British Columbia. Included were the boundary between New Brunswick and Maine where a Canadian and a United States field party had worked; the boundary marks at Lubec and Eastport, Maine, and St. Stephen, New Brunswick; boundary crossings at Lake Champlain, Jamieson's line and Trout River on the 45th parallel; and the boundary at Coutts, at Carway and at the Chief Mountain Highway in Alberta. The Commissioners also inspected the work of a United States party east of Eastport, Idaho and that of a Canadian party west of Porthill, Idaho; and the boundary at Laurier, Grand Forks, Midway and Point Roberts, all in British Columbia.

Maintenance

An 11-man field party carried out vista reclearance and monument inspection and repair on a section of the New Brunswick-Maine boundary extending south from the Saint John River for 27 miles. Basal bark spray was applied to prevent the regrowth of the trees after cutting.

On the St. Lawrence Seaway a joint party of the Commission re-established sections of the triangulation control net and placed boundary reference monuments along the newly-flooded section between Morrisburg and Long Sault. New triangulation stations and boundary reference monuments were established, replacing some of those lost in the formation of Lake St. Lawrence.

On the British Columbia-Idaho boundary, an 11-man field party inspected monuments and recleared the vista to a skyline width of 20 feet through 20 miles of heavily timbered mountains west of the Kootenay River. And at Boundary Bay, British Columbia, a reinforced concrete bulwark was erected to protect a 60-foot steel boundary range tower on the west shore from wave damage.

In all, 143 monuments were inspected, 19 repaired, 55 painted, and 6 new monuments and 10 triangulation stations were established. A total of 57 miles of boundary and 25 boundary crossings were inspected and 42.6 miles of 20-foot vista through forested areas recleared.

Reports of the Commission

The Commissioners' annual joint report for 1956 was completed and bound and, at year's end, a special report on the maintenance of the boundary from the source of St. Croix River to the Atlantic ocean from 1925 to 1958 was ready for printing.

The Topographical Survey

In 1958 the total map production of the Topographical Survey reached a new peak. A staff of 43 officers established control for the aerial photographic mapping of 71,000 square miles at 1:50,000 (detailed) scale and 98,000 square miles at 1:250,000 (medium) scale. The area covered by preliminary maps made available for distribution increased 10 per cent from that of 1957 to 160,000 square miles; mapping forwarded for reproduction increased 15 per cent to 167,000 square miles. Survey parties worked in Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia and Yukon.

Contributing to the successful year of mapping operations was a good field season coupled with the effective use of modern field and plotting equipment. Thus the tellurometer, after a trial period the previous year, emerged during the season as one of the Survey's most valuable instruments. A new Kelsh plotter and four new pantographs expedited the work of converting aerial photographs to the finished map. (For further details see Appendix IV.)

Field Work

Helicopters continued to be an inestimable boon to officers in the field. Three large parties used this form of transportation on all the medium scale and 30 per cent of the detailed mapping. One established horizontal and vertical control for a band along the Ontario Northland Railway from Cochrane to Moosonee and around the south shore of James Bay. The helicopters were then transferred to a second party which continued surveys for the 1:250,000 mapping of central Quebec and the 1:50,000 mapping of the Belcher Islands, the vicinity of Great Whale River and the headwaters of the Eastmain River. The third party continued 1:250,000 mapping in northern Saskatchewan and Manitoba with special

Helicopters engaged in survey operations atop Victoria Mountain in Yukon Territory, near Snag.

assignments for control of 1:50,000 mapping around The Pas, Flin Flon and Island Lake in Manitoba, Nokomis Lake in Saskatchewan and Cold Lake in Alberta.

Three spirit-levelling parties established vertical control required for imminent mapping. One extended a line from Ile-à-la-Crosse across Saskatchewan, Manitoba and western Ontario, ending at Red Lake. A second completed levelling on the Albany River in Ontario and the third completed levelling on the Yukon River to the Alaska Boundary.

One traverse party worked in Quebec along the railroad and roads west of Chibougamau; and two extended control along the railroads and the Trans-Canada Highway in northern Ontario.

Two traverse parties in the Prairie Provinces continued to correlate work of the Dominion Lands and Geodetic Survey systems. Nine parties in

Alberta, Saskatchewan and Manitoba made further progress toward completing the detailed mapping of the settled area of the prairies—a program of importance to agricultural interests, conservation work and petroleum development.

Five mountain parties worked in British Columbia. Two established horizontal and vertical control for development purposes in the Shuswap Lake region at the request of the provincial government. And three worked west of the Alaska Highway between Fort St. John and Fort Nelson where accurate maps are required for oil exploration leases.

Special surveys were made for large-scale plots of seven Experimental Farms—at Merivale and Kapuskasing in Ontario and at Normandin, Lennoxville, L'Assomption, Lavaltrie and Ste. Clothilde de Chateauguay in Quebec.

Tellurometer Surveys

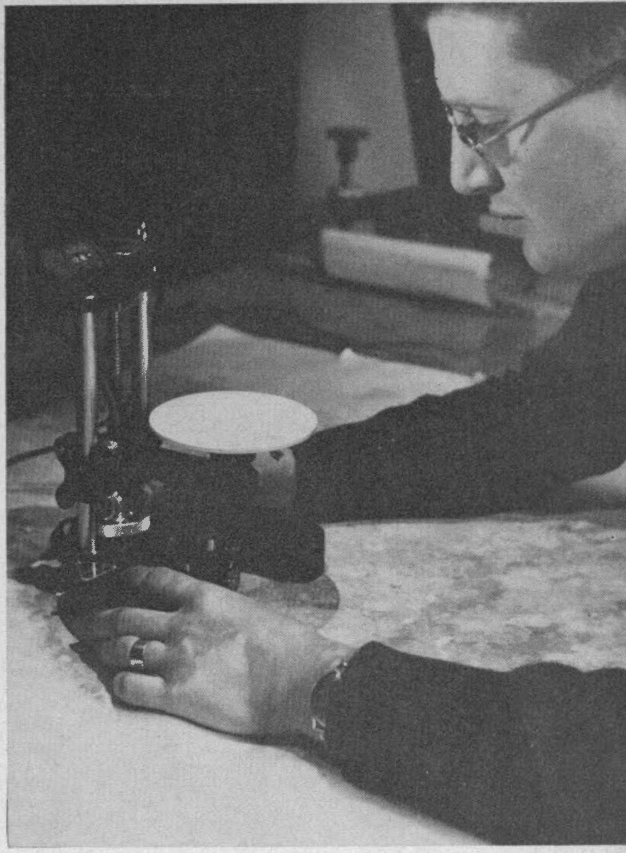
The Survey applied the tellurometer to a great variety of regular and special operations. Of great value in control surveys the instrument was used in the traversing of 3,600 miles in northern Quebec, Ontario, Manitoba and Saskatchewan, replacing slower, more costly triangulation techniques; and in the traversing of 2,750 miles of highway and rail line in Ontario and the Prairies Provinces, a task undertaken in less time and with greater accuracy than would have been possible by chaining. The tellurometer was also used to check triangulation on the St. Lawrence Seaway project and Lake Winnipeg; to establish a base for town planning in the Kitchener, Ontario district; and to extend control for a photogrammetric research test area near Ottawa. During the year the Branch sponsored a short course on tellurometer operation which was attended by about 25 field engineers, mostly from other interested federal and provincial organizations.

Map Compilation

In compilation, the Survey's main effort was directed toward contoured mapping, although some planimetric and large-scale plotting was undertaken for other departments and provincial governments. This was made available for immediate distribution in the form of advance-information prints, over 19,000 of which were supplied on order.

Of 39 special plots, 17 were undertaken for the Experimental Farm Service, and 11 were of the nickel belt area in Ungava. Others concerned potential harbour or other installation sites or were of geological interest.

Whenever possible the Survey expedited the work through the acquisition of additional man power or new equipment. A new Kelsh plotter relieved



A technician uses the Multiplex plotter for tracing detail and topography from a pair of vertical air photographs on to the map manuscript. By means of this equipment it is possible to recapture the position in space from which the photographs were taken. Reduced negatives of the two vertical photographs are used to produce a stereoscopic model which is projected on to a movable tracing table. A luminous floating mark can be set at the elevation of a contour to be traced; the table may be moved until the luminous mark appears in contact with the ground surface, as delineated in the stereoscopic model. The table is then moved to keep the luminous mark in contact with the ground surface, while a pencil traces the contour line on the manuscript. Close-up of the (circular) tracing table shows the stereoscopic model projected on to its surface.

some of the load resulting from use of high-altitude photography. Four pantographs were also acquired, enabling Balplex equipment to plot at reproduction scale with a consequent saving in photomechanical work. And about 25 seasonal employees, mainly students, worked in the office during the summer, helping to maintain production in the vacation period. A number assisted in the preparation of 400,000 square miles of uncontrolled photomosaics.*

National Air Photo Library

The National Air Photo Library which maintains complete records of all air photographs taken in Canada by or for the Federal Government, received 53,000 photos, bringing the total on file to 2,712,000. During the year, it handled orders for nearly 500,000 prints, enlargements and diapositives.

*Mosaics provide an economical aid to reconnaissance and travel over inadequately mapped territory and are in demand by topographical, geological and provincial mapping agencies.

The Canadian Board on Geographical Names

The Canadian Board on Geographical Names, a federal-provincial body responsible to the Minister of Mines and Technical Surveys, held its annual meeting early in the year attended by seven provincial members. It processed about 19,000 names for 118 new maps, 21 new hydrographic charts and 333 map or chart revisions. The *Gazetteer of Alberta* was published and a provisional *Gazetteer of the Northwest Territories and Yukon* prepared.

The Canadian Hydrographic Service

In 1958 the Canadian Hydrographic Service sent out more ships and parties and distributed more standard charts than in any previous year. It also faced its most difficult program of chart production.

During the season 22 parties charted both coastal and inland waterways—from the Grand Banks to Hecate Strait and from the St. Lawrence River to Eureka. Their fleet comprised seven departmental ships, three chartered vessels and five large launches. Three observers were aboard icebreakers of the Canadian Department of Transport and of its American counterpart.

Processing data gleaned in the field continued to impose a growing work load at home. During the year, for instance, the Service issued 35 new charts, 79 new editions, 23 corrected reprints and 17 reprints of standard navigational charts. By the end of the year the number of charts being maintained rose to 727; and for the first time the distribution of standard charts exceeded 100,000—having doubled since 1953. To ensure that all were correct to date of issue, more than 800,000 hand corrections were made. In addition the Service published a new volume of sailing directions covering the Great Slave Lake and Mackenzie River together with six supplements to others already available.

The Service's most difficult chart production task to date concerned the St. Lawrence Seaway, the first stage of which was opened in June. Several hundred engineering drawings, topographical plans and other documents produced by eight different agencies were studied. And from these the Service prepared three new charts and one new edition showing conditions when the power pool was flooded for 14-foot navigation. Furthermore, at year's end an even bigger program was in hand to prepare the completely new series of 13 charts, or new editions, by the time the Seaway opened for full 27-foot navigation in April 1959.

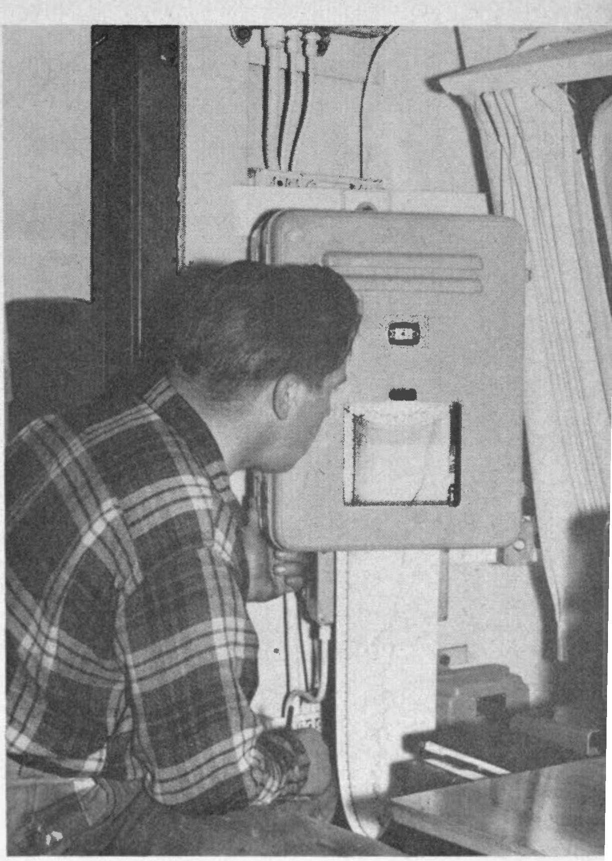
Atlantic Coast

The C.G.S. *Baffin* continued her program of offshore sounding, using two-range Decca control off southeastern Nova Scotia during the early part of the season. Three new charts were completed as a result of this work.

Offshore surveys required for defence purposes were undertaken by the C.G.S. *Kapuskasing,* which completed three different areas—off Halifax, in the Bay of Fundy and off the east coast of Newfoundland. A launch party from the ship revised soundings of the important harbour of Saint John, New Brunswick, and confirmed that extensive shoaling is taking place in its approaches.

Two launch parties were employed in inshore surveys on the coast of Nova Scotia: the C.G.L. *Henry Hudson* worked between New Harbour and the St. Mary's River, while the C.G.L. *Anderson* surveyed Barrington Bay, Clarke's Harbour and their approaches. The latter party also made a tellurometer traverse from Cape Sable Island to Digby Neck to locate control points for future work.

The Service continued its long-term program to replace outdated Admiralty charts, surveys for which were made more than a century ago.



A seaman survey assistant aboard the C.G.S. *Baffin* stands by to press the electrical fix-marker on the echo sounder. This is done at the exact moment that the ship's position is recorded by either trigonometric or electronic methods. Previous fix-marks can be seen on the echo-sounding graph in the form of arcs at regular intervals. A cross-section of the seabed can also be seen on the graph.

Thus the C.G.L. *Dawson* completed her soundings of Placentia Bay, Newfoundland, and then moved to Hermitage Bay. And the C.G.S. *Acadia* continued working the east coast of Newfoundland in the Cape Freels area and revised the survey of Clarenville.

In other Atlantic surveys the C.G.L. *Merganser* continued the systematic inshore soundings of the north shore of Prince Edward Island, working between Malpeque and Cascumpeque bays. The C.G.S. *Cartier* spent one month on the survey of Chaleur Bay, completing the Caraquet area. When conditions permitted, she moved north to the Labrador coast where a traverse was run from the entrance of Hamilton Inlet to Hopedale. This project will provide adequate control for future work.

Much of the work was of direct economic interest. The Service, for instance, undertook a survey of Makkovik Bay, where a new mine was being developed, and of two narrow channels in Goose Bay to provide a basis for planned dredging.

Hudson Bay and Strait

The Service employed two chartered ships in the area of Hudson Bay and Strait. After a survey of Quirpon Harbour in Newfoundland, the M.V. *Algerine* sailed for Ungava Bay, where detailed hydrographic and current surveys were made in both Payne Bay and Hopes Advance Bay, the sites of the projected ports for shipping iron ore.

Similarly, the M.V. *Arctic Sealer* completed the survey of Hopedale on the Labrador coast before proceeding to Great Whale River on Hudson Bay. Here a reconnaissance survey was made of Manitounuk Sound, the site of another possible iron-ore development. After transporting a party for the Topographical Survey to the Belcher Islands, the ship worked on a detailed survey of the entrance of Omoralluk Sound, the most likely site for a new port should the Belcher iron-ore deposits be developed. She then sailed for the west coast of Hudson Bay, at the request of the Department of Northern Affairs and National Resources, and moved 40 starving Eskimos northward to the settlement at Rankin. During the last few weeks of the season the party completed the survey of the approaches to the property of North Rankin Nickel Mines Limited.

The Arctic

The Canadian Hydrographic Service began the first phase of its long-term program for charting Canada's northern waters.

The C.G.S. *Baffin,* the newest ship of the Service, spent three months working on the coast of Baffin Island completing a large area of two-range

Decca-controlled soundings in the northeastern approaches to Frobisher Bay. Meanwhile, a shore-based party surveyed the Pike-Resor channel, the most hazardous portion of the approach to the head of the bay, which is fast developing into an important port.

One hydrographer was aboard each of the Department of Transport icebreakers *C.D. Howe* and *d'Iberville,* obtaining information to be added to the Service's provisional Arctic charts. Two hydrographers were also assigned to the USCGS *Storis,* the icebreaker supporting western Arctic supply operations.

Inland Waters

The Service's work in inland waters ranged from the St. Lawrence and the Great Lakes to Lake Winnipeg and the Mackenzie River.

A launch party worked throughout the summer in the St. Lawrence Seaway area, establishing control, sounding in Lake St. Francis and obtaining information required for the production of new Seaway charts. And the C.G.L. *Boulton* continued the resurvey of the North Channel of Lake Huron between Gore Bay and Mudge Bay.

On Lake Winnipeg the C.G.L. *Sandpiper* continued a detailed survey of the central portion of the lake, charts of which will replace those based on exploratory surveys of 50 years ago.

The C.G.L. *Rae* made a detailed survey of the Sans Sault Rapids, the most dangerous section of the Mackenzie River—a waterway carrying an increasing amount of traffic in the development of the western Arctic.

Pacific Coast

On the Pacific coast, the C.G.S. *Wm. J. Stewart* continued the two-range Decca sounding of Hecate Strait. Also carried out were various small surveys to facilitate future work. In completing the survey of Knight Inlet, the C.G.S. *Marabell* brought to a close a phase of the charting of British Columbia, including all the channels opening north of Discovery Passage and Johnstone Strait. During the remainder of the season, the ship worked on the east coast of the Queen Charlotte Islands between Juan Perez Sound and Skincuttle Inlet. Also obtained were data for charts and sailing directions along the Pacific coast of Vancouver Island.

Playing an important part in the demolition of Ripple Rock, the most dangerous hazard to navigation on the Pacific Coast, was the C.G.S. *Parry*. Wave recorders were operated at selected points round the blast, a survey was made to determine the success of the explosion and a tidal-current survey was carried out to determine the changes in Seymour Narrows and Discovery Passage.

The Service began a long-term study of tidal currents in the Gulf Islands with a survey of Ganges Harbour. This was undertaken by hydrographers assigned to the USCGS *Storis* before their departure to and after their return from the Arctic.

Tidal and Inland Water Levels

During the year the Service undertook a tidal and current survey of Northumberland Strait on extremely short notice for the Department of Public Works who were determining the feasibility of building a causeway to link Prince Edward Island and the mainland. This involved chartering M.V. *Theta* to make current observations at 70 points in the strait and operating tide gauges at 25 sites along the coast. It was one of the most detailed tidal surveys on record.

The current and oceanographical survey of Passamaquoddy Bay, made in conjunction with the Atlantic Oceanographical Group, was completed by the end of the season. It will provide information on the probable effects on the fishing industry of the proposed joint Canadian-United States tidal-power project.

A total of 107 gauging stations were maintained in Canadian waters. Two, at Resolute and Brevoort Island in the Arctic, were part of Canada's contribution to the program of the International Geophysical Year.

It was the Service's most active season for inland water level work. Changes in the St. Lawrence River by the Seaway project necessitated major alterations in the siting of gauging stations; for, during the actual flooding of the power pool, hydrographers worked round the clock to maintain an unbroken record of the water levels while removing old gauges whose locations were inundated.

Conforming with a recent international agreement the new tide tables, published at the end of the year, were completely revised. A radically new method of listing the information has made the use of the tables more precise and a great deal more simple.

Legal Surveys and Aeronautical Charts

In 1958 the Branch faced a heavy demand for legal surveys and aeronautical charts and, again, some of the work was assigned to private surveyors. Factors contributing to the growing work load were the development of the

Yukon and Northwest Territories and special projects (such as the laying of natural gas pipe lines and construction of the Trans-Canada Highway) which involved either federally-controlled lands or Indian reserves.

Provincial and Territorial Boundary Surveys

The Branch worked with provincial agencies in the demarcation of certain boundaries. Thus the British Columbia-Yukon boundary was surveyed and monumented for a distance of about 22 miles westward from the Tatshenshini

Helicopters have become almost indispensable to the operations of the Surveys and Mapping Branch. Here a theodolite is loaded aboard one of a half dozen machines used in 1958.

River to the Alsek River. There, however, it enters extremely rugged glaciated terrain and at present it is not practical to extend it farther. Final map-sheets, showing boundary dimensions and position were under preparation.

The Branch completed the survey and monumentation of the 277-mile Saskatchewan-Northwest Territories boundary in the winter of 1957-58 and carried out a technical inspection the following summer. Being prepared at year's end was a series of 16 final map-sheets and the final report or submission to the respective governments.

Arrangements were also under way for the survey of the Manitoba-Northwest Territories boundary. A field party was prepared to spend the winter tracing the boundary eastward from Manitoba's northwest corner. In addition the Branch discussed with the provinces concerned the possibility of surveying the northerly 250 miles of the Manitoba-Saskatchewan boundary.

Legal Surveys

At the request of the Department of Citizenship and Immigration, the Branch conducted miscellaneous legal surveys on 34 Indian reserves in the provinces of Nova Scotia, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia. In addition, lands for the use of Indians were surveyed near Amos, Knob Lake and La Tuque in Quebec, High Prairie in Alberta, and Dawson City in Yukon Territory.

At the request of the Department of Northern Affairs and National Resources, extensive surveys were carried out in Yukon and Northwest Territories and in national parks. Also surveyed in Yukon were a large residential subdivision at MacRae, a commercial and residential subdivision along the Alaska Highway near Watson Lake; miscellaneous lots, parcels, and rights-of-way at Whitehorse, Carmacks, Haines Junction, Mayo, Elsa, Stewart Crossing, Dawson City and Ross River.

In the Northwest Territories, the Branch subdivided townsites at Cambridge Bay, Fort Smith and Snowdrift; and surveyed, for the Department of Transport, an addition to the Yellowknife airport and rights-of-way for an approach lighting system at that of Fort Smith. Two lots were surveyed for the Canadian Hydrographic Service at Yellowknife and one lot for the RCMP at Cambridge Bay.

In Newfoundland, the Branch surveyed the landward boundaries of the new Terra Nova national park and undertook miscellaneous surveys in Prince Edward Island, Cape Breton Highlands, Georgian Bay Islands, Banff, Jasper, Wood Buffalo and Yoho national parks.

During the year technical instructions were issued to private surveyors for 92 legal surveys in federal lands.

Aeronautical Charts

Profiles, obtained by the use of airborne electronic equipment, are used to plot land heights on aeronautical charts. In 1958 more than 16,800 line miles of ground profile recordings were obtained from radar altimeter surveys made under private contract: 12,200 miles in the District of Keewatin, Northwest Territories, and 4,600 miles in northern Quebec.

The *Canada Air Pilot,* produced as a service to and under the authority of the Department of Transport, was kept up to date by amendments issued every two weeks for each volume. This included the production of 23 new sheets and the revision of 866.

Survey Records and Electoral Maps

The transfer of the survey records relating to lands transferred under the British North America Act, 1930 (transfer of resources) is now complete. In all, 3,259 field books and 33,441 plans have been transferred to the western provinces.

The flow of information from the survey records to government departments and outside agencies continued at a steady pace. A total of 275 plans were recorded, and approximately 18,000 prints and field notes despatched.

Board of Examiners for Dominion Land Surveyors

The Board held three meetings, chiefly concerning the annual qualifying examinations provided for by Section 10 of the Canada Lands Surveys Act. Examinations were held at Sackville, Ottawa, Edmonton, Calgary and Victoria. Eighty-one candidates were examined, of whom 20 were successful in the combined categories.

Map Compilation and Reproduction

In 1958 the Branch's program in map compilation and reproduction reached a new level of intensity, dominated by the *Atlas of Canada.* Involving considerable extra effort in drafting, photomechanics, and lithography, the *Atlas* and its 110 map sheets were an outstanding achievement in cartography and graphic arts. Work on the French edition began at mid-year.

The Branch also faced an increased demand for maps and charts in 1958. The total number printed: 1,560, an increase of 8 per cent over that of the previous year. However, the number of topographic maps produced and printed declined from 204 in 1957 to 155 because of press time taken up by the *Atlas.* And though the Branch operated at its production peak, the work load exceeded the capacity of both men and equipment. Remaining at year's end was a backlog involving about two and a half years' work.

Nevertheless new techniques that might increase production were constantly under study. Thus, a cartographic development unit for research in graphic arts was set up during the year.

Map Compilation

In office compilation the Branch gave major attention to maps at the scale of 1:250,000; 1:506,880 and of the miscellaneous variety. Routine work in this category lagged somewhat in 1958 when much of the manpower was redirected to tasks associated with the *Atlas of Canada.*

Map Drafting

Work in map drafting continued at approximately the 1957 production level. Again, the *Atlas* accounted for a major share of the effort, requiring exactly 2,906 hours of overtime. Drafting on the English edition was completed in time to meet the fall deadline and, by the end of the year, that of the French was well in hand.

Because of the pressure of miscellaneous work, the drafting of 1:250,000-scale maps was slow—limited to about one a month.

Editing

The Branch faced a considerable work load in map editing — checking manuscripts, proofs and printed copies. The preparation of nomenclature lists for all maps and charts issued by the Department was another major operation, though this work was hampered during the year by a shortage of staff.

Photomechanics

Modern map reproduction has become more and more dependent upon photomechanical methods, a trend that has greatly increased the Branch's work in this category. Particularly demanding was the *Atlas of Canada,* colours for which called for five or six overprintings on a single plate.

Faced with a growing backlog the Branch continued to seek new and more efficient photomechanical techniques. Thus, the use of photomechanical stripping, developed the previous year, has now become a standard procedure.

Lithographic Printing

The Branch gave major emphasis to printing the *Atlas,* a project that called for up to four presses most of the year. As a result the production of other maps was delayed, particularly those in the 1:50,000-scale category where, at the end of the year, over 200 awaited printing.

Map Distribution

In 1958 the number of map copies distributed increased 23,542 over that of the previous year. The total stored at year's end reached 8,590,000 copies, a gain of 23 per cent. Both the distribution centre and the storage area were considerably enlarged during the year.

The Branch received over 34,007 requests for maps and publications, sales of which amounted to $96,645.27.

geological survey of Canada

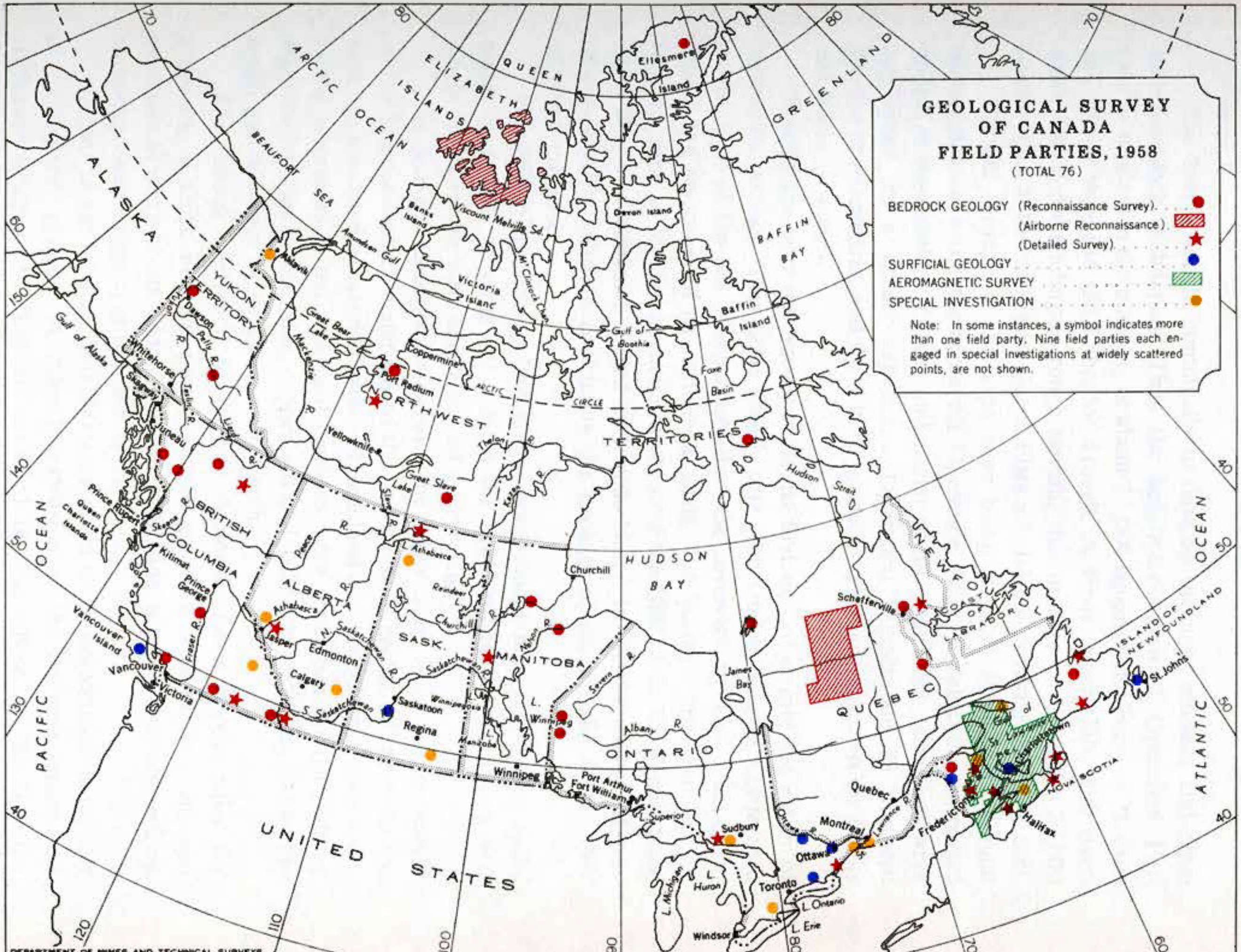
IN 1958 most of the resources of the Geological Survey of Canada were used in mapping and studying the geology of the country; and for laboratory and office research to interpret the field data and issue it as soon as possible in the form of comprehensive maps and reports.

Equally important were the development of new instruments and techniques to expedite the work both in the field and in the laboratory, and fundamental research projects to further the science of geology.

The Survey's major effort was directed at completing the initial reconnaissance mapping of Canada with detailed mapping to follow. Thus more than a third of the field staff and half of the field appropriations in 1958 were devoted to reconnaissance work in virgin territory; the remainder for detailed or special investigations of critical geological problems, many of which were of direct benefit to mineral exploration.

Field work was completed, or nearly so, for 40 of the season's 76 projects—a matter involving some 77,000 square miles. An additional 35,000 square miles were covered in reconnaissance projects still under way as well as a considerable area in geophysical surveys, geochemical surveys and special projects not confined to regular map-areas.

Twenty-five of the 76 field parties were engaged in 4-mile-to-the-inch or less-detailed mapping of bedrock and surficial deposits; 22 in 1-mile mapping and 29 in other projects, including airborne geophysical surveys, geochemical


GEOLOGICAL SURVEY
OF CANADA
FIELD PARTIES, 1958
(TOTAL 76)
BEDROCK GEOLOGY (Reconnaissance Survey)
(Airborne Reconnaissance)
(Detailed Survey)
SURFICIAL GEOLOGY
AEROMAGNETIC SURVEY
SPECIAL INVESTIGATION
Note: In some instances, a symbol indicates more than one field party. Nine field parties each engaged in special investigations at widely scattered points, are not shown.
ARCTIC OCEAN
BEAUFORT SEA
QUEEN ELIZABETH ISLANDS
GREENLAND
Ellesmere Island
Devon Island
BAFFIN BAY
Banks Island
Viscount Melville Sd.
Amundsen Gulf
Victoria Island
Baffin Island
Gulf of Boothia
Foxe Basin
ALASKA
YUKON TERRITORY
Aklavik
Dawson
Whitehorse
Skagway
Juneau
Gulf of Alaska
Great Bear Lake
Coppermine
Port Radium
NORTHWEST TERRITORIES
ARCTIC CIRCLE
Yellowknife
Great Slave Lake
Hudson Strait
Prince Rupert
Queen Charlotte Islands
Kitimat
BRITISH COLUMBIA
Prince George
Vancouver Island
Vancouver
Victoria
ALBERTA
Athabasca
Jasper
Edmonton
Calgary
L. Athabasca
SASK.
Saskatoon
Regina
MANITOBA
Winnipeg
Churchill
HUDSON BAY
James Bay
Schefferville
NEWFOUNDLAND
COAST OF LABRADOR
QUEBEC
ONTARIO
Port Arthur
Fort William
L. Superior
Sudbury
L. Huron
L. Michigan
Toronto
L. Ontario
L. Erie
Windsor
Ottawa
Montreal
Quebec
Fredericton
Halifax
Charlottetown
NOVA SCOTIA
ISLAND OF NEWFOUNDLAND
St. John's
Gulf of St. Lawrence
PACIFIC OCEAN
ATLANTIC OCEAN
UNITED STATES
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

surveys, mineral-deposit and mineralogical studies; stratigraphic palaeontology studies, water-supply surveys, palaeomagnetic studies and detailed mapping. (The distribution of parties by region and function is given in Appendix V.)

The Survey sought continually to develop the most efficient and rapid reconnaissance techniques. Thus the helicopter-supported Operation Fort George resulted in the mapping of about 35,000 square miles between Hudson and James bays and the Labrador Trough. A Piper Super Cub, with oversized wheels for landing in rough terrain, was used to cover about 20,000 square miles of the northwest Queen Elizabeth Islands at remarkably low cost.

Further projects of this type were being planned. Preliminary ground reconnaissance was undertaken for Operation Pelly, a helicopter-supported project in southeastern Yukon; and caches of fuel and other necessities were established for a similar expedition, Operation Coppermine, in northern District of Mackenzie, and for a third aircraft-supported operation on Banks and Victoria islands.

During the year the Survey made its first excursion into the realm of submarine geology. This came shortly after the United Nations Conference on the Law of the Sea which established the sovereign right of a nation to exploit the resources of its continental shelf. The Survey's first shelf project took the form of an aeromagnetic survey over the Gulf of St. Lawrence, from Nova Scotia to Anticosti Island and from Gaspé to Newfoundland. It was of considerable value in correlating the geology of the mainland with that of Newfoundland.

In addition the Survey had under development new geophysical techniques and tools of value not only in the field, but in the laboratory and offices where results were compiled and interpreted.

The Survey's geochemical work—the analysis of soils, stream waters and sediments—added materially to the usefulness of geological maps. In the field, the geochemical reconnaissance of mainland Nova Scotia was completed. In the laboratory, rapid analytical methods were developed for determining minute quantities of lead, zinc, copper and molybdenum, greatly increasing the speed and accuracy of geochemical research.

The Survey continued to provide doctorate thesis opportunities for promising recruits. For this purpose seven graduate students were engaged as seasonal party chiefs and nine other promising geology students seeking experience were engaged at the same level.

Grants in aid totalling $50,000 were made to 10 universities in support of 25 research projects. A valuable extension of the research undertaken at Survey laboratories, they are awarded on the advice of the National

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Advisory Committee on Research in Geological Sciences, from funds provided by Parliament. Three geologists with post-doctorate fellowships from the National Research Council worked in the Survey's laboratories and were assisted by its officers.

The pace of Canada's mineral and industrial development in 1958 has underlined the need for intensifying the work of the Geological Survey. By the end of the year geological maps—mainly on a reconnaissance scale—had been published for only 36 per cent of Canada* and the task ahead was formidable.

Field Work

Highlights of the Survey's 1958 field program are given below. A more detailed account of the field work may be found in *Information Circular No. 2,* December 1958.

Northwest Territories

Three parties operated in the District of Franklin. One completed the mapping of Melville, Brock, Borden, Mackenzie King, and Prince Patrick islands obtaining precise stratigraphic data that will aid in assessing the oil and gas potentialities of the District. Operating with the full-time support of a Piper Super Cub mentioned previously, the party acquired sufficient detailed information for publication of a map on a scale of 1 inch to 8 miles.

Another party, attached to Defence Research Board's Operation Hazen, continued geological reconnaissances in the Hazen Lake area, northern Ellesmere Island. They reported strata trending northeasterly and ranging in age from Early Palaeozoic to Tertiary. Apart from coal occurrences noted in the 1957 annual report, a bed of Tertiary coal at least 20 feet thick was found exposed along a creek canyon near Fort Conger.

The third party mapped an area near Cape Dorset on the southern coast of Baffin Island for publication on a scale of 1 inch to 1 mile (36 C SE¼ and the west half of 36 B SW¼). †The area was found to be underlain by Grenville-type rocks, mainly gneisses.

In District of Mackenzie, one party completed the mapping of the Fort Enterprise area (86 A) for publication on a scale of 1 inch to 4 miles. This work disclosed mainly massive and gneissic granitic rocks. In addition, preparations were made for Operation Coppermine involving the establishment of caches and an aerial reconnaissance of part of the area.

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* Actually, field work had been completed for an additional 5 per cent or more, maps for which were still to be issued.

† The numbers and letters identify the map-areas according to the National Topographic System, revised 1957.

Piper Super Cub used by the Geological Survey of Canada to make landings on rough ground in the Arctic. Specially fitted over-size balloon tires enable the craft to land and take off from rough pebbly surfaces such as shown.

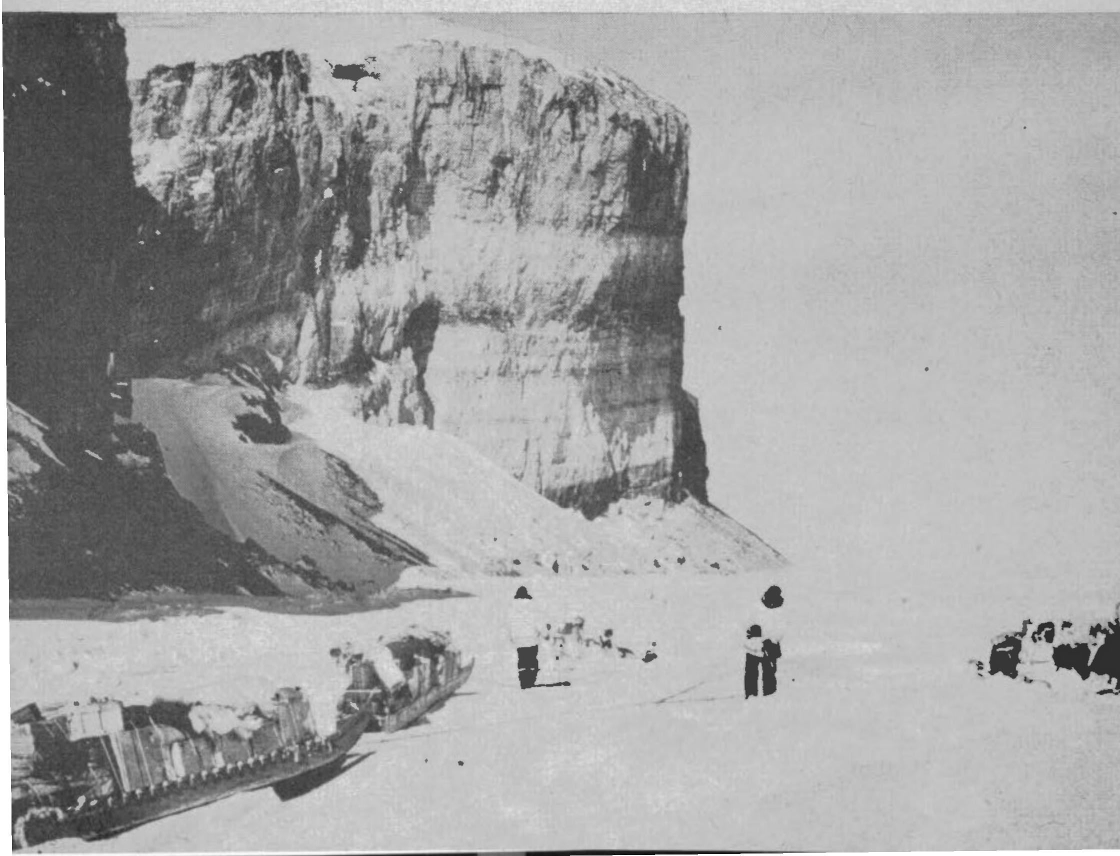
Two parties completed mapping of the west half of Mesa Lake (86 B/14 W½) and Rodrique (86 B/13 E½) areas for publication on a scale of 1 inch to 1 mile, to provide further information on the relations between the Yellowknife and Snare groups of rocks. Results indicate that the metamorphosed Yellowknife rocks in the east and the metamorphosed Snare rocks in the west are of the same age and differ only in facies.

Another party completed mapping of most of the outstanding Precambrian map-areas of southeastern District of Mackenzie (75 A, the southeast half of 75 F, 75 G, and 75 H W½) for publication on a scale of 1 inch to 4 miles. The area is underlain almost entirely by granitic rocks, mainly gneissic, and paragneisses. The latter include highly metamorphosed magnetite iron-formations, but no important concentrations of magnetite were noted. Gossans derived from pyrite are common in the paragneisses. Sedimentary rocks of the Nonacho group underlie minor areas.

Survey geologists continued to study the stratigraphy and palaeontology of Cretaceous and Uppermost Jurassic strata southwest of the Mackenzie River delta in District of Mackenzie and Yukon. While this project was launched in 1955, no further field work was done on it until 1958. Most of the season was spent on the east flank of the Richardson Mountains between the latitudes of Aklavik and Fort MacPherson, and a detailed study was made of an essentially complete succession of more than 5,000 feet of marine Lower Cretaceous and Uppermost Jurassic strata. Coal seams occurring in the lower part of the section are correlated with those mined at Moose Channel northwest of Aklavik. This succession is overlain unconformably by more than 550 feet of Upper Cretaceous marine rocks. On the Porcupine River, between the mouths of the Bell and Driftwood rivers, strata previously mapped as Cretaceous were found to comprise about 900 feet of marine Permian rocks unconformably overlain by more than 2,500 feet of Jurassic strata, mostly marine. This in turn is overlain unconformably by a thick conglomerate presumably of late Jurassic or early Cretaceous age. Near the junction of the Porcupine and East Porcupine rivers, late Lower Cretaceous fossils were found in the middle of several thousand feet of unfossiliferous sandstone and shale.

In District of Keewatin, a party commenced the geological study and mapping of Belcher Island (33 M, 34 D), where deposits of iron and copper have been reported.

The work of the Geological Survey of Canada has taken its staff to Canada's northern reaches. Here a party rounds the front of Svartevaeg (Black Wall) at the north end of Axel Heiberg Island in the high Canadian Arctic.



The Yellowknife office provided information and advice to geologists, mining men, prospectors, and government officials travelling or working in the region. Most of it was technical but often the information was more general and concerned matters such as mining costs, transportation facilities, equipment, hiring of men, and how to live and work in the area.

Data were collected and assembled for revision of a publication, *Mineral Industry of the Mainland of the Northwest Territories;* and the head offices of the Survey and the Department of Northern Affairs and National Resources were kept posted on prospecting and mining activities. Assistance was given in conducting the prospectors' courses sponsored by the Canadian Institute of Mining and Metallurgy.

Yukon

In west-central Yukon, a preliminary reconnaissance of map-areas 116 A, B, C E½, F E½, G and H was commenced. While data obtained were not sufficient to warrant publication it will aid greatly in defining the area to be covered by the helicopter project, Operation Ogilvie, now in the planning stage. Similarly, in southeastern Yukon, preliminary reconnaissance of map-areas 105 F, G, J, K, and part of B was begun by two parties supported by a light aircraft. This enabled key geological data to be obtained in a relatively inexpensive manner and, while it does not warrant publication, the information was of great value in planning Operation Pelly mentioned previously. Field caches were also laid down.

The Whitehorse office provided assistance and information to those working in the mineral industry in Yukon and northern British Columbia. It also reported to the Survey and other departments on mining and prospecting developments in the area. In 1958 there were 1,227 visitors registered at the office. A total of 2,913 copies of publications was distributed.

British Columbia

In northern British Columbia, one party completed the field work required to solve critical geological problems outstanding from Operation Stikine (1956) and to fill in gaps within the Bowser Lake (104 A), Spatsizi (104 H), and Dease Lake (104 J) areas. Of particular interest was the study of the stratigraphy and structure of the largest single sedimentary basin, uncomplicated by igneous activity, in the western Cordillera. Underlain by marine and continental clastic sedimentary rocks of Upper Triassic and Lower Cretaceous age and surrounded by varied rocks of the early Mesozoic and late Palaeozoic, it was found to have structures that were particularly favorable for oil and gas. Also noted was asbestos—in an ultramafic body in the Dease Lake (104 J) map-area.

Other parties completed field work (also outstanding from Operation Stikine) in the Iskut River (104 B) map-area and undertook a geological reconnaissance of the Sumdum (104 F) and the southern half of the Tulsequah (104 K) map-areas. Work was sufficiently advanced to warrant publication of a preliminary map of the Sumdum area, on the eastern boundary of which is a molybdenite occurrence.

The Survey continued stratigraphic studies and preliminary geological reconnaissance of the Kechika (94 L) and Rabbitt River (94 M) map-areas in preparation for future helicopter-assisted mapping. In the former, a fluorite-bearing greenstone body was noted.

In central British Columbia the geological study and mapping of the Quesnel (93 B) map-area was completed except for that part lying northeast of the Quesnel River. Several previously unrecorded occurrences of diatomite were found near Buck Ridge.

Two parties continued 4-mile mapping in southern British Columbia. One worked on a revision of previous mapping within the Kettle River west half (82 E W½) map-area. The purpose: to divide the "Shuswap complex" and the intrusive rocks in accordance with the current concepts developed by more recent mapping in adjoining areas. In addition it was found that the stratigraphy of the Tertiary volcanic and sedimentary rocks required substantial revision. The second party began the mapping of the Squamish (92 G W½) area. Despite the fact that the work was seriously hampered by circumstances beyond the party's control, including a forest-fire hazard, much of the shoreline mapping was completed and substantial progress made inland from Britannia Beach.

Survey geologists completed the study and mapping of surficial deposits of the east coast lowlands of Vancouver Island between Cumberland and Campbell River and of the lowlands and islands of the Strait of Georgia between Sooke on Vancouver Island and Howe Sound on the mainland. Obtained were basic data necessary for the full evaluation of engineering, ground-water, and soil-development studies.

Detailed studies were continued of Nelson and Valhalla granitic intrusions in parts of the Burton (82 F/13) and Passmore (82 F/12) map-areas. Part of an over-all study of the types, genesis and related features of granitic rocks, this year's work demonstrated unusual field relations in a dome of granites, quartzites, gneisses and migmatites. Further studies both in the field and in the laboratory are required.

One-mile mapping was commenced and completed within the Tetsa River (94 K/9) map-area. The area was found to be underlain by Palaeozoic, Triassic and Cretaceous strata all folded along northwesterly-trending axes. Sedimentary studies indicate that the Triassic strata were deposited from easterly flowing waters.

In addition to the work in British Columbia, several parties carried out stratigraphic and palaeontological investigations partly in British Columbia and partly in Alberta. The geological study and mapping on a 4-mile scale of the Fernie east half (82 G E½) map-area were begun with interesting results: the area contains an exceptionally comprehensive stratigraphic section ranging in age from Precambrian to Oligocene and many minor intrusions of late Mesozoic or younger age. Several windows of Upper Cretaceous rocks were mapped within the Precambrian strata of the Lewis thrust sheet, one of which suggests that the minimum horizontal displacement of the Lewis overthrust is 25 miles. A northeasterly-trending normal fault along the east side of the Flathead River valley marks a stratigraphic throw of about 23,000 feet, with the northeast side moving up relative to the southwest. Stratigraphic studies were completed of the Upper Cretaceous Smoky group and the Lower Cretaceous Fort St. John and Bullhead groups, in the Foothills of Alberta and British Columbia between the Smoky River and the Redwillow River, work that will be continued northerly towards the Peace River. Studies of Jurassic fauna and stratigraphy in the Bridge River district, Nelson area, and in the central Foothills of Alberta suggest that some reinterpretation is necessary for previously mapped areas.

The Vancouver office gave information and assistance to industrialists and others interested in metallic and industrial minerals, engineering geology, ground-water supplies, and construction materials. A number of short-term field projects were carried out by the staff geologists, mainly at the request of other government departments among which were engineering-geology reports on dam and power sites along the Columbia River. Activity at the office continued to increase: there were more than 8,039 visitors, and 17,705 copies of publications of various kinds were distributed.

Alberta

Field work was begun and completed within the Carbondale River (82 G/8 W½) map-area of Alberta. Field data suggest that the complex structures exposed along the Carbondale River are not due to a tear fault but to a gentle folding of a major westerly-dipping thrust fault. Mapping indicates also that the local easterly trend of the Lewis thrust fault is the result of erosion of a gently warped Lewis thrust plate rather than of local overriding towards the north. Thus the southerly-trending structural features of the Savanna Creek gas field may extend beneath the Lewis thrust plate in the Carbondale River map-area; and structures of the Waterton Park-Castle River gas field may likewise extend southerly beneath the thrust plate in the Beaver Mines map-area.

Other projects in Alberta included the geological study and mapping of the Miette (83 F/4) map-area which was completed with a map and report in preparation; and the examination of the Athabasca glacier between Banff and Jasper to determine whether it would permit the crossing of snow-mobiles.

The Survey continued its comprehensive study of the rocks of the Athabasca series exposed between Athabasca, Wollaston, and Cree lakes. Sedimentary features indicate that the flow direction of the waters from which the sediments were deposited was to the west and northwest, converging towards the northwest and attaining their maximum constriction in Lake Athabasca between Uranium City and Fort Chipewyan.

The oil and gas industry made increased use of the Survey's *Western Petroleum and Natural Gas office* at Calgary. There were 1,907 visitors and, though additional laboratory space was made available to those wishing to study samples, the waiting list continued to mount. In the first seven months of the year $2,283.51 worth of publications were sold.

Meanwhile the technical staff continued its research on subsurface problems, correlating this with the examination of outcrops of exposed sections. A punch-card file of wildcat wells was well under way.

Saskatchewan

Detailed geological mapping was concluded in the Milliken Lake (74 N/7) map-area on Crackingstone peninsula, Lake Athabasca. Mapping, for publication on a scale of 1 inch to 800 feet, was necessary to provide sufficient information on problems concerning the nature and origin of the ore deposits and their host rocks, for the effective guidance of exploration programs and producing mines.

One party began a reconnaissance ground-water survey of the Souris River watershed, about 12,000 square miles comprising much of Saskatchewan south and east of Regina. The survey was completed within the Weyburn (62 E) map-area, where the height of the water table, as measured in bedrock wells, was found to be about the same as it was in 1935, the year of the Survey's last well inventory there. Another party initiated the geological study and mapping of the surfical deposits of the Elbow (72 O/2), Hawarden (72 O/7) and Outlook (72 O/6) map-areas, which include the South Saskatchewan River dam and power site. This work is being done for publication on a scale of 1 inch to 1 mile, with special attention to the engineering requirements of the proposed dam and related construction, and to problems arising from the subsequent flooding.

Manitoba

Geological mapping of the Kettle Rapids (54 D) area was begun and completed. While bedrock exposures are sparse, indications are that the Palaeozoic strata probably do not extend quite so far west as shown on the geological map of Manitoba (850A). The western two-thirds of the area are underlain mainly by gneiss and granite, with minor northwesterly-trending belts of metamorphosed sedimentary rocks along Moose Lake, on the Nelson River at Turtle Island, along the Aiken River and in the extreme southwest corner of the area.

The Survey continued its reconnaissance of potential prospecting fields in northern Manitoba by mapping the northern Indian Lake (64 H) map-area. About 80 per cent of the area is devoid of outcrops, and the best exposures are mainly in the centre of the west half of the area. Except for a body of schist, gneiss, and amphibolite on the south side of Partridge Breast Lake, the rocks are mainly varieties of granites and gneisses.

Also in Manitoba, the Survey initiated detailed mapping on a scale of 1 inch to 500 feet of part of 63 K/16, including the Chisel Lake base-metal deposits of Hudson Bay Mining and Smelting Co. Limited.

Ontario

In Ontario, two parties began and completed geological field work within the Deer Lake east half (53 D E½) and Carroll Lake east half (53 M E½) map-areas. These are underlain almost entirely by gneissic and granitic rocks, except for a small area in the extreme southeast corner of the Carroll Lake area which is underlain by volcanic and sedimentary strata previously mapped.

The Survey continued its careful restudy of the region lying west of the Blind River uranium district, covered many years ago only on a reconnaissance scale. Mapping on a scale of 1 inch to 1 mile was again undertaken in the Echo Lake area (41 J/12) north of Lake Huron and the work so far has resulted in a rearrangement of the stratigraphic succession. All rocks previously mapped as Mississagi, except a minor band on the southwest side of McMahon Lake, have been reassigned, mainly to the Gowganda and Lorrain formations. Furthermore, a band of basaltic and andesitic lavas, trending northwesterly and lying between Aberdeen and McMahon lakes, was shown to be a part of the Bruce series. Also mapped were a number of major post-Cobalt faults.

Because the Blind River uranium ores are among the most extensive and most important in the world, the Survey is conducting a subsurface study of their origin, distribution and thorium content. In 1958 the field phase of this complex project was completed, though much laboratory research remains.

Also completed was the revised geological mapping of the Westport area (31 C/9), the results of which, together with mapping done many years ago, are expected to provide a map on a scale of 1 inch to 1 mile. And a good deal should be revealed on the influence of structure on the localization and development of granitic rocks.

Hammer-percussion seismic (refraction) equipment was used on an experimental basis to determine depths to bedrock in southern Ontario—information that would be of great value in the exploration for oil and gas, and in the search for ground water. The object: to determine the capabilities and limitations of the equipment. At year's end the results had still to be completely evaluated. But it appears that, while the depth of overburden can be measured within 10 per cent accuracy up to 75 feet, greater depths are beyond the capacity of the equipment. In actual practice, depth determinations in the order of 200 feet are sometimes required.

The Survey contributed to studies of the Lake Ontario basin sponsored by the Great Lakes Geophysical Group. The project, begun during the year, was a geological study and mapping of surficial deposits of Trenton (31 C/4) and Presqu'ile (30 N/4) map-areas.

A map of about 25 square miles in the vicinity of the Chalk River plant of Atomic Energy of Canada, Limited, was completed—part of an investigation related to the safe, economical disposal of radioactive waste materials. Both a map and a report are being prepared for submission to Atomic Energy of Canada, Limited. At the same time work continued on compilation of data concerning the thickness of drift within the city of Ottawa—part of the projected study of the surficial deposits of the Ottawa (31 G/5) map-area.

Quebec

The study of the Ordovician and Silurian stratigraphy and palaeontology of Anticosti Island, begun in 1957, was completed with an examination of formations in the western 60 miles of the island. Two stratigraphic sections, each of which crosses the Ordovician-Silurian contact, were measured and studied in detail. One extends from the mouth of the Oil River to the Jupiter River, and the other from Martin Bay to the mouth of the Ste. Marie River. This will provide information on the island's oil and gas potential and its post-glacial history. In fact, studies of surficial deposits show that the island, instead of sinking completely as other geologists believed, was submerged to a depth of only 250 feet.

The Survey's ground-water studies along the St. Lawrence Seaway route may be of considerable importance to the coming heavy industrialization of the area. In 1958 the survey of the Lachine (31/5) map-area was continued, and the part south of the river and west of Caughnawaga Road was completed. Much of the area is underlain by Potsdam sandstone, an excellent aquifer for wells between 100 and 200 feet deep, capable of yielding 400 to 500 gallons a minute of good quality water.

In addition, two belts of drift 60 to 110 feet thick—also potential sources of ground water—were outlined. One is near Ste. Philomène Station and the other extends from the extreme southwest corner of the map-area to Chateauguay. The hammer-percussion seismic equipment was tested in this area as a means of measuring the depth of overburden. Results are still being evaluated to determine the accuracy under conditions encountered in the Lachine area.

Another party examined iron-titanium deposits of the Morin anorthosite body north of Montreal and those of the St. Urbain. Particular attention was given to the mineralogy and the relationship of the deposits to the composition and structure of the enclosing anorthosite and related rocks.

Helicopter-supported Operation Fort George was continued with the mapping of a further 35,000 square miles of the area between James Bay and Hudson Bay and the Labrador Trough. This venture differs from previous Geological Survey helicopter-supported operations in the Canadian Shield in that it involves only one helicopter and three, instead of five, geologists. Furthermore, parallel traverses have supplanted the radial type. And the cost of the operation to date, about $2.03 a square mile, is the lowest so far achieved by a Survey helicopter project in the Shield.

In 1958 three bodies of greenstone were mapped in the southern half of the area, the largest of which is about 35 miles long and 6 miles wide. Otherwise, most of the southern third is underlain by gneiss and schist derived from sedimentary formations, and most of the northern two thirds by gneissic or massive granitic rocks. Also encountered were four bodies of pink, crossbedded and ripple-marked quartzite, younger than the granitic

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rocks, the largest about 12 miles long and 4 miles wide. Most structural features within the area trend east to east-northeast. The Survey published a preliminary map (Map 23-1958) on a scale of 1 inch to 8 miles, embracing the results of the 1958 field season.

Three field parties continued mapping the rocks of the Labrador Trough with the objective of covering the entire iron-producing area as soon as practicable. One completed the study of the geology of the Mount Wright (23 B W½) map-area on a scale of 1 inch to 4 miles. A northeasterly-trending belt of biotite-hornblende gneisses and associated rocks underlies about half the area, passing through its centre. Within it are small, scattered, intricately folded areas—generally in the northeast and southwest parts of the belt—of younger quartzite, marble, iron-formation and iron ore. Two periods of folding along northeasterly and northwesterly axes were recognized.

The second party completed a geological study and mapping at 1 mile to the inch of Marion Lake (23 I/13) map-area. The results are expected to aid in the stratigraphic and structural control data required to maintain the quality of reconnaissance 4-mile mapping of the Trough.

The third party began the geological study and mapping of the Wakuack Lake (23 O) map-area. Trough rocks, which trend diagonally through the centre of the area from southeast to northwest, have for the most part been mapped by mining and exploration companies, sometimes in considerable detail. These and other data will be incorporated in a geological map for publication on a scale of 1 inch to 4 miles.

New Brunswick

Field work was completed in the Big Bald Mountain (21 O/1), Nepisiguit Lake (21 O/7) and Serpentine Lake (21 O/2) map-areas and almost completed in the Riley Brook (21 O/3). The current study of the last three will make use of unpublished work by B. R. Rose between 1935 and 1938 and bring it up to modern 1-mile standards. Furthermore, several new collections of fossils were obtained which should add much to our knowledge of the age of the pre-Carboniferous strata. To the west another party began the mapping of St. Leonard (21 O W½) map-area and completed the southern half. Most of the rocks examined were mapped many years ago as tightly folded pre-Carboniferous strata, but again, fossils collected during the year promised to provide further information concerning their age.

The Napadogan (21 J/7) map-area was surveyed for publication on a scale of 1 inch to 1 mile. And the geological study and mapping of the Waterford east half (21 H/11 E½) map-area was completed and extended to include all of Fundy national park lying east of it.

The Survey began a geochemical study of the Bathurst-Newcastle base-metal district—a project that will further the knowledge of the distribution of these and other metals and of their origin. Specimens were obtained from the principal lead-zinc-copper deposits for geothermometry studies expected to indicate the formation temperature of the contained sphalerite.

The geological study and mapping of the surficial deposits of the Saint John River valley, a project carried on intermittently since 1950, was continued. The results, in addition to their usefulness for engineering-geology and soils purposes, should be of particular scientific interest; for the Saint John River valley presents a unique opportunity to study the surficial records in a valley crossing the Appalachian Mountains and trending parallel to the direction of ice retreat. In the course of this work, a barite occurrence of good grade and unknown extent was found a few miles northeast of Woodstock.

Nova Scotia

Mapping for publication on a scale of 1 inch to 1 mile was completed within the Bridgetown east half (21 A/14 E½), Gaspereaux west half (21 A/15 W½), Chedabucto Bay (11 F/6), and Arichat (11 F/11 E½) map-areas. In addition, field work was commenced within the St. Ann's map-area (11 K/7), the last unmapped 1-mile map-area in Cape Breton Island.

The geochemical reconnaissance of mainland Nova Scotia, begun in 1956, was completed. The zinc content of the stream sediments was found to be anomalously high within the Cobequid Mountains between Parrsboro and Pictou and, within the zinc anomaly, high local lead anomalies were found—at Lakelands, north of Parrsboro; centred on Newton Lake; and centred on Totten Lake. Their significance remained to be assessed.

The staff of the *Coal Research Laboratory*, at Sydney, Nova Scotia, continued detailed petrographic and palynological (spore) studies of Canadian coal seams as part of the research program on the coking characteristics of Canadian coal. These included petrographic studies on coal from the Sydney coalfields, Nova Scotia, and the Crowsnest coalfield, Alberta.* These studies provide fundamental data on the composition of coking coal in the various seams and information important in coal-blending for the improvement of the coke. The work consists of detailed microscopic analyses of a large number of column samples, in order to examine the lateral and vertical variations in the petrographic composition of coal seams in place. This is important, for the petrographic composition of coal is related to the quality of the resultant coke.

* The Survey's coking coal research is undertaken in close cooperation with the Fuels Division of the Mines Branch.

Also undertaken are petrographic analyses of a series of screen sizes, a matter of importance in the effective blending of coal. This step is made necessary because of the fact that coal, after it is mined and screened, has a composition different from that of the seam. And the fine sizes, generally used for coke-making, do not always contain the various petrographic components in the best proportions.

The Survey continued its study of the Harbour seam of the Sydney coalfield, a project initiated in 1957. The emphasis was on lateral variation in the petrographic composition of the seam in relation to facies changes within the ancient peat bogs. Also considered was the nature of the immediate roof rock and the distribution of ash-contributing elements in the different types of coal.

Coals are compact masses of carbonized plant debris; and the study of fossil spores found in coal measures is important in understanding their geology. In 1958 the Survey continued the study of stratigraphic ranges of small-spore genera in Upper Carboniferous coal from carbonaceous shale from the Maritime Provinces—part of the long-range project that eventually will cover the entire Carboniferous succession in the Maritime Provinces. The object: (1) to find the stratigraphic ranges of the different small-spore genera; (2) to determine the density variations of the genera in the stratigraphic column; and (3) to establish, by means of spores, the stratigraphic position of those areas in the Maritimes that have yielded insufficient megafossils for a precise age assignment. So far, the ranges of the small-spore genera in the four groups comprising the Upper Carboniferous of Eastern Canada have been established.

Spore studies, in an effort to solve structural problems and to assist in the correlation of coal seams, were carried out in the following areas: the Joggins River Hebert-Chignecto, and Springhill coalfields; the Pictou coalfield; the Minto-Chipman and Beersville coalfields in New Brunswick.

Prince Edward Island

The geological study and mapping of the bedrock and surficial deposits of Prince Edward Island have been continuous since 1953. During the year, field work within about 80 per cent of the Mount Stewart west half (11 L/7 W½) map-area was completed by Dr. G. H. Crowl, Chairman, Department of Geology with Geography, Ohio Wesleyan University, who was employed as a seasonal party chief.

The Maritime Provinces and Quebec

In 1958 the Survey undertook its first project in submarine geology consisting of an aeromagnetic survey covering the Bay of Fundy, the Gulf of St. Lawrence south of a line from Anticosti Island to Port aux Basques, Newfoundland, and parts of the eastern tip of Gaspé. Flightlines over water were controlled by the Decca navigational system, the first time—or so it is believed—this method of control has been used on an aeromagnetic survey. Furthermore, an Aero-Commander aircraft was used instead of the Canso previously employed for this type of work. Its greater speed not only halved the cost per line mile but raised the distance flown to a record 87,931 line miles.

While the results of this survey remain to be compiled, they are expected to provide significant information concerning submarine geology, including the extent and thickness of the Carboniferous basin beneath the Gulf of St. Lawrence—a matter of considerable importance to oil and gas exploration in the area.

An aeromagnetic survey was also made of those parts of New Brunswick, Nova Scotia and Prince Edward Island for which maps of this sort were not previously available. The extreme northwest corner of New Brunswick, however, remains to be covered.

Newfoundland

Two Survey parties undertook 4-mile mapping in Newfoundland and both completed their studies. One worked in the Burgeo-Ramea (11 P/11, 12, 13 and 14) map-area, the southern part of which is underlain mainly by granitic rocks and gneisses. The Grey River and Goosehead peninsulas, however, are underlain by schist and gneiss derived from sedimentary and volcanic rocks and by minor sedimentary rocks. Tungsten-bearing quartz veins, explored by Buchans Mining Company, are in the non-granitic rocks of Grey River peninsula. The northern part is underlain largely by granitic rocks and gneisses derived partly or wholly from sedimentary and volcanic strata. Within these lie belts of Devonian sediments, the largest of which is about 15 miles long and up to 4½ miles wide.

The second party worked in the Deer Lake (12 H W½) map-area and found that Precambrian gneisses occupy most of the north half, bounded on the west, south and southeast by Cambrian and Ordovician strata. These in turn are cut (between Bonne Bay and the north arm of Bay of Islands) by ultrabasic and associated intrusions. Much of the map-area southeast of Big Bonne Bay Pond is underlain by gently inclined Mississippian and Pennsylvanian sediments.

General

The study of Canada's mineral deposits is a continuing project resulting in the publication of the Economic Geology Series. In 1958 field studies were made of the iron, beryllium and molybdenum deposits of Canada. The study of iron deposits had to do mostly with those of southern Quebec and southern Ontario. Although only part of the field season was available for the study of beryllium deposits, an examination was made of the helvite deposit of Needlepoint Mountain, near Cassiar, British Columbia; and of beryllium occurrences in Ontario, in the Nipigon-Beardmore district and near Mattawa and Renfrew. Molybdenum deposits were examined in western Quebec and eastern Ontario, in western Ontario near Sioux Lookout, and in British Columbia between Smithers and the 49th Parallel.

The investigation of the heavy-mineral content of sand and gravel deposits, begun in 1957, was continued in the Maritime Provinces. This work is expected to provide information on possible economic concentrations of minerals and on the best techniques for their prospecting and appraisal. Both beach and glacial deposits were investigated.

The Survey maintains an up-to-date estimate of the coal reserves of Canada; and for this purpose one of its officers visited all producing coal mines in southern Saskatchewan, Alberta and southeastern British Columbia.

Studies of rock magnetism were continued. The science of palaeomagnetism or fossil magnetism, is founded on the fact that sedimentary and igneous rocks when formed acquired a magnetic field aligned with that of the earth. Thus the magnetic properties of a formation are clues to its age and to the position in which it was originally laid down. Information of this kind is also expected to be of considerable value in the interpretation of the Survey's aeromagnetic maps.

To supplement palaeomagnetic laboratory studies the Survey collected samples of Devonian, Pennsylvanian and Triassic rocks of Gaspé, New Brunswick and Nova Scotia. It is expected that the resulting data, compared with that obtained in Great Britain, will give further information concerning continental drift. In addition, specimens were collected around the Lakehead from various Proterozoic rocks including the Logan sills and Lower Keweenawan sediments, Duluth gabbro, and Keweenawan lavas north of Sault Ste. Marie. Palaeomagnetic measurements made of these appear to have confirmed and supplemented our knowledge of the relative ages of various Keweenawan rocks as determined by classical geological methods. For instance, palaeomagnetic data suggest that the Duluth gabbro and Keweenawan lavas are essentially of the same age, whereas the Logan sills appear to be substantially older.

The Survey continued its study of the ultrabasic rocks of Canada, and in 1958 undertook a reconnaissance investigation of those of Northwest Territories and of the Cordillera between the 49th Parallel and Clinton Creek, Yukon Territory. Some of these bodies contain asbestos, chromite, or nickel. Their structure and origin are of interest to anyone concerned with the search for and development of such deposits.

About ten tons of material were collected in Ontario and Quebec for the preparation of suites of rocks and minerals for sale to prospectors, students and the public.

Laboratory Research

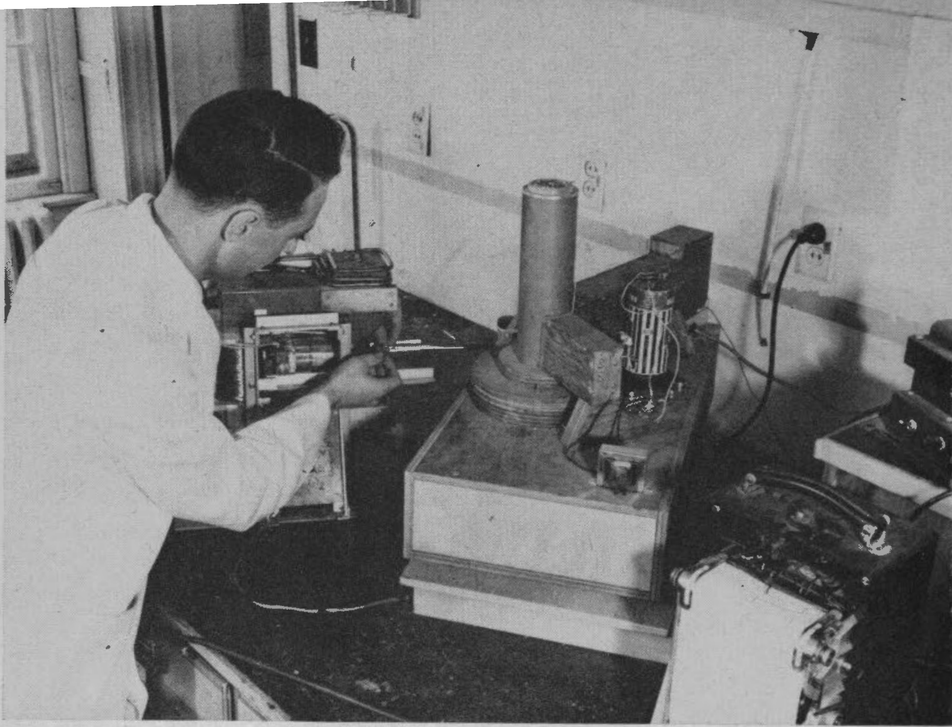
Most of the Survey's laboratory and office work was directed towards supplementing, collating, interpreting and otherwise expanding the results of current and recent field mapping; and research designed to extract as much information as possible from data gleaned in the field.

In 1958 Survey laboratories processed more than 30,000 samples including simple sieve sediments, complete chemical analyses of rocks and complex mineral separations. Among these were 176 radiometric analyses made for thorium and 76 for uranium. In addition, the *Coal Research Laboratory* at Sydney, Nova Scotia, continued its petrographic and palynological studies of Canadian coal seams (*see* Field Work—Nova Scotia), acquiring fundamental data on the composition of coking coal. And the *Western Petroleum and Natural Gas office* at Calgary faced an increasingly heavy work load (*see* Field Work—Alberta).

A substantial part of the laboratory research was given to the development of new and better techniques and instruments for use both in the laboratory and in the field. One such project has made it possible for field officers to obtain fairly accurate analyses of rock samples in a relatively short time. Also developed were simple laboratory methods for determining minute quantities of lead, zinc, copper and molybdenum which have greatly increased the speed and accuracy of geochemical field work, enabling an operator to make as many as 100 determinations a day. Furthermore, these new techniques can be adapted to field use.

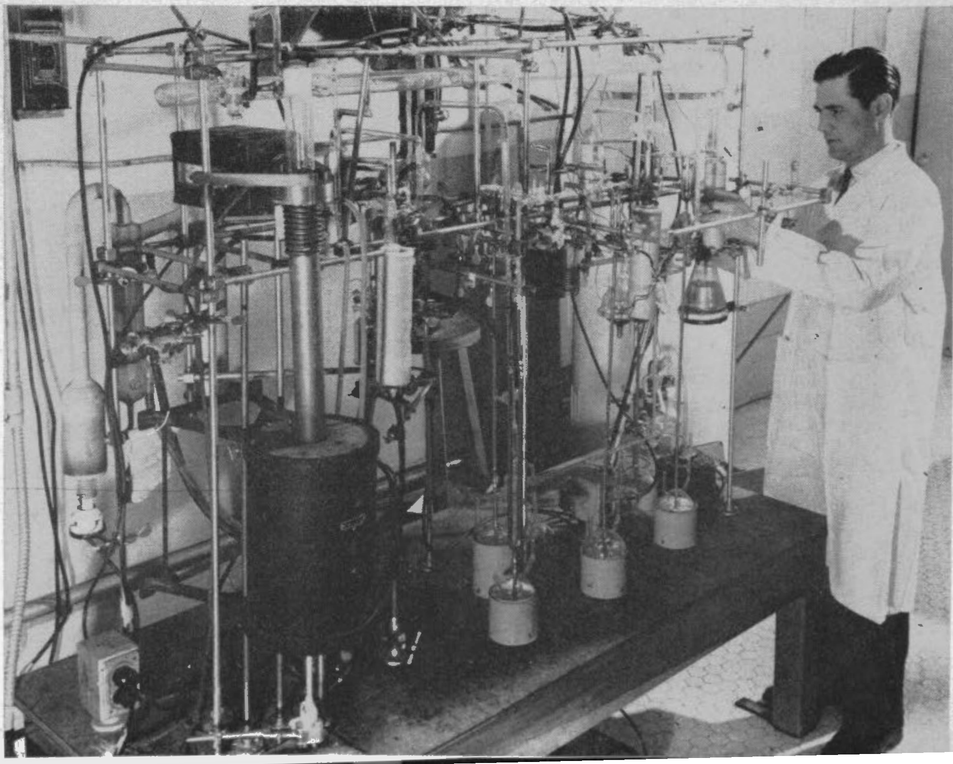
The Survey is constantly studying—indeed developing—new geophysical techniques and tools of value not only in the field but in the laboratory and offices where results must be compiled and interpreted.

For instance, the Survey's palaeomagnetic research will be helped by a new instrument, designed by its officers, for measuring the so-called Curie



Palaeomagnetic and rock magnetism studies form an important part of the research on geophysics being carried out by the Geological Survey of Canada. This "Curie Point" meter was designed as a means of identifying the simultaneous presence of minerals of different ferromagnetic curie points in rocks, and of indirectly establishing the chemical composition of members within solid solution series of ferromagnetic minerals present in different rock types.

Radiogenic argon-40, which has accumulated from the decay of calcium-40, is extracted from micaceous minerals in this high vacuum apparatus. The very small volume of gas obtained is purified before being transferred to the mass spectrometer for isotopic analysis. Ages so determined are used by Survey geologists to assist them in the correlation of major rock units and in the subdivision of the Canadian Shield.



Point of rocks. This is the temperature at which all magnetism is destroyed. The instrument will provide data concerning the probable stability of original magnetization and help in establishing the capabilities and limitations of palaeomagnetic techniques.

Also sought is an instrumental means of identifying rock types from the air. The Survey has made considerable progress in this direction, having established that distinct contrasts may exist between the spectra of gamma rays emitted by various rocks. This is a development that may eventually lead to a valuable aerial aid to geological mapping.

Nearing completion at year's end was a second mass spectrometer for isotopic analyses, built to the Survey's specifications by the Mines Branch. Equipment of this type has proved to be a valuable research tool, providing necessary data for determining the absolute ages of rocks and minerals, data on the origin and formation of ore deposits and other geological problems. The new instrument is more versatile and easier to use; it will permit isotopic analyses to be carried out on very small samples and for a greater number of elements.

The Survey hopes to apply the phenomena of nuclear magnetic resonance to its geophysical work. Magnetometers based on this principle make use of the spinning nuclei of atoms to measure the magnetic field of the earth. The instruments are lightweight and have an accuracy approaching one part in ten million.

These and other research projects will be given considerable impetus in the Survey's new $6,300,000 eight-storey headquarters which brings under one roof offices and laboratories formerly occupying nine buildings. New facilities include laboratories for radio-carbon age determinations, pollen and spore studies, coal analysis, radiometric assaying, X-ray and mass

Hon. Paul Comtois, right, Minister of Mines and Technical Surveys, and Dr. Marc Boyer, Deputy Minister, stand in front of the new Geological Survey of Canada headquarters in Ottawa.

spectrography, petrography and many other scientific procedures. A roof-top greenhouse is available for experiments in biogeochemistry, a relatively new science involving the analysis of vegetation and micro-organisms for traces of metal.

The demand for the Survey's mineral specimens and collections (designed for prospectors, educational institutions, etc.) increased approximately 17 per cent in 1958. Specimens distributed during the year came to 222,351 compared to 188,008 in 1957, plus a total of 6,000 contained in 50 large sets.

In answer to requests on the part of industry and the public the Survey distributed a total of 134,830 separate copies of publications.

mines branch

THE Mines Branch in 1958 continued to develop and improve commercial processing methods for Canadian metallic ores, industrial minerals and fuels. The work, however, involved both fundamental and applied research and was of benefit not only to mining technology but to many other aspects of Canadian industry and science.

Reflecting current mining developments there was an increase in the number of gold and iron-ore samples received for treatment, though those of copper, nickel and uranium continued to loom large. And the Branch gave more attention to large-tonnage, low-grade deposits—a matter of increasing importance as smaller, richer orebodies are mined out. Also under investigation was the retreatment of mill waste and the application of uranium extraction methods to other ores.

Keeping pace with the industrial trend toward the use of lighter metals, the Branch intensified its research on alloys of aluminum and magnesium and, in addition, sought to develop alloys of high purity and those capable of withstanding temperature extremes. The work in physical metallurgy was of importance not only to metal fabrication but to the development of improved military and nuclear-reactor materials. In fact, the requirements of atomic and missile development have made the investigation of new alloys and a basic understanding of the behaviour of metals more urgent than ever.

Although the Branch's research in non-metallics involved more than twenty different minerals, major emphasis was given to commodities presently being imported, (e.g. silica-glass sand, kyanite and kaolin) and to construction materials (mainly aggregates used in concrete structures, bituminous roads, etc.). Nevertheless the work load in ceramics was particularly heavy. It ranged from the solution of technical problems faced by manufacturers to the development of ceramic electronic components and high-temperature refractories.

Much of the research work in fuels was designed to encourage the use of Canada's abundant low-grade resources, particularly Canadian coal for heating and power plants and in metallurgical work. Equally important was the search for practical methods of refining low-grade crude oils and bitumens and fundamental studies of the structure of hydrocarbons.

Mineral Dressing and Process Metallurgy

The Branch's work in mineral dressing and process metallurgy in 1958 involved a diversity of ores, mostly those of base metals and iron—although eight were of gold. Branch scientists continued to work closely with the mining industry, collaborating with metallurgists from 16 companies on various projects, principally pilot-mill runs on large ore shipments. Over 1,100 tons of material were processed during the year.

As grinding is the most expensive ore-dressing operation, the Branch has applied a good deal of effort to the improvement of grinding techniques. One such project involved exhaustive tests in a mill that, instead of applying the conventional steel balls, forces the ore lumps to grind themselves. The Branch processed some 154 tons of material (the largest shipment of the year) and found the mill to be an efficient grinding machine. However, a wealth of data resulting from the operation remained to be analyzed.

Niobium

Substantial progress was made in treating ores of niobium, a metal used in the manufacture of stainless-steel and high-temperature alloys. Pilot-plant runs on samples from two Canadian deposits (totalling 145 tons of material) demonstrated that flotation applied as a continuous process to both ores would produce acceptable concentrates with recoveries in the neighbourhood of 80 per cent. Thus the commercial treatment of Canadian niobium ores was brought considerably closer to reality.

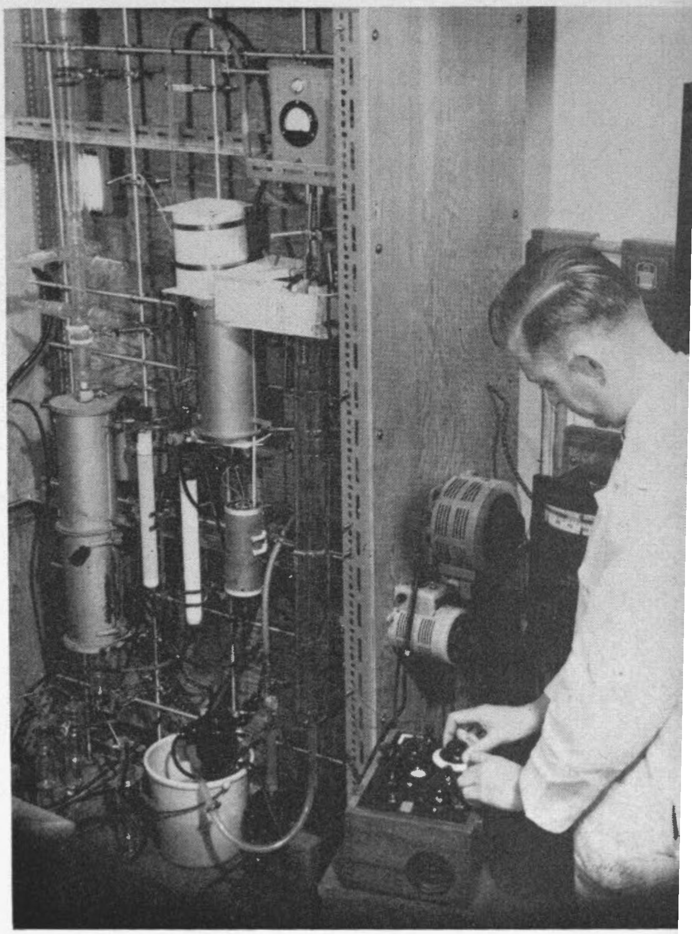
Also encouraging was the Branch's work on the next processing step, the treatment of niobium concentrates for the production of pure niobium metal. Chlorination was found promising but research on smelting procedures also yielded valuable results.

Iron Ore

Reflecting the industry's intense interest in the beneficiation and utilization of Canadian iron ores, the Branch continued its investigations in this field. The work took the form of drying, agglomeration, and magnetizing-roasting tests on typical ores conducted on a laboratory and pilot-plant scale. It was shown in the case of one Canadian ore that simple drying would substantially improve its commercial acceptability, and, in another, that magnetizing-roasting would produce iron-oxide concentrates of exceptionally high grade.

Considerable work was done on a favorably-located siliceous iron ore. The Branch found that, although not amenable to concentration, the ore could be smelted in the electric furnace under a comparatively low-lime slag to produce an acceptable grade of pig iron. Accurate data on slag compositions and power and reductant requirements were also obtained and it was shown that coal from an Alberta mine might be used in this operation.

Other activities in the field of ferrous metallurgy included a study of the physical chemistry of oxygen steelmaking, a project that has helped in understanding some of the problems in the use of this new technique; and



One of the fundamental research goals in metallurgy is to understand more fully the thermal decomposition of metallic sulphates. A postdoctorate research fellow, assigned to the Mines Branch, studies conditions for the decomposition of iron and aluminum sulphates in mixtures of the two.

laboratory work on direct iron reduction—basic research, pointing toward the possibility of designing a relatively small steelmaking plant in Western Canada able to use indigenous non-coking coals for fuel.

Aluminum

Of interest to manufacturers of abrasives were the experiments performed on bauxite to increase its usefulness in the production of fused alumina. It was found that bauxite could be sintered on a continuous machine to provide an excellent raw-material feed for the electric-furnace production of this important abrasive.

The Branch's chemical metallurgists took up the problem of treating Nova Scotia shales for the recovery of aluminum. A pilot plant previously used by a private company was taken over and, by the end of the year, laboratory work in this field was well under way.

Nickel-Copper

Low-grade nickel-copper ores continued to receive attention. In many cases deposits of these ores are too small to justify the construction of a refinery and the resulting concentrates are too low grade for economical shipment elsewhere. This is a problem which the Branch is well on the way to solving. During the year it was established that, in the case of one deposit, low-grade concentrates could be roasted with salt and leached to produce saleable products of small bulk.

Titanium

One of the best methods of extracting titanium is by direct electrowinning of the metal from a fused salt bath. However, metallurgists are hampered by a lack of basic scientific knowledge of the processes involved. As a result the Branch continued its program of basic research on the electrolysis of fused salts and its officers published three comprehensive papers on the subject during the year.

Analytical Techniques

Frequently problems which appear simple on the surface turn out to involve highly complex techniques. Thus a problem in the manufacture of high-quality chrome-magnetite refractory brick involved the study of phase relationships in a fused complex of half a dozen metallic oxides, and experiments conducted at very high temperatures. An apparently simple problem in analytical chemistry can also call for the most advanced techniques.

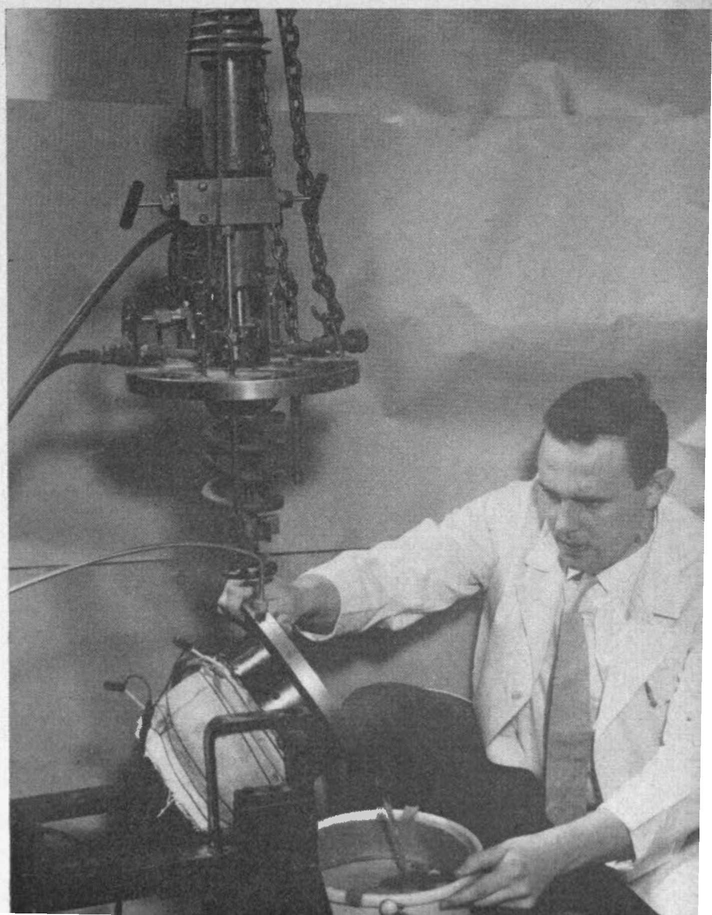
For instance, in searching for better methods for analyzing platinum metals, Branch scientists resorted to the use of radioactive isotopes.

In fact, since metallurgical investigations depend heavily on rapid and accurate chemical analyses, the Branch has given careful attention to analytical techniques. In addition to radioactive isotopes, which are frequently used by Branch scientists, instrumental methods are continually applied, replacing older and slower techniques.

A good illustration is the problem of determining impurities in certain alloys. Formerly this was done by analyses which were time-consuming and often inaccurate; now the use of polarographic methods with controlled potential electrodeposition has greatly simplified the work and offered more reliable results.

Corrosion

The Branch continued to investigate metal-corrosion problems submitted by government departments, Atomic Energy of Canada Limited and by industry. This involved such diverse matters as testing a low-carbon stainless steel for its ability to handle certain solutions in uranium ore processing; and determining the cause and cure of corrosion in the boiler tubes of a coastal steamship.



In the extraction of metals from ores, pressure leaching methods are proving highly effective. Here is some of the equipment (autoclaves, open vessels, and pachucas) used in studies to determine the best leaching conditions for ores and concentrates in acid and basic solutions.

A comprehensive report was prepared for the benefit of industry on the relative merits of ordinary steel and wrought iron from the standpoint of corrosion resistance. It concluded that, in general, there is little to choose between the two—a finding of importance, since wrought iron is imported while steel is produced at home.

Industrial Minerals

The need for research on the processing and commercial application of Canada's industrial minerals continues to grow. The efforts in this field ranged from coping with simple technical inquiries (1,750 of which were received during the year), to intricate research and pilot-plant projects. The Branch investigated a wide diversity of materials from every province and the Yukon, receiving in all 684 samples. These involved 28 mineral varieties in addition to clays, shales and aggregates. But while increased attention was given to materials used in construction, the work had a direct bearing on many other aspects of the Canadian industry.

Chemical analyses involving 1,635 determinations were performed on 1,003 samples which, in addition, were subjected to a variety of physical tests. Petrographic, X-ray and other techniques were applied to 344, of which 87 received detailed study. Branch officers prepared 99 reports, contributed 12 technical articles to various periodicals and issued annual reviews concerning 32 mineral commodities.

Non-metallics

In its intensive effort to make Canada more self-sufficient in its raw materials, the Branch gave major emphasis to development work on industrial minerals now being imported. Thus the search continued for a domestic high-quality glass sand; laboratory studies were aimed at developing Canada's sources of garnet for the manufacture of abrasives and, in all, twenty different minerals from 27 locations were subjected to milling and beneficiation tests.

Pilot-plant runs were carried out on kyanite concentrates, and the engineering data gleaned to date on this important refractory mineral have brought its commercial production in Canada considerably closer. Equally promising were the Branch's concentration and calcining research on magnesite and its efforts to process the pyrophyllite deposits of Newfoundland. Both minerals have important industrial applications.

As Canada has no commercial sources of kaolin (a mineral used in the manufacture of chinaware, porcelain, tiles and other refractory materials), the low-grade kaolin-bearing clays of Manitoba are of particular interest. Hydrocyclone and ellutriation methods were applied to materials from these deposits—a project that is continuing.

The Branch also assisted mining companies in working out processing procedures for material that would normally have gone to waste. For instance, at one mill a method was developed for recovering barite (valuable as an oil-drilling mud) from base-metal tailings and, at another, improved grinding techniques have made possible the recovery of talc from previously-discarded rock. Similarly, the Branch's investigations of grinding and air-tabling methods have resulted in greater efficiency and better quality control in the commercial production of magnesia.

Considerable effort was brought to bear on the flotation of beryl and the zeolites with advances made in both projects. Milling procedures were investigated for feldspar, quartz, graphite, apatite, and marl and, in each case, a method of concentrating a commercial-grade product was developed.

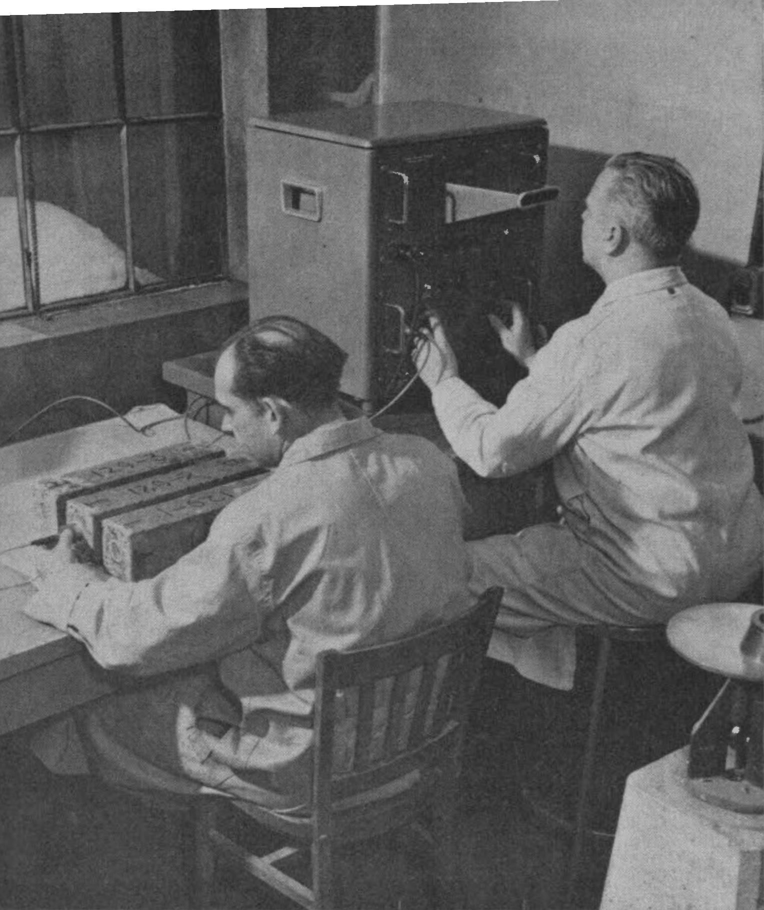
Construction Materials

For the most part the Branch's research in construction materials has concerned the properties of aggregates and methods of improving their quality. And because the Canadian climate is hard on concrete structures, bituminous roads etc., particular attention was given freeze-thaw research in which materials are subjected to alternately high and low temperatures.

During the year the Branch sought methods of improving the quality of sand and gravel to meet the rigid specifications of modern-day construction. For example, it undertook a full-scale investigation of heavy-media separation methods, for up-grading the aggregates to be used in the Pointe Fortune dam, and conducted rigorous physical tests on the resulting concrete. In another project experiments were under way to determine the behaviour of various specimens of concrete exposed to fire.

Of interest to the mining industry were the Branch's attempts to use gold mill-tailings for aggregate, the resulting concrete to be used underground. The problem: to design a satisfactory mix with a minimum of gravel, a maximum of mill waste and a normal amount of cement. In this the Branch had considerable success, producing a concrete of the required strength and abrasion resistance that contained approximately 50 per cent tailings.

Again under investigation were methods and materials for the production of sand aggregate, a commodity that, because of increased construction, is in short supply in some parts of the country. One investigation in this category concerned the Lockport dolomite found in the area of Hamilton, Ontario.



Because the Canadian climate, with its wide variations in temperature, is hard on concrete structures, the Mines Branch has given particular attention to freeze-thaw research in which samples are subjected to alternately high and low temperatures. Here Branch scientists are determining the ultrasonic pulse velocity in concrete made from differing types of stone aggregate, which have been exposed to accelerated freezing and thawing.

The Branch conducted pilot-plant tests with a peripheral-discharge rod mill and impact crusher and obtained sand of satisfactory grade and particle shape.

New developments in precast and prestressed concrete have created a growing demand for lightweight aggregates. Keeping pace with the advances in this field the Branch continued its search for new sources of raw materials and better processing methods. Many samples of clays, shales, and vermiculite were investigated, some on a pilot-plant scale in a study of feed preparation and firing techniques. Other lightweight aggregates were subjected to concrete-proportioning tests.

Similarly the use of high-density concrete as a shield against radiation has underlined the need for heavy aggregates. And, during the year the Branch investigated several possible sources of this material and prepared and tested concrete samples. An impure ilmenite, normally of no value as an ore, was found to be particularly suitable as a heavy aggregate and is already being used for this purpose.

Industrial Waters

With sampling stations operating in the drainage basins of the upper Great Lakes and Hudson Bay, the Branch continued its detailed surveys of Canada's industrial water resources. It also conducted municipal water studies in these areas and in the lower St. Lawrence River basin. The results of this work—published as a series of water survey reports—are in considerable demand by both government and agricultural agencies and by industry. In all, 1,525 water samples were analyzed during the year.

Some water-quality surveys were designed to assist special projects. For instance samples from 112 ground-water sources were analyzed for the Geological Survey of Canada and waters of the Peel River and Mackenzie River delta were surveyed for the Geographical Branch. In addition, local water-quality surveys were undertaken for the Department of National Defence and the United States Air Force.

Of importance to certain aspects of scientific research is the analysis of dissolved solids being carried by our river systems to the ocean. For this purpose the Branch initiated a year-long survey of the waters of the Mackenzie, Nelson, Churchill, Fraser and St. Lawrence rivers—a project undertaken in cooperation with the International Association of Scientific Hydrology. Also under study was the natural radioactivity of Canadian surface waters, some 98 of which were analyzed during the year.

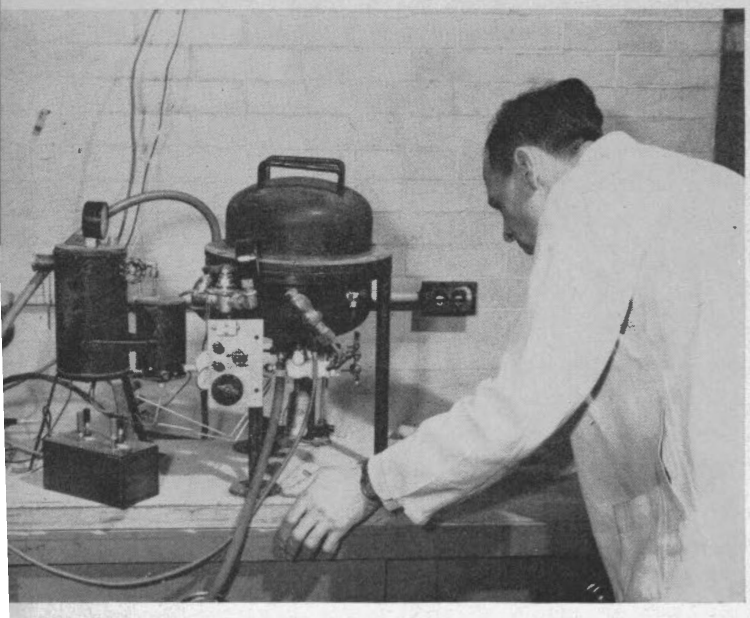
Equally important are the Branch's assistance in the quality control of water and the treatment of boiler water at army camps across the country; and its studies of the relationship between water quality and corrosion. Provincial governments, cities and towns were advised on domestic water supplies; federal agencies and private companies were assisted in the solution of water-treatment problems; and private industries, both foreign and Canadian, were provided with information to aid in the location of new plants.

The Branch continued its development of water-analysis techniques, particularly for determinations of sulphate, calcium, chloride, lead and alkali. It began an investigation of the cause of natural color in water and what might be done to remove it; and continued to study the effects of silica on the alkalinity of water.

Ceramics

The laboratories of the Mines Branch offer the only facilities in Canada for comprehensive research in ceramics and, in 1958, the work load in this field was particularly heavy. It ranged from the solution of technical problems faced by manufacturers of ceramic products, the evaluation of potentially useful ceramic raw materials; and the testing of ceramic components and other research for the Department of National Defence. Projects of a general nature involved complete determination of the physical, pyrophysical and chemical properties of refractory products including firebrick, castables, plastics, mortars and insulating firebrick.

The Branch continued its correlation and classification of Canadian clays, laying the foundation for a valuable reference work to be published in due course. Data assembled to date concern kaolins, ball clays, fireclays, stoneware clays, bentonites, common clays and shales—their location, mineral composition, physical properties and industrial uses. A detailed mineralogical study of the Queenston shale, one of Canada's best known brick-forming ingredients, was completed.



The Mines Branch houses the only facilities in Canada for comprehensive investigations in ceramics. One of the major projects in this field is to correlate and classify Canadian clays—a matter of considerable importance to those interested in their commercial applications.

Electronic ceramics were an important aspect of the work. Again under investigation were methods of manufacturing piezoelectric barium-titanate components and the fabrication of large and complicated barium-titanate shapes, a large number of which went to the Naval Research Establishment. Greatly furthering this work in the future will be the new equipment, acquired during the year, which will enable the Branch to carry out a complete evaluation of experimentally produced ceramic materials.

The Branch undertook further research on high-alumina refractories capable of withstanding extremely high temperatures. It had considerable success in the production of good mullite aggregate from Canadian kyanite, samples of which were sent to interested companies. Determination procedures have already been established for the study and identification of constituents in the fired products.

Other problems tackled by the ceramics laboratory involved the development of sewer-pipe bodies from local clay, the use of chemical additives for improving the drying characteristics of clay, the use of asbestos in brick manufacture, the prevention of scumming in clay products, and methods for determining the high-temperature thermal conductivity of refractory brick and concrete.

Physical Metallurgy

In 1958 Mines Branch delved into almost all aspects of physical metallurgy. Some projects were of direct benefit to Canadian metal fabricators; other, more fundamental, investigations pointed the way to the development of new alloys and to a basic understanding of their behaviour.

Research

The key to the study of metals and alloys is the determination of their crystal structures, a field in which the use of X-ray diffraction equipment and the electron microscope has played an important role. The X-ray laboratory was concerned with the high precision determination of crystal lattice parameters and new techniques were sought in the transmission electron microscopy of thinned metal foils—a project offering new tools for investigating the atomic mechanisms of alloy behaviour.

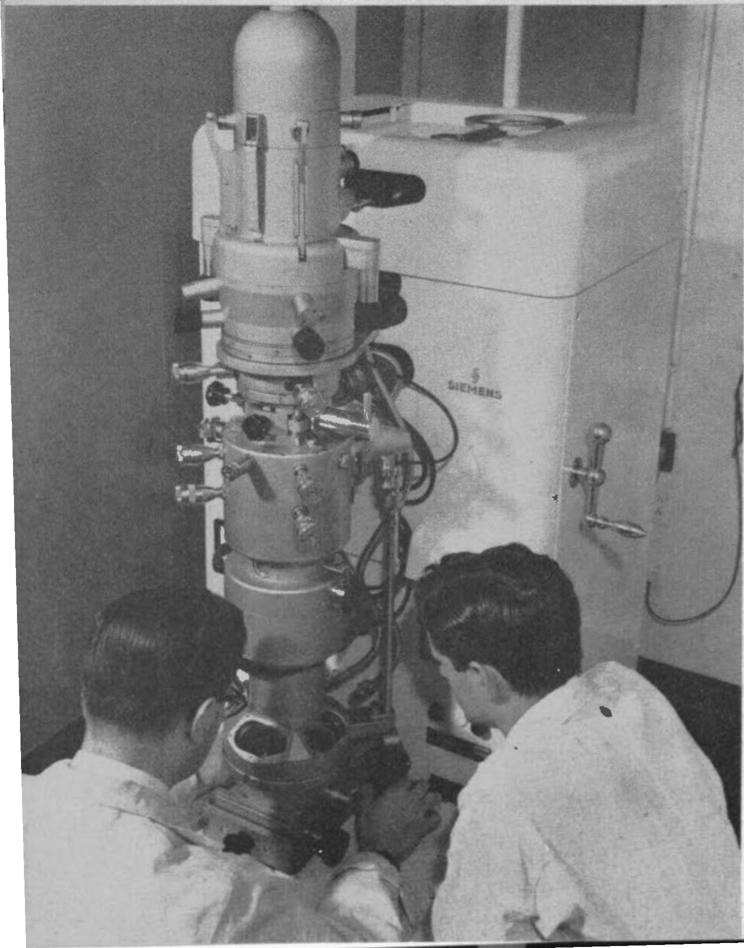
The study of fatigue and the behaviour of metals under stress continued to be an important area of research. The Branch has given particular attention to the cause of crack formation and the development of non-destructive tests for the detection of damage caused by fatigue. A recent project, carried out with research organizations of twelve other countries, involved rotating, bending, and direct-stress tests on an aluminum alloy and a chromium-molybdenum alloy steel. Also studied during the year was the effect of surface treatments and surface imperfections on the impact tension-bending characteristics of aluminum and other metals. Considerable progress was made in determining the effects of iron impurities on the creep rupture of aluminum.

The Branch continued to investigate the titanium-rich alloys of aluminum and molybdenum. This work has revealed a hitherto undetected phase in this type of alloy—a finding that has contributed to a greater understanding of the influence of titanium alloy additions.

Development

Research in the realm of ferrous metallurgy during the year involved the development of a low-alloy ferric steel to be used in naval steam turbines designed to operate at 1050°F; and a study of niobium steels to be used at low temperatures—a project of considerable importance with the rapid development of Canada's northland.

Of particular interest to the mining industry was the work undertaken on the design of drill-rod attachments made more durable by spiral rolling. Meanwhile those engaged in lumbering and forestry operations stood to gain from the Branch's efforts to develop a more efficient circular saw plate. During the year particular attention was given to the angle of tooth attack and its effect of stresses set up within the blade.



Fine-scale imperfections in metals exert marked influence on their mechanical behaviour. The electron microscope is a valuable tool in correlating a metal's previous history with its mechanical properties, permitting the study of metals at magnifications of up to one million times.

The Branch continued to work with newsprint manufacturers in the search for new alloys with which to make a stronger fourdrinier wire screen, the device used to feed watered pulp to the paper machine. A wear-testing machine to duplicate actual operating conditions of modern high-speed paper machines was designed and assembled.

An important aspect of the research on non-ferrous metals is a program instituted at the request of the Canadian Zinc Research and Development Committee for the development of improved zinc alloys, particularly for die casting and the manufacture of wrought products. Among other factors, the Branch investigated those affecting the structure and properties of hot-dipped galvanized coating (e.g. immersion time and temperature, sheet steel finish and bath composition). Data from the first phase of this project were reported to the 5th International Hot Dip Galvanizers Conference in Brussels.

Military and nuclear-reactor components were also investigated. Thus a dynamic shear test was developed for the Department of National Defence enabling alloys used in fuse-closing discs (a component used in shells and missiles) to be evaluated without resorting to expensive firing trials. The Branch produced sintered aluminum powder alloys for Atomic Energy of Canada Limited, fabricated aluminum-uranium alloys for nuclear-reactor fuel elements and investigated possible improvements through minor alloying additions of magnesium, zirconium, silicon and titanium. Zirconium-base alloys with a number of elements added were also investigated with the object of developing superior creep strength at high temperature while retaining good nuclear and corrosion-resistant properties.

Investigation

The Branch's research in welding was broad in scope, often involving less familiar materials such as invar, titanium and zirconium. Typical problems: the repair of a heavy power-shovel frame, the butt welding of small-diameter tubing and examination and testing of induction-welded pipes. The St. Lawrence Seaway Authority, the Royal Canadian Navy and the Department of Public Works were advised on inspection and welding techniques.

The Branch's work in non-destructive testing included such diverse projects as the radiographing of welds in boiler-economiser units aboard destroyer escort vessels and the use of ultra-sonic methods in the examination of molten metal (the purpose: to measure the size of the melted area in zone refining). The Branch-designed crack-depth indicator was used in a minute examination of wall thinning in a 70-foot coal bunker. And the

Department of National Defence was assisted in determining the effectiveness of leak-preventing seals for special bronze parts, in the manufacture of aircraft propellers and in the examination of faulty ammunition components. Canadian industries were advised on a number of problems—for example, the identification of inclusions in light-alloy castings used in aircraft, and difficulties in the manufacture of a component for a Cobalt 60 beam-therapy unit. In another project, ten cast magnesium alloys were examined to determine the effect of healed hot-tears on their fatigue properties.

An office was opened at the British Columbia Research Council in Vancouver, and an engineer assigned to carry out metallurgical investigations of interest to the industries of the province.

Fuels

Much of the research work in fuels is designed to stimulate the use of the country's abundant low-grade resources, particularly the use of Canadian coal in heating and power plants and in metallurgical work. Equally important is the search for practical methods of refining low-grade crude oils and bitumens and fundamental studies of the basic structure of hydrocarbons.

In 1958 the Branch's fuels laboratory analyzed 1,693 samples of solid, liquid and gaseous fuels, an undertaking involving 19,278 determinations. Analyses for the Analysis Directory of Canadian Coals include 131 samples of commercial coal collected at 17 Nova Scotia mines, 11 in New Brunswick, 7 in Alberta, 1 in British Columbia and 4 in Saskatchewan.

The Electrical Certification Laboratory continued to test and certify the safety of electrical equipment to be used in explosive atmospheres and the fireproof properties of conveyor belting used in coal mines.

Two members of the staff attended international conferences and visited research laboratories in Europe to discuss research problems in carbonization and mining and to promote closer liaison with scientists. One member of the staff acted as technical consultant on a mission to Japan seeking markets for the coking coals of Western Canada.

Petroleum

In order to improve the quality of hydrocarbon fuels the Branch's fuels division has sought new techniques and better catalysts to speed the chemical reactions taking place in the refining process. Particular emphasis has been given to refining low-grade crudes and bitumens of which Canada has vast reserves.

Being explored in the recently-built radiation laboratory was the effect of intense gamma radiation upon solid catalysts and upon reacting hydrocarbons. It has been found that, while some desirable reactions occur, the efficiency with which radiation can be used is rather low. Steps are being taken to overcome this difficulty.

Hydrodesulphurization—a method used by refiners in removing sulphur from distillate oils—was again under study with particular emphasis on the mechanism of sulphur removal from pure compounds. This line of research has revealed the importance of studying in detail the chemistry of cobalt, molybdenum and chromium. Many compounds of the first two were prepared and are currently under investigation.

An aspect of the hydrogenation program has concerned the production of gasoline and diesel oil from heavy crudes. Previous research revealed that the pore size of commercial catalysts was too small for this class of oil, permitting only a small area of the compound to be exposed to the feed stream. However, during the year the staff had considerable success in developing alumina-silica catalyst supports with more desirable pore structures. And while the full implications remain to be seen, this work promises to bring about a substantial increase in the rates of high-pressure refining and to have a profound influence on the preparation of aluminum oxide used in the drying and separation of gases by thermal diffusion.

Research has continued on the flash distillation of heavy crude in a hydrocarbon vapour stream. This has led to a design for an improved distillation tower and afforded valuable experience in the extrapolation of laboratory experiments to an industrial scale.

Equally valuable has been the research in fluidized catalytic cracking. During the year the staff investigated the mechanics of fluidization of catalyst beds at high pressures and gathered equipment for cracking petroleum fractions under these conditions.

Of prime importance to the development of new and improved refining techniques is a knowledge of the basic chemical structure of oils and bituminous substances. However, determining the structural formulae of complex hydrocarbons is often difficult and present methods of doing so are not always satisfactory. Seeking new tools for the study of these substances, the staff has evolved a technique in which information on the physical and chemical properties of the compound is converted into the number of characteristic chemical groups contained. This method, which requires the use of an electronic computer, was first tested with considerable success on pure compounds and recently on petroleum mixtures.

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Coal

Work on solid fuels during the year included projects designed to improve the combustion and coking properties of Canadian coals, research in rock mechanics and ground stress, and investigations of the chemical constitution of pitches.

The Branch's fuels division has sought to encourage the use of Maritime coal in government and commercial heating plants of Central Canada. Most of the heating equipment presently in use is designed for American coal; but the Branch's combustion engineers are developing furnaces more suitable for Canadian coals. This program has included a project to change the design of grates and the alloys used in their manufacture; and performance tests on recently designed stoking equipment. A special high-temperature probe was developed and successfully used in these experiments.

Another problem in combustion research involved the deposition of ash in oil-fired boilers. Fuel-oil ash deposits from marine boilers were analyzed and possible corrective measures investigated.

Research work on Canadian coals has been undertaken both on laboratory and pilot-plant scales. One project undertaken with the Geological Survey of Canada is to correlate the petrographic characteristics of Canadian coals with their coking properties. The aim: to develop reliable laboratory methods for predicting the coking qualities of coal and coal blends.

Research in rock mechanics and ground stress seeks a solution to the problem of bumps and outbursts, one of the serious hazards of mining at depth. Studies were continued of the properties of mine rock, the deformation of strata and the strength of pillars in mine workings. Designed and tested was a new instrument for measuring the visco-elastic properties of rocks and minerals. Also under development were special instruments to measure stress changes in mine rock and a new type of electro-mechanical load cell.

Field studies in rock mechanics were undertaken in Alberta, Nova Scotia and Newfoundland, and in Europe, where a member of the staff observed the work of similar organizations.

Of value to industries using carbon and products of coal is a program of research on the chemical constitution of pitches. One of the immediate and practical benefits of this work will be a better understanding of pitches used in manufacturing electrodes for the aluminum industry. The Branch's fuels division has sought to define the constitution of these substances with greater precision by measuring characteristics such as density, refractive index, the hydrogen/carbon ratio and magnetic susceptibility. The structural analysis technique, referred to previously, was applied to pitches in an

"Bumps" and "outbursts" in certain coal mines in Eastern and Western Canada make mining at depth hazardous and costly. The Branch has under way a long-term project of investigating the complex mechanism of stress relief in mines. Here a Fuels Division engineer studies the strength properties of rock from a coal mine in Nova Scotia.

exploratory manner—a line of research that will provide a stepping stone to the systematic study of coal. And improvements were made in infrared spectroscopic methods of estimating the amount of aromatic carbon present. This technique will be a valuable help in selecting pitches for specific applications.

Radioactivity

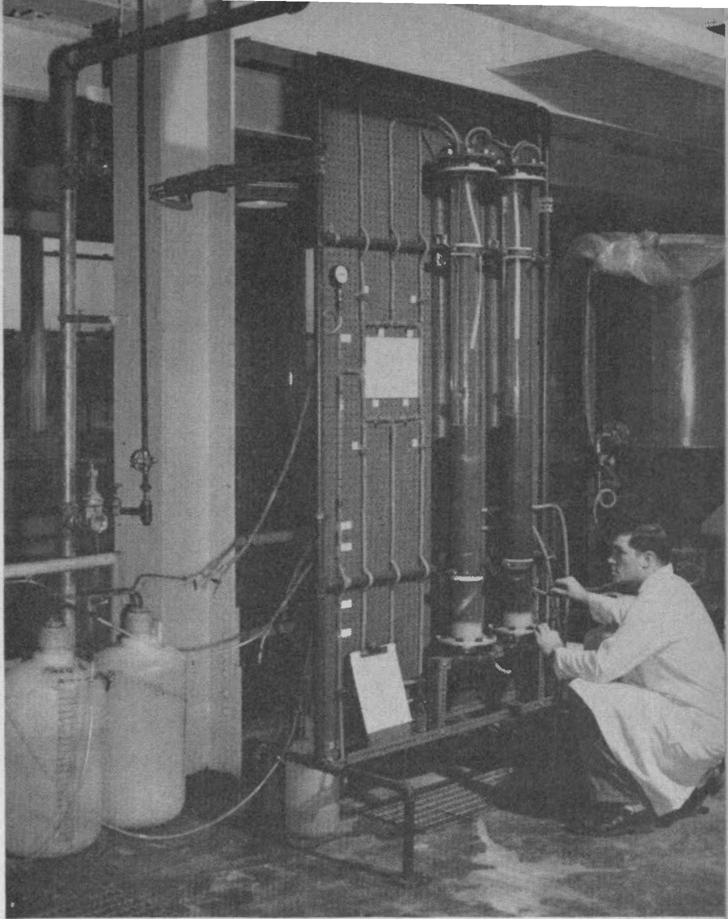
In 1958 the services and facilities of the Mines Branch continued to be in demand for the treatment of radioactive ores. However, this year, with Canada's mines largely in production, more attention was given to specific technical problems than to the design of complete extraction plants.

During the first eleven months of 1958, some 675 samples of ore, products and other materials were received for investigation, of which 651 were for assaying only, 4 for mineralogical examination and assaying, and 20 underwent concentration and extraction tests.

The Branch carried out pilot-plant studies on ores supplied by Amalgamated Rare Earth Mines Limited, Rexspar Uranium and Metals Mining Company Limited and British Newfoundland Exploration Limited. The work included high pressure and atmospheric pressure leaching, settling and filter investigations and ion exchange and solvent extraction studies, all of which provided basic data for mill design.

However, major emphasis was given to the investigation of more detailed problems such as the flotation of acid consumers, improvement of the precipitation process, and the preconcentration of values by physical means. These were undertaken for Rayrock Mines Limited, Consolidated Northland Mines Limited, Ridley Mines Limited, Northspan Uranium Mines Limited, Lorado Mines Limited and Eldorado Mining and Refining Limited. The Branch also carried out extensive pilot-plant work with Faraday Uranium Mines Limited on the recovery of thorium from waste products remaining after the extraction of uranium.

Having solved the principal problems in uranium ore treatment the Branch concentrated on the improvement of present uranium extraction processes. The object: to reduce costs, develop more efficient techniques and, if possible, apply some of these methods to the treatment of other ores. Thus the Branch in 1958 investigated the ores of Blind River, sought a better understanding of their leaching characteristics, studied the possibility of obtaining reactor-grade products from leach liquors, examined pressure-leaching techniques and applied solvent-extraction methods to the removal of iron from aluminum sulphate solutions.



Ion exchange has proven a valuable process in the treatment of uranium ores. This two-column ion exchange unit is used in conjunction with the recovery of uranium from solutions produced in a leach pilot plant.

The Branch also completed detailed mineralogical examinations of 15 uranium ore samples, continued to investigate the synthesis of brannerite —compounds similar to the natural mineral were produced artificially—and conducted further tests on the recovery of rare-earth minerals from Blind River ores. It undertook special studies of uranium minerals of particular interest and prepared X-ray diffraction data for a family of rare-earth minerals.

The volume of chemical analyses of radioactive ores remained at approximately the 1957 level. However, considerable attention was given to the investigation of new analytical methods for detecting uranium and thorium that might be applied at the mill; and better techniques for determining the presence of rare earths in uranium concentrates.

Research on the solvent-extraction method of recovering uranium has underlined the need for better methods of detecting traces of chemicals in solution. In this project the Branch had considerable success, having developed satisfactory recovery methods for all solvents and inert diluents used in the work. In addition its chemists carried out a comprehensive program on the use of amine-type solvents in radioactive ore analysis and investigated the cation-exchange method of separating thorium and rare earths from sulphate solutions.

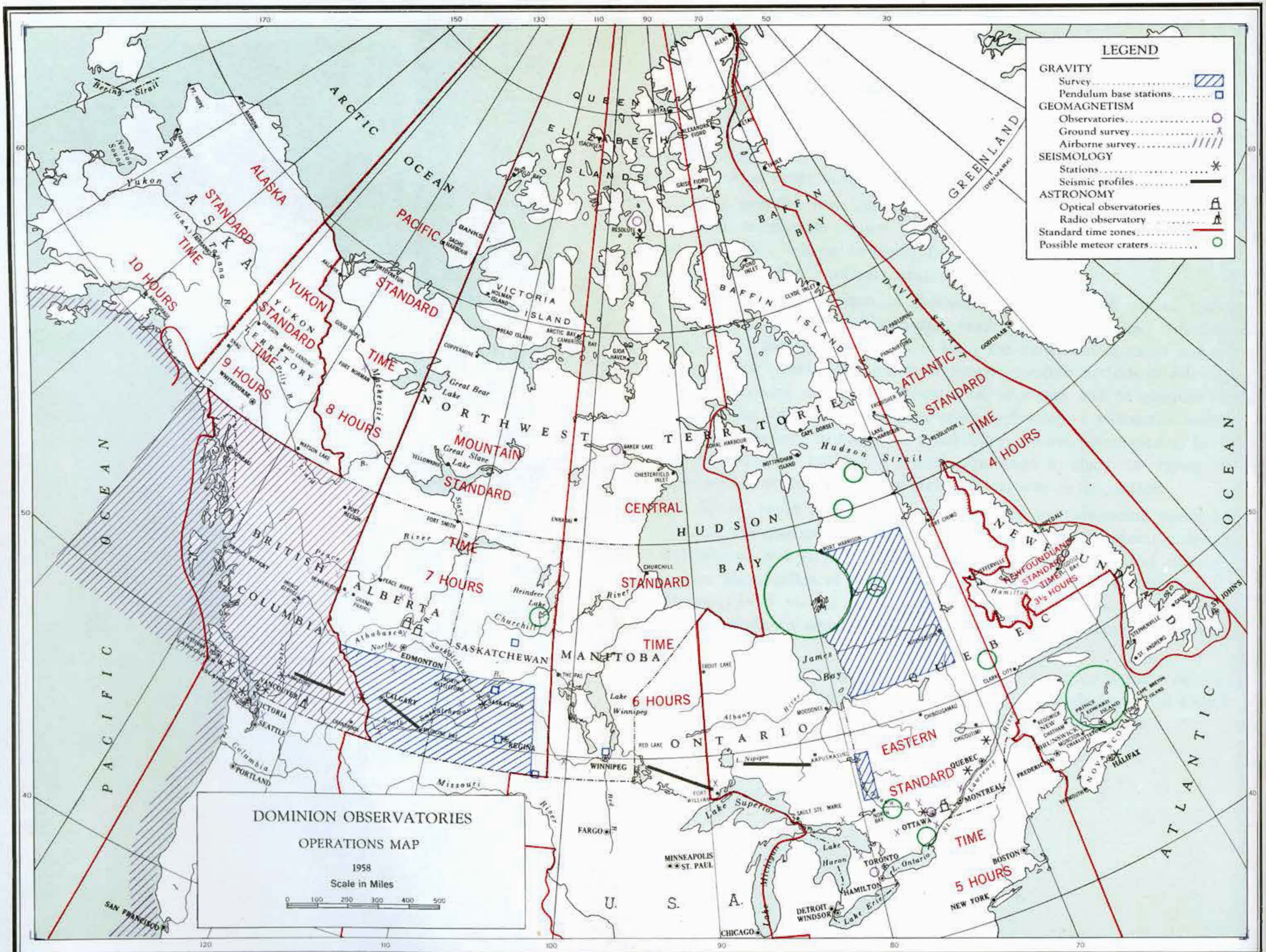
The Branch also evaluated the solubility of thorium pentacarbonate dodecahydrate in carbonate-bicarbonate solutions, developed methods for the determination of various ionic species in complex thorium carbonate solutions and made an intensive study of the thorium-Thorin color reaction as a guide to better methods for detecting thorium.

The Branch's resin-life-testing apparatus was used to evaluate a new carbonate-bicarbonate elution scheme and preliminary work was initiated on a recycling scheme involving the use of neutral 5N sodium chloride elution followed by a solvent-extraction up-grading step.

A number of projects in radioactivity furthered the use of tracers in scientific research and industrial processes. For instance, radioactive tracers were used by the Branch to study the movement of metal and slag in an electric smelting furnace, to investigate possible methods of following mineral particles in the ore-concentration processes and to compare the viscosities of mineral slurries. In another application, a radioactive isotope (Cs-137) was used to trigger an aerial survey camera automatically. In the metallurgical field radioactive tracers were used to study the segregation of impurities in metals to follow exchange reactions at the surface.

In all, about 800 samples were analyzed by radiometric means for uranium and thorium. The possible use of the gamma-ray spectrometer for this purpose was given considerable study. The instrument was also used for the identification of fission products in airborne dust samples and for the analysis of various metallic samples exposed to radioactivity. During the year alpha-ray counting equipment was set up to determine the radium content of water.

In addition to its work on radioactive ores, the Mines Branch continued to investigate corrosion problems encountered by Atomic Energy of Canada Limited and to investigate materials used in its nuclear reactors.



Dominion Observatory, Department of Mines and Technical Surveys

Produced by the Surveys and Mapping Branch, Ottawa, Canada

dominion observatories

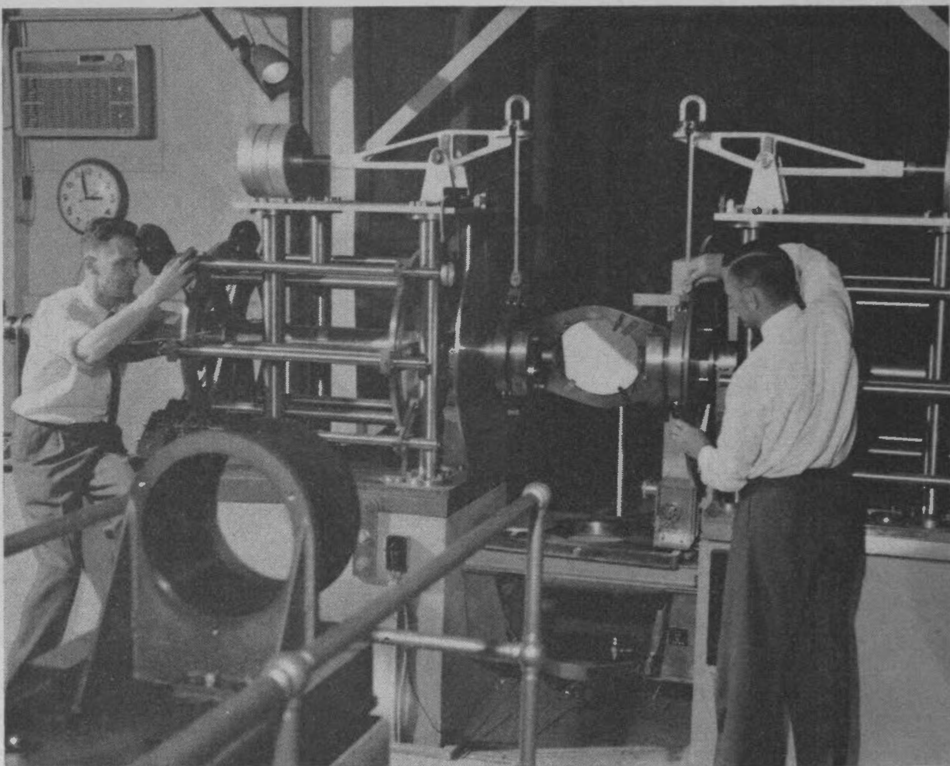
THE Dominion Observatories, whose realm in the field of stellar and earth physics extends from sea to sea and from the earth's centre to the reaches of outer space, faced an increasingly heavy work load in 1958. Contributing to a growing demand for data were, among other developments, the launching of artificial satellites, the demolition of Ripple Rock and variations in the earth's magnetic field resulting from solar flares.

In contributing to the International Geophysical Year, the Branch's responsibilities were made heavier by the fact that its segment of the globe is afflicted by intra- and extra-terrestrial forces peculiar to the Northern Hemisphere. This meant the establishment of additional research stations, the design of new instruments and the development of better observational techniques. An airborne magnetometer was flown some 22,000 miles on traverses over the Pacific Ocean as far as Australia, the Philippines and Japan.

The Branch increased its facilities for the determination and dissemination of more accurate time and, in pursuing another major objective, continued to extend the network of gravity stations in northern Quebec and across the Prairies. Soon the Branch will enter the field of radio-astronomy. Under construction during the year was one of the largest radio-telescopes in North America with a parabolic antenna 84 feet in diameter.

Positional Astronomy

The Branch's positional astronomers seek to determine where stars are located in the celestial sphere; they are also concerned with the motions of stars, the determination of time and, recently, the observation of sputniks.

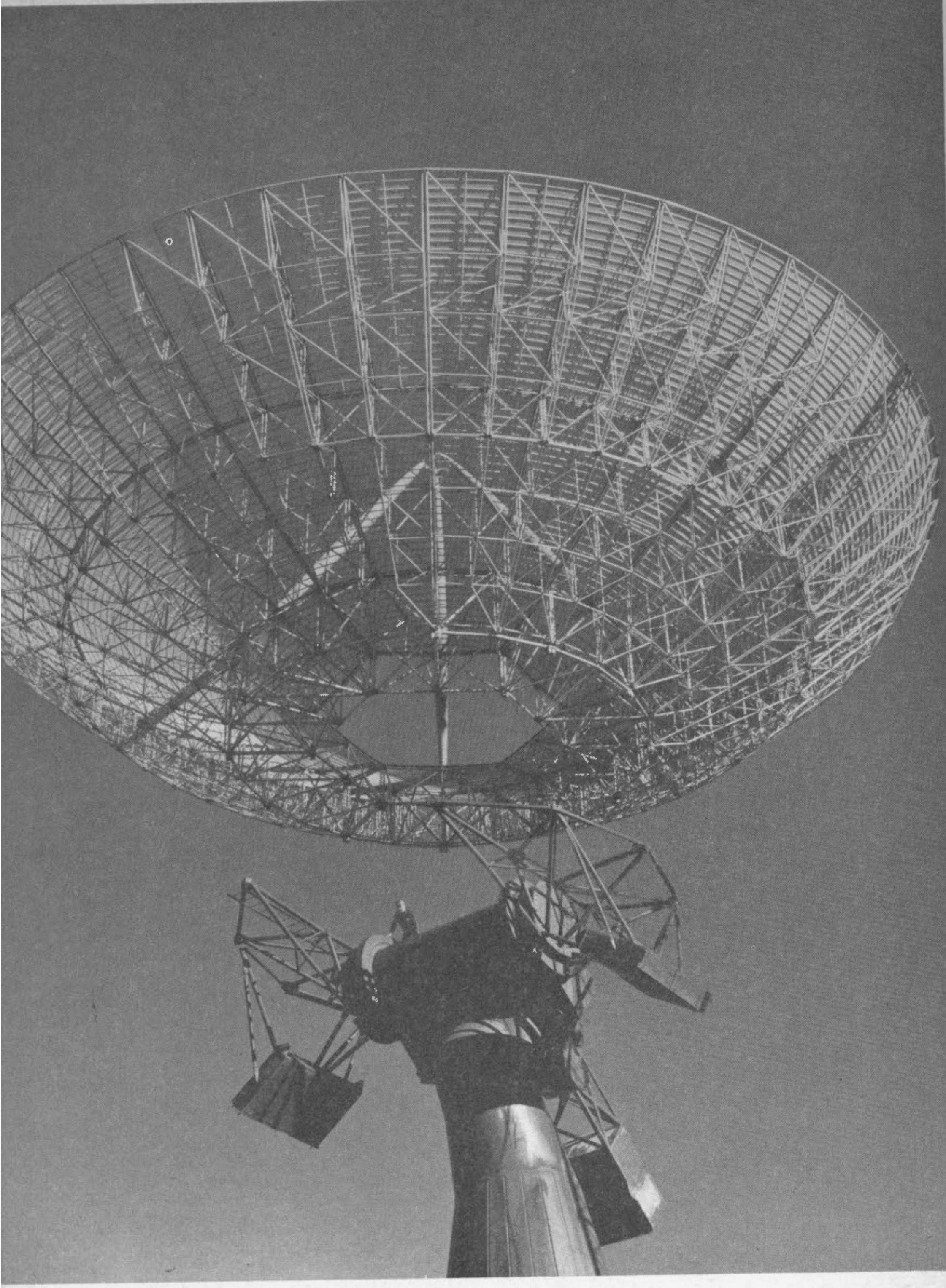


Star positions must be determined precisely to provide locations of additional stars for time determination for use in aerial and marine navigation, for surveying purposes, and for fundamental astronomical research. To this end, Observatory scientists have designed and are now assembling a new photographic instrument, the mirror transit. It brings to the determination of star positions the same sort of accuracy as the photographic zenith tube brings to the determination of time.

The Branch continued its participation in the current world program to determine the positions of some 6,500 stars—a project destined to take approximately 6 years.

For certain purposes stars may be considered as fastened to a great sphere at the centre of which is the earth. But as the earth turns on its axis, the dome of the heavens appears to rotate in the opposite direction and the reappearance of the same star on the meridian marks the passage of one star-day. So the dome of the sky may be considered as a giant 24-hour clock on whose face the location of each star is to be determined to the nearest fraction of a second.

The present survey, conducted at Ottawa and at similarly equipped observatories, shows where certain stars are now. But it also provides information that is basic to an understanding of the structure of our galaxy.



Near Penticton, B.C., the Observatory's new radio-telescope, a valuable new tool for research in radio-astronomy, is under construction. Photo shows the 84-foot paraboloid approaching its final position on the radio tower.

For instance, by comparing the observations of today with those of several decades ago the proper motion of a star can be determined, which in turn enables astrophysicists to calculate its absolute direction and speed—data leading to other facts of basic significance to man's knowledge of the universe. Specially designed for this work is the meridian-circle telescope with which Branch astronomers undertake almost 9,000 observations in the 180 clear nights a year over Ottawa.

In present-day instruments the human eye is usually replaced by a photographic plate or a photoelectric cell and the human hand by accurate frequency control. The Branch's new mirror transit telescope, which, at the end of 1958 was almost completed, will incorporate many of these improvements and add a new order of precision to meridian-circle observation.

In the determination of time, for the familiar time signal and other purposes, the Branch continued to use the photographic zenith telescope, a fixed instrument pointing directly to zenith; and the moon camera which provides a measure of ephemeris time by recording photographically the position of the moon against the star background. Modern precision quartz clocks are used to record the time of stellar observations, store the correct time between observations and provide the on-the-second beats of Canada's official time signal, broadcast continuously on three frequencies.

Once considered to be an ideal timekeeper, the earth spinning on its axis is now known to fall short. It wobbles on its axis, creating variations in latitude observations and turns more slowly in the spring and faster in the fall, aberrations that must be allowed for if accurate time is to be determined. The Branch continued to observe astronomical time and latitude at Ottawa, reporting the data immediately to the international time and latitude services and getting in return corrections for the above phenomena. The result is a highly uniform time, known as UT2, which is used to rate the most precise modern timekeepers.

Possibly the ultimate in accuracy is the atomic clock which has as its basic unit an electronic vibration rather than a mechanical one. Such an instrument has been set up at the National Research Council and its rate checked with UT2-time determined at the Dominion Observatory. In due course its rate will be compared with a similar clock in England and ultimately with ephemeris time. The atomic clock will in future provide evidence of small changes in the rate of rotation of the earth.

The broadcast of Dominion Observatories, in addition to an official time check, will soon be used to calibrate commercial and other radio transmitters. Plans were under way during the year to modify the broadcast so that carrier frequencies would be controlled by the same precision oscillator that generates the seconds' "pips". This will give Canada three standards of frequency against which other frequencies may be checked.

In 1958 the Branch made accurate observations of artificial satellites each time they came within visible range, reported the information directly to computing centres, and prepared forecasts for the Canadian public. Data gleaned from sputnik observations are furthering our knowledge of the upper atmosphere, the earth's gravitational field and other phenomena.

In August, an officer of the Branch attended a meeting of the International Astronomical Union in Moscow where he reported on the work of the Ottawa group and served as English secretary to Commission 31, Time.

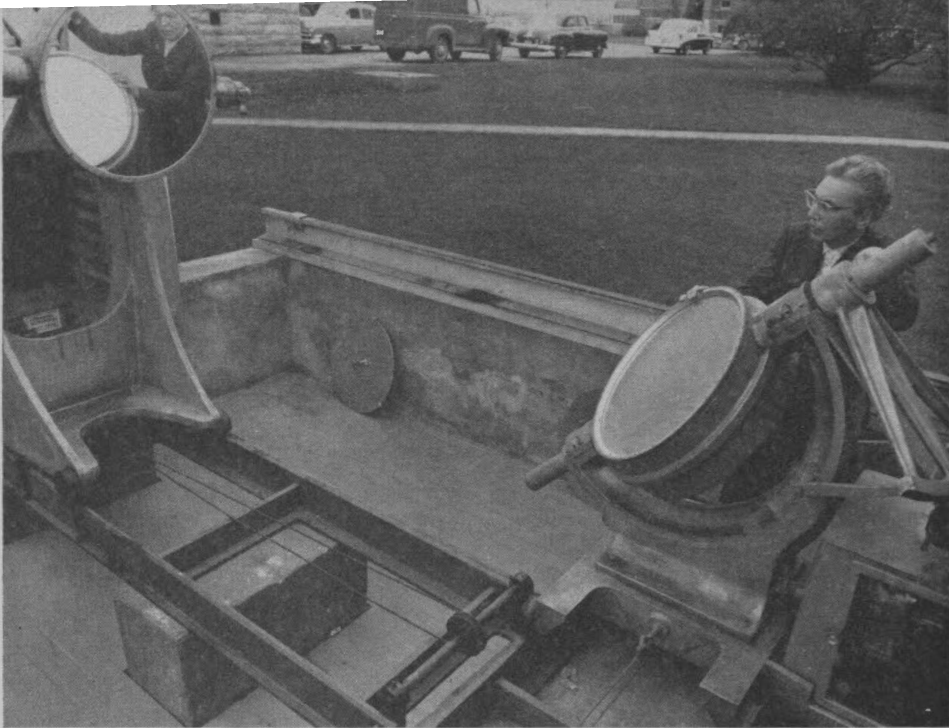
Stellar Physics

A major project during the year was the establishment of a radio observatory south of Penticton at White Lake, British Columbia. Under construction was one of the largest radio-telescopes in North America with a parabolic antenna 84 feet in diameter. The telescope foundation and control building, nearing completion at year's end, are nestled in mountains immediately west of the Okanagan valley, a location chosen for its freedom from man-made radio signals and static. Thus, the Branch is entering a field which promises to greatly further our knowledge of the universe; for the radio-telescope, although unable to produce a visual picture of the sky, can receive radiation originating at much greater distances. In fact radio waves can permeate interstellar dust clouds which obstruct the view of even the largest optical telescopes.

Work in stellar physics in 1958, much of it undertaken for the IGY program, included the systematic study of meteors, photography of the sun's surface and the observation of sputniks.

The detection and measurement of flares on the sun are essential to the scientist seeking to understand the physics of the earth's atmosphere. Violent solar flares have a profound effect upon our upper atmosphere and are the direct cause of auroras and disturbances in the earth's magnetic field. At Ottawa pictures of the sun were taken at half-minute intervals through a special filter permitting normally-invisible eruptions on the sun's surface to be seen.

During the International Geophysical Year the study of meteors was intensified. This work is of more than pure astronomical interest; meteors serve as upper-atmosphere probes, furnishing information about the regions through which they pass. At Meanook and at Newbrook in Alberta a pair



The Observatory's solar telescope, at present used in the study of the constituents of and conditions in the solar and terrestrial atmospheres, produces a solar image 9 inches in diameter. Consisting of a coelostat mirror, a second flat mirror, and a concave mirror 18 inches in diameter and 80 feet focal length, it can be focussed and guided from a position near the spectrograph. A mirror-type image rotator makes it possible to take spectra with the slit of the spectrograph in any desired direction with respect to the solar coordinates.

Dr. Paul Serson, officer in charge of the Observatory airborne magnetometer survey of British Columbia and of the Pacific Ocean, and Capt. James Greenshields, left, in command of the aircraft, exhibit the flight paths of the 1958 operations, totalling about 43,000 miles.

of the most modern cameras took simultaneous photographs of meteors from which Branch astronomers determined heights, velocities and decelerations. In addition, spectrographs were used to analyze their light and study the interaction of meteors and the atmosphere. At Ottawa, Branch astronomers cooperated with the National Research Council in studying the number of meteors reaching the earth, correlating those observed visually with those detected by radar.

At Ottawa, Meanook and Newbrook, astronomers took accurately-timed photographs of Sputnik III and thus determined its position. The information, together with that gathered at other Canadian observatories, was reported to centres in the Soviet Union, United States and England.

In addition to IGY projects the Branch continued its studies of the solar atmosphere using its large solar telescope and associated spectrograph, and carried on its systematic search for meteor craters and studies of meteor-crater formation.

Geomagnetism

Despite the development of gyroscopic and electronic direction-finding instruments, the magnetic compass is still essential for air and marine navigation, to surveying and prospecting operations, and in countless other endeavours. In fact, the need for reliable data on variations in the earth's magnetic field is greater than ever. Thus, 1958 brought an intensified demand for general and detailed magnetic charts of Canada. Items of magnetic data supplied to mapping agencies and geophysical prospecting companies totalled 1,544.

The Branch conducted ground magnetic surveys at selected stations all the way from Ottawa to Good Hope, Northwest Territories. The three-component airborne magnetometer, developed by the Dominion Observatories, was used in a Boeing B-17 on a systematic survey of the entire province of British Columbia. Flightlines in the project totalled about 21,000 miles.

The instrument was also used in an IGY project involving a 22,000-mile flight over the Pacific Ocean as far as Australia, the Philippines and Japan.

An important part of the work in geomagnetism is to record disturbances and variations in the earth's magnetic field caused by flares on the sun or by other phenomena in outer space, a task undertaken at the Branch's six magnetic observatories.* This information is important to geophysical pros-

* The Branch's magnetic observatories are located at Agincourt, Ontario; Meanook, Alberta; Victoria, British Columbia; and Baker Lake and Resolute, Northwest Territories. A sixth, at Yellowknife, N.W.T., was closed down in August 1958 after 14 months of operation.

In a study of regional gravity in the region east of Hudson Bay, an Observatory scientist is shown reading a Worden gravimeter near the shore of Clearwater Lake in western New Quebec.

pecting in which magnetic methods are used and disturbances of this sort must be allowed for. Also affected are telecommunications by wireless, land lines and submarine cables as well as certain radar-detecting installations. Canada's responsibility in the matter is made more important by the fact that the north magnetic pole and part of the zone of maximum auroral activity are within its borders.

Studies of all types of disturbance phenomena were intensified in 1958. Copies of magnetic records from Canadian observatories were supplied to world data centres, to commercial geophysical prospecting companies and to an increasing number of scientific centres in Canada and elsewhere.

The Branch investigated magnetic rock samples from drill cores of suspected meteor craters. Preliminary studies point to the possibility of determining whether or not certain geological features resulted from the impact of fallen meteors.

Gravity

Gravity measurements are important to the solution of geodetic problems concerning the true shape of the earth and to understanding the physical properties of the earth's crust. They have also proved valuable in determining the structural geology of certain areas and in the search for mineral wealth.

To be of greatest use, therefore, the gravity survey of an area should be carried out before or at the same time as the geological survey.

In 1958 the demand for gravity data increased approximately 38 per cent. The Branch continued to extend the network gravity stations aiming eventually to completely cover Canada's land mass. Two major regional surveys were carried out during the year: an airborne project in northern Quebec, in which more than 1,000 stations were established within an area of approximately 75,000 square miles, will help in determining the structural geology of part of the Canadian Shield; the other major regional survey was carried out on the Prairies in cooperation with the oil industry. Results from field work permitted the compilation of three new gravity maps for the area south of latitude 52°N in Alberta and Saskatchewan.

To date, the results from more than 16,000 stations in the southern areas of Canada have been compiled. But the Cordilleran region and northern half of the country are limited to a few widely scattered measurements and it is estimated that it will take at least 30 years to complete the gravity mapping of Canada on a reconnaissance scale.

If gravity measurements are to be applied successfully to geodetic problems it is important that a homogeneous network of stations be established over the whole surface of the earth, and that gravity standards in Canada be consistent with those of other countries. These standards are maintained with the use of the Branch's recently-developed pendulum apparatus and during the year observations were made at Winnipeg, Estevan, Regina, Saskatoon and Lac la Ronge to serve as control for regional gravimeter surveys. Measurements were also completed at Washington, D.C.; Ithaca, New York; and Prescott, Ontario to strengthen the ties between the gravity networks of the United States and Canada.

As part of Canada's contribution to the IGY program, the Dominion Observatories have maintained specially constructed gravimeters at Meanook, Alberta; Resolute, Northwest Territories; and at Ottawa, continuously recording tidal variations in gravity. The results, which are forwarded to world data centres, provide important information concerning the rigidity of the earth.

Seismology

The Canadian seismograph network continued in operation with little change. Reconstruction of the station at Resolute was completed during the year, making it the best equipped and most sensitive in Canada; and a new seismograph vault was being built on the radio-telescope site near Penticton, British Columbia. A temporary station was set up at Lillooet, British Columbia, to record local earthquakes that might affect dam sites in the area, while the Kirkland Lake station in Ontario and a temporary one at Schefferville, Quebec were closed.

The eleven-station network records several earthquakes a day from all parts of the world. Information from the three key stations is sent by radio to the United States Coast and Geodetic Survey in Washington, the central agency for determining the times of occurrence and the positions of earthquakes. However, final data from all eleven stations were published in quarterly bulletins; and frequent measurements of continuous small earth movements (microseisms) were made for the IGY program which also required the maintenance of special instruments for other research organizations.

The Observatories were represented at the conference of experts on the detection of nuclear explosions held in Geneva. Recommended was an international control system which would include a world-wide network of stations equipped with elaborate geophysical apparatus including seismographs of the most advanced design.

Research continued on the nature of movement at the focus of an earthquake. The original method of earthquake analysis has now been reduced to a routine which is applied to all large enough to yield reliable results—normally about 30 a year. In addition the Branch sought to develop new methods of recording and analyzing data. Holding considerable promise is a project to record earthquakes on magnetic tape, instead of on photographic paper, which will enable seismologists to study the earth's motion in much greater detail. At year's end the seismometer for generating the electric impulses was completed and the assembly of the recording and playback equipment about to begin.

Also undertaken during the year were field studies of the Ripple Rock explosion—undertaken with the cooperation of the Department of Public Works, the Royal Canadian Navy, the Canadian Broadcasting Corporation, the Canadian Pacific Railway and various oil and geophysical exploration companies. Tremors from the explosion were observed strongly at Banff, and less strongly at temporary stations on a line extending eastward in Alberta to Medicine Hat.

In another field operation, carried out with the Defence Research Board, tremors were recorded from atomic explosions in Nevada. Observations were obtained at five temporary stations in northern Ontario and at permanent observatories as far away as Resolute.

Astrophysics

The astrophysicist seeks to determine, among other things, the speed of stars, the elements in their atmospheres, their surface temperatures, their true brightness and their distances.

The work of the Dominion Astrophysical Observatory at Victoria, British Columbia consists primarily in observing stellar spectra for this purpose. Original observations are made with the 72-inch reflecting telescope and the stellar spectrograph attached to it. Thus the light from a star is broken into a spectrum whose lines reveal much about the star's composition and physical condition. Moreover, the displacement of these lines from the normal is a clue to the star's velocity of approach or recession.

In 1958 the telescope was used on 213 clear nights to obtain 1,417 photographs of stellar spectra. Line-of-sight speeds were measured for the first time for more than 100 stars and close scrutiny was given to 20 double-star systems. The latter are particularly important for they provide the key to the study of stellar masses and densities. Detailed studies were made of the spectra of very hot and very luminous stars and those of variable light intensity. These projects will lead to a greater understanding of the size of our galaxy, the sun's position in it, and indeed the history of the universe itself.

As part of the IGY program, the Astrophysical Observatory put into operation a special camera and timing equipment for taking photographs of earth satellites and thus obtained accurate information on their positions.

Considerable progress was made in the design and construction of new equipment: a new 48-inch reflecting telescope was under way during the year and a building for the observatory shop was completed. Numerous pieces of equipment required in astrophysical work were also designed and assembled. Some 10,000 persons visited the Astrophysical Observatory during the year.

geographical branch

IN 1958 the Geographical Branch intensified its research on the geography of the country and surveys of land use. It continued also to provide basic geographical data to government departments, institutions and to private interests.

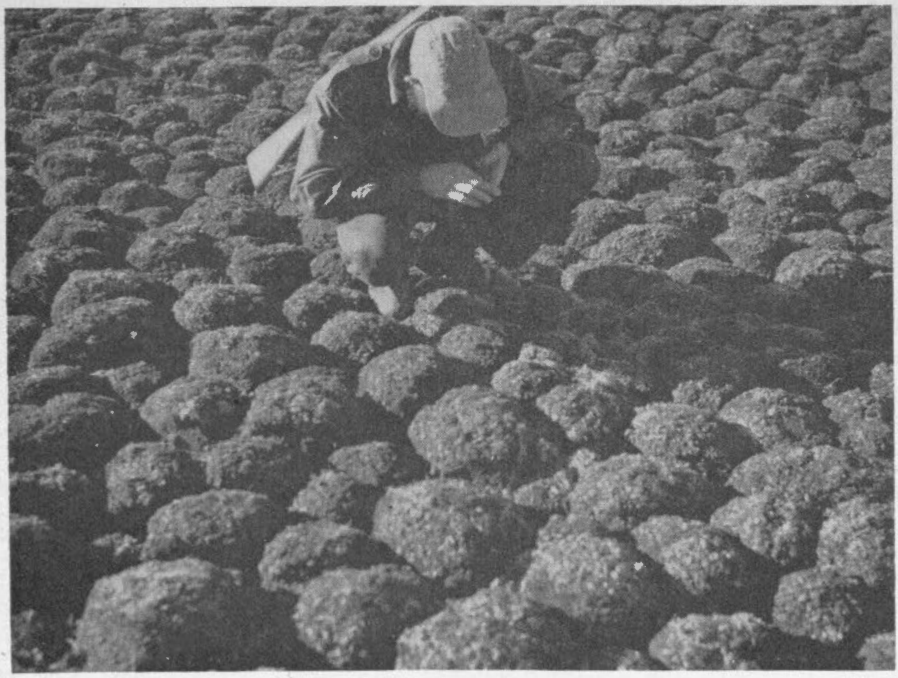
Publication of the English edition of the *Atlas of Canada* in December was among the main accomplishments of the year. Meanwhile, preparation of the French edition was under way, with publication expected by the end of 1959 or early 1960.

Other activities included: surveys of ice conditions in the Gulf of St. Lawrence and in the eastern Arctic; field studies of surface terrain conditions in portions of the Arctic and sub-Arctic to acquire information needed in northern development and defence; land-use surveys in Newfoundland, Nova Scotia, Ontario, Saskatchewan and British Columbia; and studies in connection with the proposed causeway across Northumberland Strait, which separates Prince Edward Island from the mainland.

In all, 12 parties carried out field investigations: five in the Far North, three in the Maritimes, two in Quebec, one in Ontario and one in British Columbia.

On invitation of the Soviet Academy of Sciences, the Branch Director attended a meeting of the International Geographical Union's commission on national atlases in Moscow; he also visited Leningrad and government agencies producing atlases in the two cities.

Geographers examine the strange arctic phenomenon known as "patterned ground" in northern Ellesmere Island, N.W.T. The earth hummocks shown in a wide expanse above, and in the close-up below, are thought to be caused by soil uplift resulting from ground-water pressure and frost action.



Terrain Analysis

The Branch conducted field studies of surface conditions and land forms in the Mackenzie River delta and along the Peel River, at various points on the western section of the Distant Early Warning Line, on Boothia and Melville peninsulas and in northwestern Ungava. A Branch geographer made investigations at Lake Hazen on Ellesmere Island as part of Canada's program for the International Geophysical Year coordinated by the Defence Research Board. The work included a study of the evolution of the landscape and the distribution of terrain types in the region; hydrographic observations; observations of wild life, evidence of glaciation, Eskimo occupancy and ice conditions. The resulting geographical reports in preparation at the end of the year will include photo-interpretation keys to enable land features to be identified and their significance to be determined from their photo-images.

In addition, a geographer was assigned to the McGill University Sub-Arctic Research Station at Schefferville, Que. to examine periglacial geology in the vicinity. His purpose: to obtain information on periglacial features of the sub-Arctic for comparison with data previously collected in the high Arctic islands. Another participated in a symposium on applied geography at Laval University, Quebec.

In the office, the Branch continued to gather information on surface terrain conditions in Northern Canada for use of the Defence Research Board. The data, which concerned land forms, surface deposits, vegetation and water features, are plotted on 1-inch-to-8-mile sheets of the National Topographic series. During the year a complete revision was made on 92 sheets as more data and more detailed topographic maps became available.

Land-use Surveys

The Branch's land-use surveys, which aid in the development of a solid basis for forestry, agricultural or community planning, are carried out in collaboration with the provinces concerned.

In Newfoundland, the Branch completed its 1957 land-use survey of the Avalon peninsula and made the resulting data available to the provincial government. In addition the 33 large-scale maps prepared from the survey were generalized for presentation on a scale of 1 to 1,000,000 to be included in the *Atlas of Canada* and the World Land Use map of the Maritime Provinces.

Field work carried out in 1958 completed the Branch's preliminary land-use survey of Nova Scotia. Map sheets at a scale of 1 to 250,000 embodying the results are in preparation. The Branch prepared special reports on the Sackville-Amherst and the Springhill areas, based on this survey. One was requested by the Canadian National Railways, the other was for use in planning the redevelopment of the Springhill disaster area.

The Branch began a land-use map of southern Ontario on a scale of 1 to 1,000,000. Intended for future publication in the *Atlas of Canada* as a supplementary plate, the map will also form a contribution to the World Land Use mapping program of the International Geographical Union.

In addition, Branch geographers surveyed the distribution of daytime population in Hamilton, Ontario and completed the last of seven large-scale maps of the Hamilton land-use series. The work is part of a program undertaken for the Civil Defence Division, Department of National Health and Welfare.

In Toronto, the Branch continued its geographical analysis of the relationship between land-use and manufacturing—a project conducted with the cooperation of the Department of Geography, University of Toronto.

Material and advice were provided to the National Film Board for the production of a filmstrip on Winnipeg, embodying the results of the Branch's land-use surveys of that city.

In 1958 the Branch acted as the coordinating agency in Canada for the UNESCO Advisory Committee on Arid Zone Research which is concerned in part with the systematic compilation of data on the arid areas of the world. It also continued to investigate and compile data on southwestern Saskatchewan. The research project, undertaken in the office, is essentially a study of land use, including many geographical aspects: aridity, occupancy, transportation and settlements; and the present exploration of the area and the adjustment of the people to their environment, tracing past and present relationships. By year's end a preliminary report had been completed and the results of the work were being combined with those concerning the semi-arid area of Alberta.

Research was also completed for a precise climatic definition of the vegetation zone of the southern Great Plains.

The Branch began a land-use survey of British Columbia. Manuscript land-use maps of Richmond and Delta municipalities were completed on a scale of 1,000 feet to one inch.

Canadian Ice Distribution

In the spring of 1958 the Branch conducted an aerial survey of ice conditions in the Gulf of St. Lawrence for the purpose of observing and mapping the

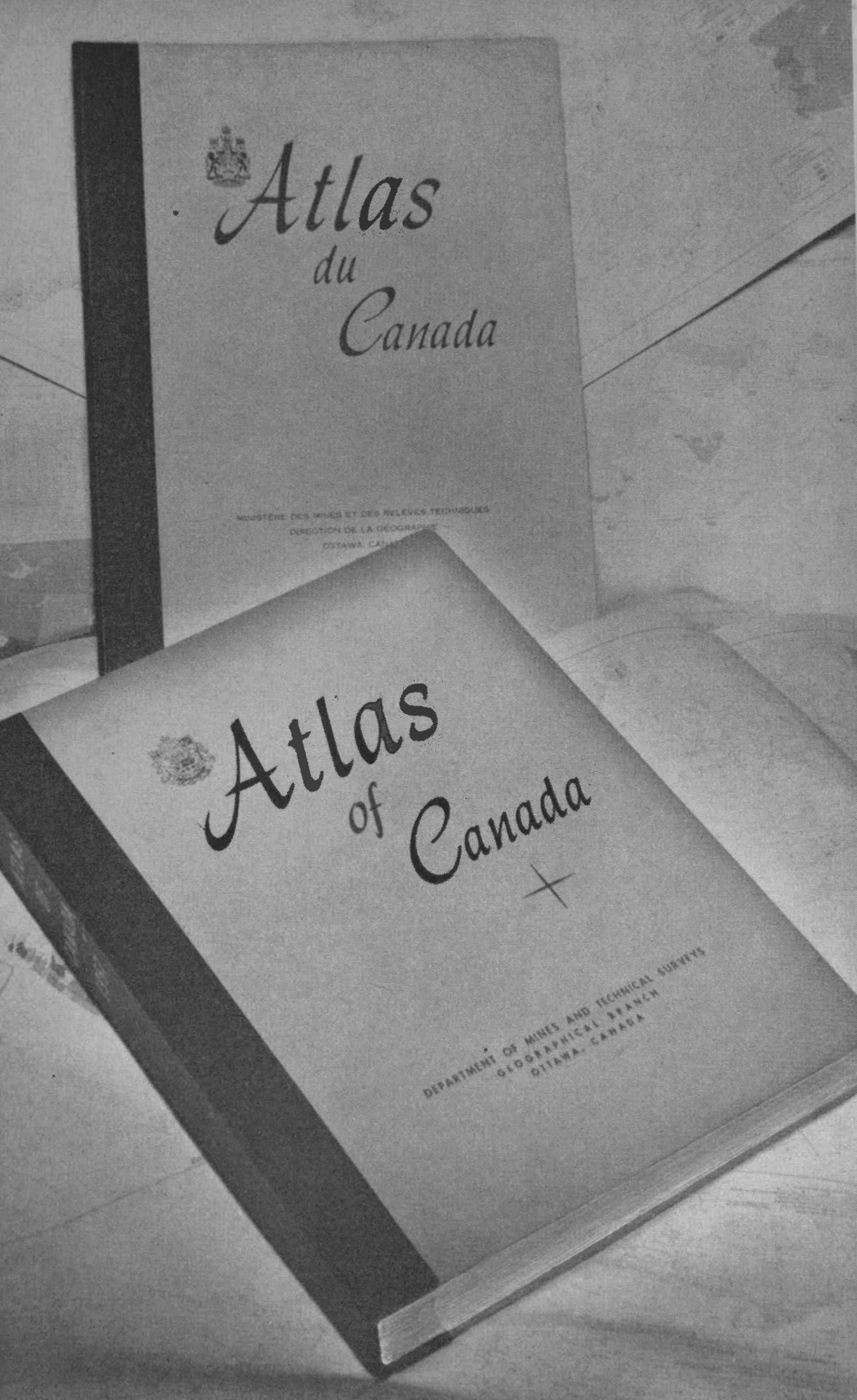
Branch geographers frequently accompany Department of Transport vessels on northern patrol, to check and record ice conditions in Canada's north. Here the C.G.S. *d'Iberville* steams north in open pack ice in the central Norwegian Bay area of the Arctic archipelago. (*NFB photo*)

coverage and distribution of various types of ice and its general movement.* The survey was part of a program to determine the relationship of ice distribution to climatic factors and the effects of ice coverage on winter navigation. The results have now been published.

The Branch initiated a system of ice observation from shore stations along the estuary and Gulf of St. Lawrence between Quebec and the Strait of Belle Isle along the north shore, and from Pointe-au-Père to Cap-des-Rosiers along the south shore. Altogether, 30 observation stations were established in the winter of 1957-58. This number was increased to 60 for the 1958-59 program. An analysis of the observations will permit the study of ice conditions in relation to factors such as temperature, wind, currents and tides. The information will supplement knowledge gleaned from the aerial ice survey and enable the data to be used in connection with winter navigation in the estuary and Gulf of St. Lawrence.

Sea-ice conditions were also surveyed by a Branch geographer acting as ice-observer on the C.G.S. *d'Iberville* during its annual supply mission to the eastern Arctic. His purpose: to report on the distribution and nature of the ice along the ship's route and acquire other pertinent information. The geographer also participated in an International Arctic Sea-ice Conference, on the invitation of the United States National Research Council, at Easton, Maryland.

* This project was undertaken jointly with the RCAF and the Defence Research Board and with the cooperation of the Federal Department of Transport.


Atlas du Canada
MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES
Atlas of Canada
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
GEOGRAPHICAL BRANCH
OTTAWA, CANADA

In addition, over 11,000 extracts were made and filed from books, pamphlets and other data on the annual dates of break-up and freeze-up of inland waterways.

Regional Surveys

In 1958 the Department of Transport was investigating the feasibility of building a causeway across Northumberland Strait, separating Prince Edward Island from the mainland. Certain aspects of this study were, at the Department's request, undertaken by the Geographical Branch. Under consideration was the effect of the causeway on sea-ice conditions and the shorelines of the Strait. The fact that tides and currents would be greatly altered by the existence of a causeway led the Branch to make a detailed investigation of probable damage to property and increased erosion that would occur. During the summer it mapped shoreline characteristics, sought data on ice formation and acquired additional information from aerial photographs.

Cartography and Reference Services

Special Maps

In all, 375 drawings were produced to illustrate Branch reports and 48 maps and diagrams were drawn for other government departments and agencies. Three of the latter were published in *Foreign Trade,* a Department of Trade and Commerce publication, 13 were route maps in connection with Princess Margaret's visit to Canada and 8 were for the proposed visit of the Queen in 1959.

Maps, Books, and Photographs

The Branch arranged special exchanges of geographical texts and small-scale maps with 39 countries, with the cooperation of the Department of External Affairs. It added approximately 8,500 sheets, including 365 Canadian city maps and town plants, to its map library, bringing the total to 128,500. Nearly 1,500 books, phamphlets and atlases were acquired, bringing the total number of volumes to almost 20,000. Close to 3,500 photographs were added to the ground photograph library so that the collection now amounts to about 23,500 prints.

In addition, the Branch provided a folio of map sheets of various foreign countries to the Prime Minister and his staff for use on their tour of Commonwealth countries. A bibliography on Canadian geography was submitted to *Bibliographie Géographique Internationale,* a reference work on world geography, published under the auspices of the International Geographical Union; and an annual listing of maps published in Canada was sent to *Bibliographie Cartographique Internationale.*

The Branch also supplied bibliographic references on Canadian mapping to *Deutsche Gesellschaft fur Kartographie* (German Association of Cartography). This information will be published in *Bibliotheca Cartographica* to which the branch will continue to act as Canadian contributor.

Atlas of Canada

The final 86 sheets of the English edition of the *Atlas of Canada* were printed during the year, and the whole published in December. Work on the French edition continued and a special committee was established to deal with the French translation of geographical names. By the end of the year, it had dealt with all names on the Atlas base maps; three sheets of the French edition had reached the color-proof stage of reproduction.

administration

AS the Department broadened the scope of its research and technical surveys, the work associated with the administration of its finances, the management of its property and the purchase of new equipment continued to grow. Meanwhile the Department shouldered the increasingly demanding task of keeping tab on the economic health of the mineral industry and administering the Emergency Gold Mining Assistance Act and the Explosives Act.

A major problem during the year—made particularly difficult by the Department's intensified interest in oceanography—was the recruiting of personnel. Generally speaking, the staffing picture in 1958 showed improvement; but both oceanographers and hydrographers were extremely hard to find.

Personnel officers continued to visit universities to encourage graduating students to consider a career with the Department, and in summer, a number of university professors were taken on strength. In all there were 296 additions to staff and 219 separations; 70 intradepartmental promotional competitions were conducted during the year.

In 1958 the Department's Scientific Appraisal Committee held sessions for the first time. It was set up to review recommendations for advancement of scientific officers in the Mines Branch, Geological Survey of Canada and the Dominion Observatories.

Mineral Resources Division

Despite the 1958 price and production declines, Canada's mineral industry, generally speaking, overcame many of the difficulties wrought by recession. Uranium mines, for instance, almost offset the losses recorded by producers of iron ore, petroleum and asbestos. In fact, at $2,122,154,000, the value of Canada's mineral output was only 3 per cent below that of the previous year.

The activities of the Mineral Resources Division reflected the state of the industry and the developments affecting it: In October, 1958 the natural gas pipeline from Alberta to Ontario and Quebec was completed. Output from the world's largest nickel producer at Sudbury, Ontario, was stopped owing to a strike from September to almost the end of the year. The United States Government reimposed the import tax on copper, effective July 1, 1958, and instituted a quota on lead and zinc imports which took effect on October 1. These and similar matters occupied the attention of the Mineral Resources Division.

Royal Commission on Energy

An officer of the Division was on loan throughout the year to the Royal Commission on Energy (the Borden Commission) as a senior technical adviser. The Division also aided the Commission in gathering data on the development, transmission, domestic use and export of energy and energy sources. Also important was the Division's work in the preparation of legislation for the establishment of a National Energy Board for introduction in Parliament early in 1959.

Lead and Zinc

The Division was intensely concerned with developments affecting Canada's lead and zinc producers.

In August 1957 the President of the United States directed his country's Tariff Commission to determine whether the health of the American lead and zinc mining industry called for tariff increases or similar action. After a series of public hearings, the six-man commission unanimously recommended higher duties and, in a split decision, import quotas amounting to about 50 per cent of annual imports from 1953 to 1957.

Meanwhile, the U.S. Department of the Interior, whose sliding-scale tariff recommendation had been rejected a year earlier, introduced their Domestic Minerals Stabilization Plan for the subsidization of domestic production of lead and zinc. This, however, was defeated in the House of Representatives and the President announced that quotas on imports of lead and zinc would be imposed, effective October 1, 1958.

The Mineral Resources Division not only prepared information for briefs submitted to the U.S. Tariff Commission, but discussed the effect of the stabilization bill and the imposition of quotas with Canadian industry and various government departments. Subsequently the Interim Co-Ordinating Committee for International Commodity Agreements of the United Nations met in London and later in Geneva to discuss ways and means of solving the situation confronting the world lead-zinc industry. Again, the Mineral Resources Division reviewed the briefs of delegates to both meetings and assigned an officer to act as an official delegate to that at Geneva.

Wartime Oils Limited

In 1958 the Division continued to administer the agreements which Wartime Oils Limited, a former Crown company, made with certain oil-well operators in Turner Valley, Alberta. This entails the preparation of regular reports of all maintenance work on each well, appraisal of the condition of well equipment, and many other matters.

Roads to Resources

Under its roads to resources policy, the federal government, through the Department of Northern Affairs and National Resources, offers financial assistance to the provinces for road construction of value in the development of resources in new areas.*

In 1958, officers of the Mineral Resources Division met several times with those of the various branches of the Department to consider the roads program submitted by British Columbia, Saskatchewan, Manitoba, Ontario, New Brunswick and Newfoundland. The plans were critically reviewed and, in several cases, rerouting or new routes were recommended to the Interdepartmental Roads Appraisal Committee and to the provinces.

The Division is active on the above committee which comprises officers from the departments of Northern Affairs and National Resources, Public Works, and Mines and Technical Surveys. Three officers from the Division, one of whom acts as secretary, comprise the Mines and Technical Surveys membership.

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* This is for a five-year period beginning April 1, 1958 and will amount to 50 per cent of the cost of construction of roads in an agreed program up to a maximum of $1,500,000 for each province in any one year, or up to $7,500,000 over the five-year period.

Officers of the Branches and the Mineral Resources Division also reviewed northern development roads programs of Yukon and Northwest Territories, and proposed an additional number of new roads.

U.S. Copper Tariffs

Prior to the reimposition of the 1.7-cent-a-pound import duty on copper entering the United States, the Division prepared a study of the Canadian copper-mining, smelting, refining and consuming industries. It traced the development of the Canadian copper industry and the effects the tariff would have on various segments of the copper-mining industry.

Consulting Services

The Division served both industry and government in a variety of ways. It advised the Industrial Development Bank in connection with loans made to industry; prepared a report on Russian nickel production and reserves for a Canadian producer of nickel; assisted metal producers in respect to the costs of producing lead and zinc in Canada vis-à-vis the United States and advised the National Film Board in the preparation of a Department-sponsored filmstrip on aluminum. The Division was consulted by the Department of National Revenue on an income tax court case involving depletion calculation in the petroleum and natural gas industry. It also provided information to the Air Transport Board regarding applications to operate airline flights to the Ungava nickel area of Quebec; advised the Department of Justice in a court case involving the expropriation of a silica property; and the Department of Northern Affairs and National Resources on requests for federal government financial participation in the construction of mining access roads.

The Division prepared numerous memoranda and reports and was constantly consulted on mining and petroleum taxation and legislation by government departments, private organizations and individuals. At the request of the Department of National Revenue, it reviewed applications of 29 companies for a tax exemption under the provisions of subsections 5 and 6 of Section 83 of the Income Tax Act and two for certification under subsection 1 of Section 1201 of Income Tax Regulations. New and proposed foreign legislation, which might directly or indirectly affect the Canadian mineral industry, were closely studied.

An ever-increasing number of mining and other companies were furnished with statistics relative to the mineral industry; and Canadian and foreign companies of all kinds were given information and advice as to sources and grades of Canadian ores, concentrates and refined metals. The Division was also consulted by a number of foreign companies interested in investing in Canadian mines and other projects.

Field Work

A factual, first-hand knowledge of the mineral industry is indispensable to the work of the Division. In fact, its officers annually carry out field investigations involving all aspects of the industry—mining, milling, metallurgical and final fabrication. In 1958, studies of this kind were carried out in all provinces and territories except Nova Scotia and Prince Edward Island. Given particular emphasis were: lead and zinc, copper, iron ore, iron and steel, petroleum and natural gas, nickel, uranium, and titanium. The Division also inspected all gold mines receiving assistance under the Emergency Gold Mining Assistance Act.

Information Services

With the collaboration of two divisions of the Mines Branch, the Division issued 63 reviews during the year covering 1957 developments in each of the metals, minerals and fuels produced or extensively used in Canada. Public demand for these has increased tenfold over the past decade.

The Division's popular 1-inch-to-120-mile map of Canada's principal mineral areas was revised, and some 13,000 copies distributed during the year. Also prepared was a colorful brochure on the Canadian mineral industry for distribution at the Brussels exhibition in Belgium, to Canadian schools, Canadian missions abroad and foreign trade fairs; and, seven annual Operators Lists, two information bulletins, and one memorandum for general distribution. Published in time for the completion of the St. Lawrence Seaway in 1959, was a revised edition of the Division's map showing the location of coal, iron-ore, iron and steel areas in relation to the St. Lawrence Seaway.

Each month the Division prepared a summary of important developments in, or affecting, the Canadian mineral industry, for the Minister. This report was also distributed to senior officers of the federal and provincial government departments.

Foreign Visitor Tours

The Division assisted mining and geological specialists from foreign countries in study tours of the industry, arranging lengthy ones for specialists from Australia, Burma, India and France.

The work was undertaken as part of Canada's commitments to the Colombo Plan and the United Nations Technical Assistance Organization.

The Emergency Gold Mining Assistance Act

Assistance to the gold-mining industry was continued during 1958 under the terms of The Emergency Gold Mining Assistance Act. Extension of payments to the calendar years 1959 and 1960 was authorized by Chapter 28, 7 Elizabeth II, 1958, which received Royal Assent on September 6. The amendment to the Act also authorized an increase in the amount of assistance, as calculated under the present formula, by 25 per cent for each of the years 1958, 1959, and 1960.

The Act is administered under the direction of the Deputy Minister by a senior officer of the Division. An inspection engineer visits annually each mine or project receiving assistance, reviews its operation for the year, discusses any pertinent problems, and determines the exploration and development capital expenditures to be included as "allowable costs", as defined by the Act. In addition, the Cost Inspection and Audit Division, Office of the Comptroller of the Treasury, conducts an annual audit of the books of account of each mine to verify the applications.

Since the inception of The Emergency Gold Mining Assistance Act in 1948 the amount payable to gold mines has been calculated by multiplying two factors: 1) the *rate of assistance,* based on the cost of producing one ounce of gold, 2) *assistance ounces* which are a specified proportion of the number of ounces produced. The rate of assistance is two-thirds of the amount by which the production cost per ounce exceeds $26.50. The maximum per ounce is $12.33. The number of assistance ounces is two-thirds of the number of ounces produced and sold in accordance with the terms of the Act in the calendar year.

This formula has not been altered for the three years 1958 to 1960, but 25 per cent is added to the amount computed by the formula to obtain the total cost-aid to be paid to the operator.

The average price per ounce of gold paid by the Royal Canadian Mint in 1957 was $33.35 as compared with $33.97 in 1958. During 1958 the average weekly Mint buying price for gold in Canadian dollars steadily declined from $34.62 per ounce in the first week in January to a low for the year of $33.59 per ounce during the week of July 21-25. The buying price stood at $33.74 for the last week of December. Thus, the gold-mining industry was adversely affected by the premium on the Canadian dollar throughout the year.

During the year, 200 applications for assistance were received from 57 operating lode and placer gold mines. The applications were processed by the Cost Inspection and Audit Division of the Office of the Comptroller

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of the Treasury, reviewed by the Department of Mines and Technical Surveys, and the approved payments made to the mines. Fifteen final audits remained to be completed at the end of 1958 with respect to the calendar year 1957.

One lode gold mine resumed operation and two ceased production in 1958. Nine lode gold mines were operating at costs less than $26.50 per ounce and, therefore, were not eligible for cost-aid.

The amount of assistance paid to the gold-mining industry to December 31, 1958, in respect of each of the calendar years since the Act became operative is tabulated below:

Year	Assistance paid	Per ounce produced
	$	$
1948	10,546,315.84	3.33
1949	12,571,456.90	3.48
1950	8,993,490.51	2.55
1951	10,728,503.71	3.30
1952	10,845,978.62	3.76
1953	14,678,482.79	4.62
1954	16,251,042.70	4.28
1955	8,866,143 81	2.96
1956	8,667,235.38	3.46
1957*	8,805,776.65	3.45
1958**	5,018,070.34	not available

* Final audits are not completed.
** Advance payments made during 1958.

Administration of the Explosives Act

The Division issued 1,841 licences and permits in 1958 covering the manufacture, storage and transportation of explosives. These comprised 20 for factories, one for a magazine depot, 437 for permanent magazines, 1,032 for temporary magazines, 98 for registered premises and 253 transportation permits.

The number of inspections carried out during the year was as follows:

Factories	39
Magazines and Registered Premises	2,142
Unlicensed Premises	126
Transportation	76

The Division issued 1,357 general import permits and 40 annual import permits, covering mainly fireworks and ammunition, distress signals, nitrocellulose for paint and lacquer manufacture, and seismic explosives for oil exploration.

Prosecutions for infractions of the Explosives Act and Regulations were instituted in over 35 instances. One case was dismissed and several are still pending. Offences included illegal manufacture, storage, and transportation. Fines of up to $150 were imposed but in some cases of youths charged with making rockets or home-made bombs, suspended sentences were given.

In the laboratory, explosives were tested and analyzed as required by the Act. In all, 185 samples were received and examined as follows:

Commercial High Explosives	
authorization	17
run-of-work	24
Ammunition	20
Fireworks including toy pistol caps	116
For other government departments	8
	185

Considerable interest continued to be shown in the use of the "field-blended" explosive, ammonium nitrate and fuel oil, which is relatively insensitive and low in cost. So far the use has been limited to open-pit mines and quarries although some construction companies have used it in excavation work. In all, 152 letters of permission have been issued for the explosive, 58 of them in 1958. Such permission covers blending of the two ingredients at the drill-hole for immediate use, but one large open-pit operator has applied for a factory licence which will allow mechanical blending in a building provided for the purpose. Experimental work was done by industry recently on "water-compatible" or "slurry" explosives, an important ingredient being water.

An inspector of the Division rendered assistance in connection with the storage of explosives for the demolition of Ripple Rock in Seymour Narrows, British Columbia. This was the largest commercial blast in history, involving the use of 2,700,000 pounds of explosives.

Accidents

A survey of explosives accidents during the year shows that, in manufacturing, the good record of previous years was maintained although for the first time in more than a decade a fatal accident occurred in a dynamite factory.

In accidents caused by the misuse of explosives the record is less encouraging. Several factors have contributed to this. The highly dangerous actions on the part of teenagers in mixing propellants and in launching home-made rockets resulted in two deaths and many serious injuries. Several

76101-5—7½

injuries were reported from explosives that were left where children had access to them following the laying of pipelines for natural gas over extensive areas.

These, along with the perennial distressing accidents to children who find and misuse detonators, resulted in higher accident figures in this category for 1958. To combat this rise the Division has issued warnings through the press and by television and radio. In addition, it has taken legal action against individuals and companies responsible for the careless storage and handling of explosives.

A fatal accident, in which one man died and four others were burned, one seriously, occurred at an explosives factory in Quebec on August 12. Fire and explosion resulted when the nitration reaction went out of control during the manufacture of T.N.T. The building was completely destroyed. Several recommendations were made by the Division.

A fire and subsequent explosion occurred on April 8 in the "vibro-packer" dynamite cartridging house of the same factory. The building and equipment were a total loss but the operators had time to leave the building before the explosion took place. Friction between parts of the machine within the "vibro-packer" enclosure, is believed to have caused the accident.

One man was killed and another injured when a can of home-made blasting powder exploded. The men had been blasting stumps on a farm and were placing their equipment in the trunk of a car when the explosion took place. The cause of the explosion was thought to be friction brought about when a steel auger fouled the container of powder, thereby setting off the sensitive, unauthorized mixture.

A 17-year-old boy, trying to develop a new fuel for his home-made rocket, died from the effects of nitrobenzene poisoning.

A 15-year-old boy constructed a home-made gun from a length of pipe plugged at one end with a bolt. A hole was drilled near the end of the pipe, a fuse inserted and the pipe was filled with gunpowder purchased from a local sporting goods store. The attempt to fire this device proved fatal.

A truck carrying 10,000 pounds of dynamite from a factory in Ontario was stopped when it was noticed the tail-gate was open. The trucker, assisted by police, retraced the route of the truck and recovered 13 cases of explosives that had fallen from the load. An improved locking device on the tail-gate was the obvious answer. No accident resulted.

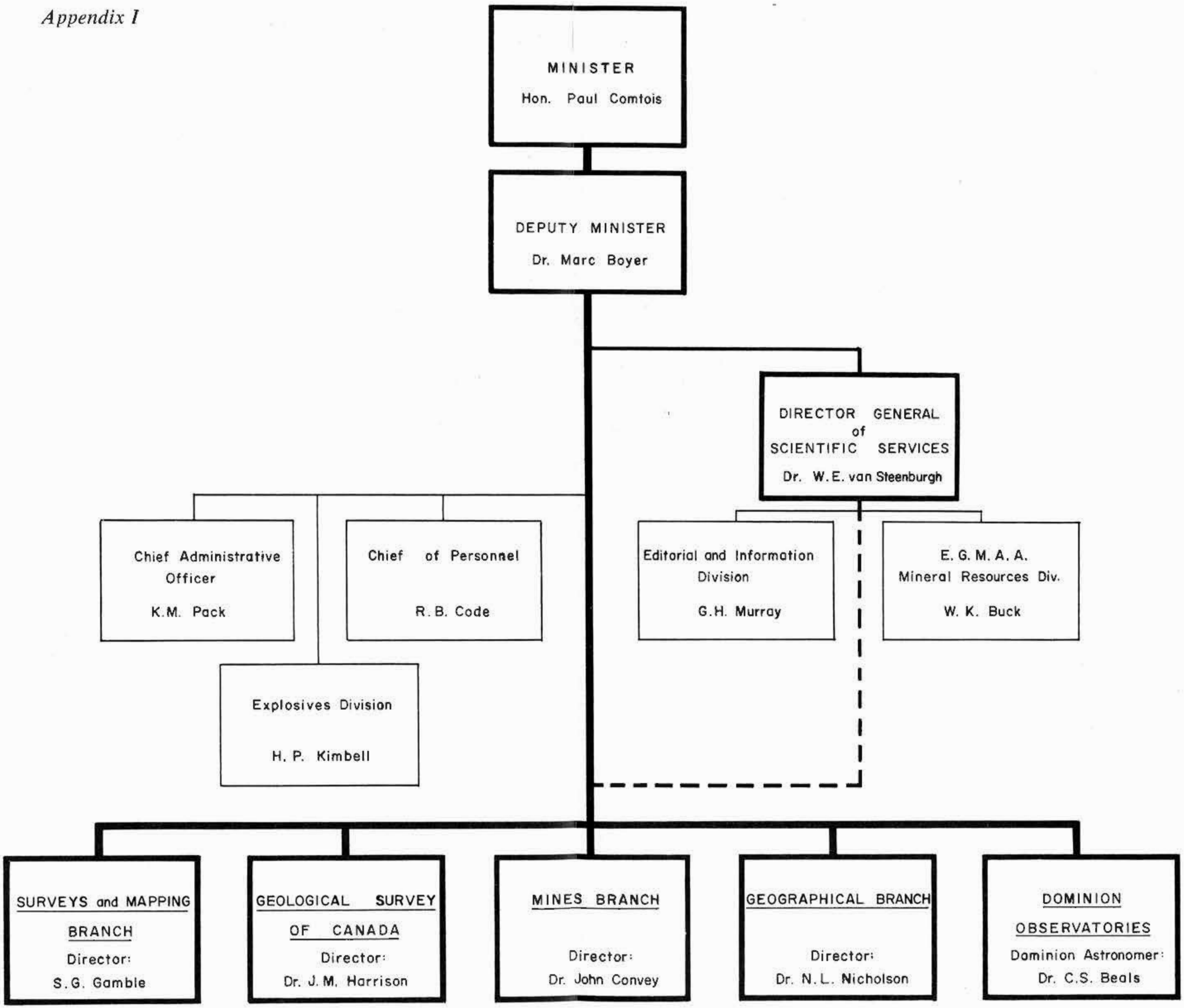
A half-ton pickup truck in Ontario carrying 1,500 pounds of dynamite caught fire and burned and a box of 1,000 detonators in the cab exploded. There were no casualties. The fire was attributed to a defective exhaust pipe, resulting in overheating. Prosecution proceedings were entered against the company for violations of Part VI of the Regulations under the Explosives Act.

A dump truck in Quebec carrying 2,000 pounds of dynamite, together with 400 detonators and metal tools, caught fire and exploded, demolishing the truck and setting fire to a house, barn, and other buildings. No one was injured. The cause of the fire was overheating from the exhaust which was designed to heat the platform of the truck. Prosecution of the construction company which owned the truck was initiated.

A complete analysis of the reported accidents with explosives appears in a separate annual report issued by the Division.

appendices

Appendix I



MINISTER
Hon. Paul Comtois
DEPUTY MINISTER
Dr. Marc Boyer
DIRECTOR GENERAL of SCIENTIFIC SERVICES
Dr. W. E. van Steenburgh
Chief Administrative Officer
K.M. Pack
Chief of Personnel
R. B. Code
Explosives Division
H. P. Kimbell
Editorial and Information Division
G.H. Murray
E. G. M. A. A.
Mineral Resources Div.
W. K. Buck
SURVEYS and MAPPING BRANCH
Director:
S.G. Gamble
GEOLOGICAL SURVEY OF CANADA
Director:
Dr. J. M. Harrison
MINES BRANCH
Director:
Dr. John Convey
GEOGRAPHICAL BRANCH
Director:
Dr. N. L. Nicholson
DOMINION OBSERVATORIES
Dominion Astronomer:
Dr. C.S. Beals

Appendix II

Senior Personnel of the Department as at December 31, 1958

MINISTER

The Honourable Paul Comtois

DEPUTY MINISTER

Dr. Marc Boyer

Director General of Scientific Services	Dr. W. E. van Steenburgh
Director, Surveys and Mapping Branch	S. G. Gamble
Director, Geological Survey of Canada	Dr. J. M. Harrison
Director, Mines Branch	Dr. John Convey
Dominion Astronomer	Dr. C. S. Beals
Director, Geographical Banch	Dr. N. L. Nicholson

76101-5—8

Appendix III

Revenue and Expenditures

A summary of revenue and expenditures for 1958 follows:

	Revenue	*Ordinary Expenditures*
Minister of Mines and Technical Surveys	$	$ 16,999.92
Miscellaneous Gratuities	....	963.32
Departmental Administration	....	630,572.40
Explosives Act	8,581.57	112,310.03
Mineral Resources Division	....	233,966.40
Surveys and Mapping Branch	171,330.17	8,744,498.41
Geological Survey of Canada	21,859.66	3,076,770.45
Mines Branch	21,640.34	3,540,522.52
Geographical Branch	3.00	321,641.82
Dominion Observatories	4,680.72	1,139,706.57
General—		
To provide for payments under the Emergency Gold Mining Assistance Act (Chap. 95, R.S., as amended)	....	9,933,484.91
To provide for purchase of Air Photography and the expenses of the Interdepartmental Committee on Air Surveys	....	2,764,781.61
Provincial and Territorial Boundary Surveys	20.00	52,538.57
Polar Continental Shelf Project	....	10,222.40
Awards	....	6,000.00
	$228,115.46	$30,584,979.33

76101-5—8½

Appendix IV

Surveying, Mapping and Charting Activity

(a) Geodetic Survey of Canada

Province or Territory	Parties	Type of Work	Stations	Mileage	Bench Marks	Measured Lines
Northwest Territories	1	Triangulation (reconnaissance)	47	330	...	...
British Columbia	1	Precise Levelling	..	327	143	...
Northwest Territories—Alberta	1	Triangulation	25	160	...	..
Northwest Territories—Alberta—Saskatchewan—Ontario	1	Astronomy and Base Lines	2	...	...	4
Northwest Territories—Saskatchewan—Manitoba	1	Triangulation (reconnaissance)	32	250	...	..
Alberta—Saskatchewan	1	Precise Levelling	..	326	156	..
Saskatchewan	1	Triangulation	15	115	...	..
Saskatchewan—Quebec	1	Astronomy	3	...	...	..
Manitoba	1	Triangulation	18	100	...	..
Manitoba—Ontario	1	Tellurometer	..	...	...	58
Ontario	1	Precise Levelling	..	248	97	..
	1	Base Line	..	...	...	1
Quebec	1	Triangulation	11	100	...	..
		Reconnaissance	8	90	...	..
Newfoundland (Labrador)	1	Triangulation	10	100	...	..
TOTALS Triangulation	5		79	575	...	..
Reconnaissance	2		87	670	...	..
Precise Levelling	3		..	901	396	..
Astronomy and Base Lines	1		2	...	...	4
Astronomy	1		3	...	...	..
Base Lines	1		..	...	...	1
Tellurometer	1		..	...	...	58

(*b*) Topographical Survey

Province or Territory	Field Surveys				Map Compilation						Map Sheets Forwarded for Reproduction		
					Scale 1/50,000		Scale 1/250,000		Tota Area (Sq. Mi.)	Photo Mosaic			
	No. of Parties	Type of Work	Mapping Scale	Area Controlled (Sq. Mi.)	No. of Map Sheets	Area (Sq. Mi.)	No. of Map Sheets	Area (Sq. Mi.)		Area (Sq. Mi.)	1/50,000	1/250,000	Area (Sq. Mi.)
Quebec	1*	Topographic	1/250,000	42,500									
		Topographic	1/50,000	9,800									
	1	Traverse	—	250 mi.	103	37,600	2	4,350	41,950	242,200	100		37,140
Ontario	1*	Topographic	1/250,000	10,320									
		Topographic	1/50,000	7,780									
	2	Traverse	—	530 mi.									
	2	Spirit Levelling	—	560 mi.	2	810			810	147,150			
Manitoba	1*	Topographic	1/250,000	15,040									
		Topographic	1/50,000	8,560									
	2	Vertical	1/50,000	4,100									
	2	Traverse	—	1,225 mi.									
	1	Spirit Levelling	—	275 mi.	7	2,550			2,550	2,700	12		4,030
Saskatchewan	1*	Topographic	1/250,000	30,100									
		Topographic	1/50,000	1,300									
	4	Vertical	1/50,000	16,750									
	1	Traverse	—	950 mi.									
	1	Spirit Levelling	—	320 mi.	20	7,040	1	5,300	12,340	1,150	14	1	9,990
Alberta	3	Vertical	1/50,000	11,500	45	15,840	3	15,470	31,310		55	2	29,960
British Columbia	5	Photo Topographic	1/50,000	10,600	19	6,750	2	8,820	15,570		23	2	14,320
Yukon	1	Photo Topographic	1/50,000	500									
		Spirit Levelling	—	180 mi.	33	6,000	4	21,120	27,120		29	5	32,180
Northwest Territories					6	1,400	7	27,440	28,840	10,700	19	9	39,790
TOTALS				168,850	235	77,990	19	82,500	160,490	403,900	252	19	167,410

* Helicopter party.

(c) Canadian Hydrographic Service

Province	Field Operations							Published Charts		
	Surveying Units	Linear Nautical Miles of Soundings	Square Miles Surveyed	Shoals Examined	Miles of Coastlining	Gauging Stations	Current Surveys	Number Maintained	First Editions	Revised Editions
Newfoundland	ACADIA	2,150	98	702	61	2		84	10	2
	KAPUSKASING	4,630	8,443	2						
	ARCTIC SEALER	94	35	101	5					
	DAWSON	297	9	236	41					
	ALGERINE	89	5	5	5					
	CARTIER	519	35	15	70					
Nova Scotia	KAPUSKASING	3,191	598	3		14		73	1	11
	BAFFIN	2,898	875	1						
	HENRY HUDSON	1,031	100	131	93					
	ANDERSON	1,334	43	167	35					
New Brunswick	KAPUSKASING	1,621	574			7	1	26		5
	CARTIER	911	43		41					
Prince Edward Island	MERGANSER	859	64	1	75	13		12	1	1
	THETA						1			
Quebec	ARCTIC SEALER	99	20	1		26		104	5	15
	ALGERINE	1,041	26	7	18					
Ontario	ST. LAWRENCE SEAWAY	1,309	68	265	40	27		96	4	21
	BOULTON	1,000	80	170	107					
Manitoba	SANDPIPER	1,457	430	3	158	1		20	2	1
Saskatchewan								1		
Alberta								2		
British Columbia	WM. J. STEWART	6,458	3,369	77	30	12		156	6	27
	MARABELL	1,943	147	337	163					
	PARRY	15	1	2	18		2			
	CURLEW	221	12	60	19					
Northwest Territories	ARCTIC SEALER	2,477	280	214	66	7		117	6	18
	BAFFIN	5,051	1,442	9	104					
	RAE	514	16		46					
	C. D. HOWE	3,126		1						
	d'IBERVILLE	1,200								
	STORIS	1,638		2						
TOTALS	22	47,173	16,813	2,512	1,195	109	4			

DISTRIBUTION	
Standard Navigation Charts	104,500
Special Charts	37,800
Tide and Current Tables—	
Pacific Coast	68,500
Atlantic Coast	19,800
Inland Water Levels Bulletins	10,000
Other Publications	4,180

(*c*) Canadian Hydrographic Service—(*Cont.*)

New or Revised Nautical Charts

The last column, headed "Edition", gives the month of publication and the type of edition. F, indicates a first edition; N, a new edition; CR, a corrected reprint; and R, a reprint.

Number	Name	Location	Scale	Latitude	Longitude	Edition
	Navigation Charts					
1201	White Island to Goose Cape	Que.	1:81,726	47°29′–48°00′	69°25′–70°15′	Mar. '58 CR
1204	Ile du Bic to White Island	Que.	1:77,913	47 58–48 25	68 46–69 48	Apr. '58 CR
1209	Saguenay River, St. Fulgence to Shipshaw	Que.	1:17,910	48 25–48 27	70 53–71 13	Feb. '58 N
1210	Bersimis River to Ile du Bic	Que.	1:94,200	48 21–48 56	68 22–69 22	Oct. '58 R
1215	Pointe des Monts to Father Point	Que.	1:149,800	48 30–49 20	66 40–68 40	Nov. '57 CR
1220	Baie Comeau	Que.	1:24,000	49 12–49 17	68 03–68 11	May '58 N
1220	Baie Comeau	Que.	1:24,000	49 12–49 17	68 03–68 11	Oct. '58 R
1223	Bic Island Roads	Que.	1:24,000	48 18–48 27	68 42–69 00	Sept. '58 R
1224	Matane Harbour	Que.	1:2,400	48 51–48 52	67 31–67 32	Dec. '57 N
1333	Quebec to St. Antoine	Que.	1:36,000	46 40–46 50	71 10–71 37	Nov. '57 CR
1336	Champlain to Lake St. Peter	Que.	1:36,000	46 14–46 27	72 15–72 42	Mar. '58 N
1338	Head of Lake St. Peter to Lavaltrie	Que.	1:36,000	45 50–46 09	72 57–73 17	Mar. '58 N
1414	Cornwall to Cat Island	Ont.	1:25,000	44 54–45 04	74 43–75 01	Apr. '58 F
1415	Cat Island to Iroquois Lock	Ont.	1:25,000	44 49–44 58	75 00–75 20	Apr. '58 F
1416	Iroquois Lock to Prescott	Ont.	1:25,000	44 41–44 51	75 16–75 33	Apr. '58 F
1443	Brockville Narrows	Ont.	1:10,069	44 31–44 36	75 40–75 46	June '58 CR
1450	Lake St. Louis	Que.	1:25,219	45 18–45 27	73 40–73 59	Aug. '58 CR
1451	Lake St. Francis, General Chart	Que.	1:48,080	45 00–45 17	74 08–74 44	Apr. '58 N
1457	Galop Island to Rockport	Ont.	1:33,333	44 22–44 46	75 22–75 56	July '58 CR
1542	Wendover to Ottawa	Ont.	1:24,000	45 25–45 37	75 08–75 43	Dec. '57 N
2000	Lake Ontario	Ont.	1:400,000	42 49–44 30	76 00–80 00	Apr. '58 N
2052	Picton Bay	Ont.	1:7,500	44 00–44 04	77 05–77 09	Nov. '57 CR
2060	Main Duck Island to Scotch Bonnet Island	Ont.	1:77,342	43 42–44 04	76 38–77 34	Aug. '58 CR
2064	Kingston to False Ducks	Ont.	1:61,243	43 54–44 15	76 27–77 10	May '58 N
2069	Bay of Quinte, Picton to Presqu'ile	Ont.	1:60,588	43 59–44 18	77 01–77 44	Aug. '58 N
2071	Presqu'ile Bay	Ont.	1:18,200	43 59–44 03	77 39–77 45	Feb. '58 N
2175	Long Point Bay and Approaches	Ont.	1:80,627	42 26–42 54	79 45–80 42	Nov. '57 N
2182	Pelee Passage	Ont.	1:40,000	41 45–41 55	82 23–82 42	June '58 N
2258	Bayfield Sound and Approaches	Ont.	1:40,000	45 48–46 03	82 32–83 02	Feb. '58 F
2286	Georgian Bay to Clapperton Island	Ont.	1:90,381	45 42–46 13	81 09–82 15	Oct. '57 CR

2291	Goderich to Chantry Island	Ont.	1:93,314	43 41 –44 30	81 20 – 82 05	Dec. '57	CR
2292	Chantry Island to Cove Island	Ont.	1:91,693	44 27 –45 20	81 15 – 82 00	May '58	CR
2293	Byng Inlet and Approaches	Ont.	1:12,188	45 43 –45 46	80 33 – 80 45	May '58	CR
2295	Meldrum Point to St. Joseph Island	Ont.	1:75,000	45 54 –46 18	83 04 – 83 58	Apr. '58	N
2296	Cape Hurd to Gull Island	Ont.	1:91,820	45 13 –45 53	81 14 – 81 56	Nov. '57	N
2298	Cove Island to Duck Islands	Ont.	1:91,010	45 17 –45 49	81 44 – 82 58	July '58	N
2300	Lake Superior	Ont.	1:547,160	46 15 –49 00	84 15 – 92 15	Sept. '58	N
2311	Thunder Cape to Pigeon River	Ont,	1:76,663	47 52 –48 19	88 37 – 89 36	Jan. '58	N
2312	Nipigon Bay	Ont.	1:60,810	48 45 –49 02	87 30 – 88 17	Feb. '58	N
3000	Juan de Fuca Strait to Dixon Entrance	B.C.	1:1,250,000	47 40 –54 50	122 00 –139 00	Jan. '58	F
3413	Esquimalt and Victoria Harbours	B.C.	1:12,160	48 23 –48 28	123 20 –123 30	Aug. '57	N
3430	Fraser River, Sands Head to Tilbury Island	B.C.	1:12,000	49 05 –49 08	123 02 –123 20	June '58	N
3431	Fraser River, Tilbury Island to Douglas Island	B.C.	1:12,000	49 08 –49 14	122 47 –123 04	June '58	N
3452	Moresby Passage to Gabriola Passage (southern sheet)	B.C.	1:39,870	48 42 –48 55	123 07 –123 39	Apr. '58	N
3453	Moresby Passage to Gabriola Passage (northern sheet)	B.C.	1:39,870	48 48 –49 09	123 28 –123 48	May '58	N
3474	Bedwell Harbour, Port Browning	B.C.	1:12,000	48 42 –48 47	123 12 –123 17	Feb. '58	CR
3508	Plans in the Vicinity of the Strait of Georgia	B.C.	Various			Apr. '58	CR
3509	Plans in the Strait of Georgia	B.C.	Various	49 07 –49 32	123 38 –124 23	Nov. '57	CR
3521	Okisollo Channel	B.C.	1:24,354	50 13 –50 20	125 06 –125 24	Nov. '58	CR
3522	Chatham Point to Stuart Island	B.C.	1:24,330	50 20 –50 29	125 07 –125 27	Nov. '58	CR
3558	Approaches to Nanaimo Harbour	B.C.	1:18,200	49 08 –49 14	123 51 –123 58	Jan. '58	CR
3566	Johnstone Strait (Eastern Part)	B.C.	1:36,495	50 16 –50 30	125 22 –125 52	Mar. '58	CR
3568	Johnstone Strait (Western Part)	B.C.	1:36,494	50 28 –50 41	126 17 –126 47	Sept. '58	N
3575	Noble Islets to Pine Island	B.C.	1:37,372	50 48 –51 02	127 34 –128 05	Aug. '57	N
3577	Sands Head to Ballenas Islands	B.C.	1:77,293	49 05 –49 32	123 12 –124 14	Jan. '58	N
3579	Sands Head to Cape Mudge	B.C.	1:153,734	49 06 –50 04	123 13 –125 17	Aug. '58	N
3583	Port Harvey and Havannah and Chatham Channels	B.C.	1:18,248	50 30 –50 40	126 10 –126 20	Oct. '57	F
3586	Howe Sound	B.C.	1:37,500	49 19 –49 42	123 09 –123 32	Nov. '58	N
3589	Jervis Inlet and Approaches	B.C.	1:76,384	49 33 –50 13	123 31 –124 16	Aug. '57	N
3590	Ballenas Islands to Cape Lazo	B.C.	1:77,007	49 17 –49 44	123 54 –124 57	Sept. '58	N
3597	Pulteney Point to Egg Island	B.C.	1:73,000	50 36 –51 15	127 06 –127 54	Feb. '58	F
3627	Barkley Sound and Approaches	B.C.	1:77,918	48 40 –49 07	124 54 –125 56	Aug. '58	N
3643	Clayoquot Sound (Main Channel)	B.C.	1:18,280	49 06 –49 14	125 52 –125 58	Nov. '57	N
3652	Swiftsure Bank to Estevan Point	B.C.	1:55,578	48 30 –49 25	124 58 –127 02	Nov. '57	N
3703	Northern Air Bases	B.C.	Various			Jan. '58	R
3713	Approaches to Skeena River	B.C.	1:31,741	54 03 –54 12	129 54 –130 18	Aug. '57	N
3725	Tuck Inlet and Prince Rupert Harbour	B.C.	1:17,264 1:12,174	54 20 –54 27	130 13 –130 20	July '58	N
3728	Milbanke Sound and Approaches	B.C.	1:76,557	51 50 –52 30	128 16 –129 02	Jan. '58	N
3734	Jorkins Point to Sarah Island	B.C.	1:36,028	52 26 –52 45	128 13 –128 36	Feb. '58	N
3804	Masset Harbour	B.C.	1:20,060	53 58 –54 09	132 07 –132 19	Oct. '57	F

CANADIAN HYDROGRAPHIC SERVICE—(*Cont.*)

NAVIGATION CHARTS

Number	Name	Location	Scale	Latitude	Longitude	Edition	
3853	Cape St. James to Tasu Sound	B.C.	1:144,956	51°50′–52°52′	130°50′–132°15′	Feb. '58	N
3862	Plans on the North Coast of Graham Island	B.C.	1:39,700	53 56–54 14	132 26–133 06	Oct. '57	F
			1:18,260				
3894	Selwyn Inlet to Lawn Point	B.C.	1:73,026	52 50–53 28	131 20–132 05	Mar. '58	N
4308	St. Peters Bay to Strait of Canso	N.S.	1:37,500	45 25–45 39	60 50–61 18	Feb. '58	F
4314	Plans of Harbours, Bay of Fundy	N.B.	Various	45 05–45 12	66 08–66 26	Sept. '57	N
4315	Sydney Harbour	N.S.	1:20,940	46 06–46 16	60 08–60 19	July '58	N
4316	Halifax Harbour	N.S.	1:12,000	44 35–44 41	63 31–63 37	Apr. '58	N
4322	Yarmouth Harbour	N.S.	1:7,200	43 47–43 51	66 07–66 11	July '58	N
4328	Lunenburg Bay	N.S.	1:24,335	44 17–44 26	64 08–64 21	July '58	N
4335	Strait of Canso and Approaches	N.S.	1:75,000	45 17–45 45	60 40–61 35	Feb. '58	N
4340	Grand Manan	N.B.	1:60,000	44 25–44 56	66 35–67 07	Oct. '57	N
4342	Harbours in Grand Manan	N.B.	Various	44 35–44 39	66 48–66 55	Oct. '57	N
4346	Saint John River, Swan Creek to Fredericton	N.B.	1:36,467	45 48–45 59	66 12–66 43	July '58	N
			1:12,000				
4354	Bras d'Or Lake	N.S.	1:81,400	45 36–45 56	60 30–61 10	Dec. '57	CR
4375	Guyon Island to Flint Island	N.S.	1:75,733	45 46–46 11	59 15–60 12	Sept. '58	CR
4377	Main-à-Dieu Passage	N.S.	1:18,000	45 56–46 02	59 44–59 51	Dec. '57	N
4392	Sydney Harbour (South Arm)	N.S.	1:12,000	46 06–46 10	60 11–60 15	Oct. '58	N
4394	Lahave River, West Ironbound Island to Riverport	N.S.	1:12,152	44 13–44 18	64 15–64 23	July '58	N
4423	Miramichi Bay	N.B.	1:36,630	47 02–47 15	64 45–65 14	July '58	N
4452B	Piashti and Quetachu Bay	Que.	1:12,000	50 15–50 18	62 45–62 49	Aug. '58	F
4460	Charlottetown Harbour	P.E.I.	1:11,990	46 11–46 16	63 06–63 12	May '58	N
4464	Cheticamp to Cape St. Lawrence	N.S.	1:74,488	46 36–47 12	60 33–61 10	Sept. '57	N
4467	Rustico and New London Bays	P.E.I.	1:15,000	46 24–46 32	63 12–63 32	Apr. '58	F
4470	Bradore Bay, Blanc Sablon to Five Leagues Harbour	Que.	1:36,643	51 18–51 31	57 02–57 35	June '58	N
4472	Lobster Bay to Outer Island	Que.	1:36,501	51 05–51 24	58 04–58 26	Feb. '57	R
4475	Gethsemani Anchorage	Que.	1:6,000	50 11–50 14	60 39–69 43	Sept. '58	F
4480	Cape Whittle to Anticosti Island (West Point)	Que.	1:354,500	48 20–50 29	59 52–64 40	July '58	N
4490	Atlantic Coast, Gulf and River St. Lawrence		1:1,293,000	42 40–52 20	50 55–69 00	Aug. '58	CR
4526	Lewisporte	Nfld.	1:9,000	49 13–49 16	55 01–55 04	Mar. '58	R
4546	Smith and Random Sounds (Western Part)	Nfld.	1:36,000	47 59–48 18	53 40–53 59	Jan. '58	N
4563	Conception Bay to Trinity Bay	Nfld.	1:75,000	47 48–48 27	52 42–53 25	Aug. '58	F

4566	Bell Island	Nfld.	1:25,000	47 28–47 41	52 51 – 53 05	May '58	N
4567	St. John's to Ferryland Head	Nfld.	1:75,000	46 56–47 35	52 23 – 53 03	Sept. '58	F
4571	Trinity Harbour and adjacent bays	Nfld.	1:12,500	48 19–48 24	53 15 – 53 25	Feb. '58	F
4574	Approaches to St. John's	Nfld.	1:37,500	47 26–47 46	52 25 – 52 46	Dec. '57	F
4660	Codroy Road to Bear Head	Nfld.	1:149,000	47 44–49 02	58 20 – 59 37	Oct. '57	F
4663	Cow Head to Pointe Riche	Nfld.	1:144,000	49 46–50 49	56 58 – 58 15	Oct. '57	F
4664	Port Saunders, Keppel Harbour and Hawke Bay	Nfld.	1:18,255	50 35–50 41	57 10 – 57 24	Jan. '58	F
4665	St. Margaret Bay and Approaches	Nfld.	1:18,295	50 59–51 05	56 54 – 57 10	Oct. '57	F
4716	Chateau Bay	Nfld.	1:18,345			Oct. '57	F
4738	Plans of Anchorages on Northeast Coast of Labrador	Nfld.	Various			Aug. '55	R
5349	Hopes Advance Bay	Que.	1:24,000	59 18–59 26	69 24 – 69 46	Mar. '58	F
5398	Eskimo Point to Dawson Inlet	N.W.T.	1:150,000	61 02–61 59	91 38 – 94 21	Jan. '58	F
5399	Egg Island to Eskimo Point	N.W.T.	1:150,000	59 52–61 10	92 58 – 94 57	Jan. '58	F
5406	Cape Tatnam to Port Nelson	Man.	1:125,300			Mar. '14	R
5411	Lower Savage Islands to Pritzler Harbour	N.W.T.	1:137,520 1:73,131	61 36–62 11	65 39 – 67 30	June '58	N
5433	Chesterfield Inlet, Dangerous Point to East Point	N.W.T.	1:31,680	63 34–63 50	91 30 – 91 57	Mar. '54	R
5435	Chesterfield Inlet, Promise Point to Primrose Island	N.W.T.	1:31,680	63 46–63 58	92 28 – 93 05	Mar. '54	R
5439	Baker Lake	N.W.T.	1:100,000	63 55–64 25	94 30 – 96 20	Mar. '54	R
5451	Cape Dorset and Approaches	N.W.T.	1:25,000	64 06–64 19	76 16 – 76 38	Mar. '54	R
5453	George River	Que.		58 30–59 08	65 50 – 66 30	Mar. '52	R
5456	Button Islands	N.W.T.	1:40,000	60 29–60 43	64 20 – 65 00	Feb. '58	N
5457	Deception Bay	Que.	1:40,000	62 05–62 20	74 30 – 75 00	Apr. '58	F
5458	Sugluk Inlet	Que.	1:50,000	62 06–62 24	75 14 – 76 10	Feb. '58	N
5470	Belcher Islands	N.W.T.	1:225,000	55 20–57 17	77 53 – 80 26	May '58	N
5475	Povungnituk Bay	N.W.T.	1:63,360	59 40–60 05	77 12 – 78 00	Mar. '58	F
5505	Padloping Island and Approaches	N.W.T.	1:65,000	66 51–67 16	61 40 – 63 07	Feb. '58	N
5516	Approaches to Koojesse Inlet	N.W.T.	1:40,000	63 37–63 45	68 22 – 68 42	Jan. '58	CR
5521	Resolution Island to Cape Mercy	N.W.T.	1:500,000	61 17–65 02	62 00 – 69 00	Mar. '58	N
5524	Padloping Island to Clyde Inlet	N.W.T.	1:500,000	66 57–70 53	62 00 – 70 30	May '58	N
5526	Pond Inlet to Cape Crauford	N.W.T.	1:500,000	72 15–75 00	74 00 – 86 50	Feb. '58	N
5527	Cape Crauford to Cornwallis Island	N.W.T.	1:500,000	72 40–75 35	83 45 – 99 20	Feb. '58	N
5528	Passages adjacent to Boothia Peninsula	N.W.T.	1:500,000	70 08–73 02	87 00 – 99 00	Feb. '58	N
5556	Bellot Strait and Approaches	N.W.T.	1:75,000	71 45–72 10	93 45 – 95 45	Apr. '58	F
5578	Approaches to Brevoort Harbour	N.W.T.	1:150,000	62 44–63 28	63 05 – 65 10	Feb. '58	N
5579	Brevoort Harbour	N.W.T.	1:12,000	63 15–63 20	64 01 – 64 11	Mar. '58	N
5595	Bellot Strait	N.W.T.	1:25,000	71 53–72 02	94 13 – 95 14	Apr. '58	F
5607	Cornwallis Island to Lougheed Island	N.W.T.	1:500,000	74 50–77 55	89 30 –106 30	Feb. '58	N
5621	Craig Harbour	N.W.T.	1:50,000	76 00–76 15	80 35 – 82 00	Jan. '56	R
5712	Baillie Islands and Approaches	N.W.T.	1:63,360	70 25–70 49	127 33 –129 12	May '51	R
5713	Booth Islands and Approaches	N.W.T.	1:63,360	69 55–70 20	123 57 –125 35	Mar. '58	N
5718	Port Epworth and Approaches	N.W.T.	1:31,680	67 40–67 52	111 30 –112 12	Apr. '53	R

CANADIAN HYDROGRAPHIC SERVICE—(*Cont.*)

Number	Name	Location	Scale	Latitude	Longitude	Edition	
	NAVIGATION CHARTS						
6241	Berens River to Nelson River	Man.	1:255,723	52°13′–53°53′	96°58′–99°21′	Aug. '57	N
6271	Lake Winnipegosis, Winnipegosis to Red Deer Point	Man.	1:63,360	51 34–52 06	99 35–100 15	Dec. '57	F
6272	Lake Winnipegosis, Red Deer Point to North Manitou Island	Man.	1:63,360	52 03–52 36	99 37–100 16	Feb. '58	F
6368	Southeast approach to Yellowknife Bay	N.W.T.	1:31,680	62 04–62 15	113 41–114 17	June '58	F
6369	Yellowknife Bay	N.W.T.	1:31,680	62 10–62 27	114 02–114 28	June '58	N
6370	Great Slave Lake, Slave River to Mackenzie River	N.W.T.	1:219,356	60 47–62 27	112 35–117 05	June '58	N
6372	Tuktoyaktuk Harbour	N.W.T.	1:9,000	69 23–69 28	132 56–133 06	Feb. '58	N
6373	Approaches to Tuktoyaktuk Harbour	N.W.T.	1:30,000	69 24–69 39	132 47–133 20	Apr. '58	F
6374	Kugmallit Bay	N.W.T.	1:144,103	69 10–69 55	132 00–134 40	Mar. '58	N
	DECCA CHARTS						
1207	Goose Cape to Grosse Ile	Que.	1:77,821	46°55′–47°35′	70°01′–70°45′	Feb. '57	R
1208	Grosse Ile to Quebec	Que.	1:48,000	46 49–47 06	70 37–71 14	Feb. '57	R
1212	Anticosti Island (West Point) to Ile du Bic	Que.	1:344,946	48 23–50 20	64 22–69 02	July '52	R
4333	Point Lepreau to Cape Spencer	N.B.	1:76,976	44 51–45 17	65 54–66 28	Jan. '42	R
4367	Flint Island to Cape Smoky	N.S.	1:75,185	46 10–46 42	59 40–60 40	Dec. '53	R
	INSTRUCTIONAL CHARTS						
3449	Race Rocks to Turn Point	B.C.	1:78,575	48°16′–48°46′	122°29′–123°32′	Aug. "57	R
3577	Sands Head to Ballenas Islands	B.C.	1:77,293	49 05–49 32	123 12–124 14	Jan. '58	R
3579	Sands Head to Cape Mudge	B.C.	1:153,734	49 06–50 03	123 14–125 16	Aug. '58	R
3652	Swiftsure Bank to Estevan Point	B.C.	1:155,578	48 30–49 25	124 58–127 02	Nov. '57	R
4311	Egg Island to Pennant Point	N.S.	1:97,218	44 05–44 50	62 49–63 41	Sept. '52	R
	MERCATORIAL PLOTTING CHARTS						
4074	Mercatorial Plotting Chart 39°–42°			38°40′–42°20′	....	Jan. '53	R
4075	Mercatorial Plotting Chart 42°–42°			41 40–45 20	....	Jan. '53	R
4087	Mercatorial Plotting Chart 38°–42°					'58	R

Special Charts

11	Tidal Currents in Halifax Harbour	N.S.	1:24,300	44°31′–44°41′	63°29′– 63°37′	Nov. '51	R
2000	Lake Ontario	Ont.	1:400,000	42 50 –44 30	76 00 – 80 00	Apr. '58	R
2062	Oshawa to Toronto	Ont.	1:72,900	43 33 –43 55	78 49 – 79 35	Aug. '55	R
2063	Toronto to Niagara River	Ont.	1:73,031	43 10 –43 38	79 02 – 79 54	May '56	R
S-146	Ice Report Chart, Gulf of St. Lawrence			43 00 –52 00	50 00 – 69 00	'58	F
S-147	Ice Report Chart, St. John's to Hamilton Inlet	Nfld.		47 00 –55 00	48 00 – 59 00	'58	F
S-148	Plotting Sheet, North Pacific			33 00 –67 00	120 00 –140 00	'58	F

(*d*) Legal Surveys and Aeronautical Charts

Type of Chart	Scale	New Editions	Revisions	Total
Air Overprint Compilations and Revisions				
Aeronautical	1:506,880	25	102	127
World Aeronautical	1:1,000,000	3	46	49
Aeronautical Route	1:1,000,000	6	8	14
Navigation Route	1:3,000,000	....	2	2
Trans-Atlantic Plotting	1:4,000,000	....	1	1
Aeronautical Planning	1:5,000,000	....	1	1
Winnipeg Navigation Plotting	1:2,000,000	....	1	1
Radar Aeronautical Video	1:729,600	10	....	10
Canada Air Pilot				
Instrument Landing		15	32	47
Radio Range		....	145	145
Radio Beacon		3	25	28
Radio Facility		2	128	130
Miscellaneous		3	536	539
Contour and Spot Height Compilations from Oblique Multiplex Plotter				
		New Compilations		
Aeronautical	1:506,880	3		3

(*e*) Map Compilation and Reproduction

In the following tabulation the column headed "Year and Edition" refers to the year of publication and the edition number—for example 58-1 means it was published in 1958 and is the first edition; 58-P-1 means it was published in 1958, is a preliminary map and is the first edition; 58-PR-1 means it was published in 1958, is a provisional map and is the first edition.

(1) Aeronautical Charts—National Topographic Series
(scale—1 inch to 8 miles)

Number	Name	Location	Latitude	Longitude	Year and Edition
13 NW	Naskaupi	Que.-Nfld.	54°00′–56°00′	60°00′– 64°00′	57–3
13 SE 3 SW	Battle Harbour-Cartwright	Nfld.	52 00–54 00	55 30– 60 00	58–P–4
14 NW	Hebron-Cape Territok	Nfld.	58 00–60 00	60 00– 65 00	57–P–3
23 NW	Kaniapiskau	Que.	54 00–56 00	68 00– 72 00	58–P–5
23 SE	Ashuanipi	Que.-Nfld.	52 00–54 00	64 00– 68 00	58–6
24 NE	George River	Que.-Nfld.	58 00–60 00	64 00– 68 00	57–P–4
24 NW	Fort Chimo	Que.	58 00–60 00	68 00– 72 00	54–P–4
25 SW	Wakeham Bay	Que.-N.W.T.	60 00–62 00	68 00– 72 00	50–P–4
34 NE	Payne Lake	Que.	58 00–60 00	72 00– 76 00	51–P–4
35 SW	Cape Smith	Que.-N.W.T.	60 00–62 00	76 00– 81 00	56–P–6
35 SE	Povungnituk	Que.	60 00–62 00	72 00– 76 00	49–P–4
84 NE	Fort Vermilion	Alta.	58 00–60 00	112 00–116 00	58–P–4
103 NE and part NW	Prince Rupert-Stewart	B.C.-U.S.A.	54 00–56 00	128 00–133 00	57–3
104 NW	Juneau-Atlin	B.C.-Alaska	58 00–60 00	132 00–136 00	58–4

Number	Name	Location	Latitude	Longitude	Year and Edition
104 SE-SW	Stikine River	B.C.-U.S.A.	56°00′–58°00′	128°00′–113°00′	57–5
105 SW	Whitehorse-Teslin	Yukon	60 00–62 00	132 00–136 00	58–3
105 NW-NE	Pelly River	Yukon	62 00–64 00	128 00–136 00	58–3
115 NW-NE	Fort Selkirk	Yukon-U.S.A.	62 00–64 00	136 00–144 00	58–4
34 NW	Port Harrison	N.W.T.	58 00–60 00	76 00– 81 00	55–P–6
55 SW	Eskimo Point	N.W.T.	60 00–62 00	92 00– 96 00	58–P–6
56 SW-SE	Wager Bay	N.W.T.	64 00–66 00	88 00– 96 00	58–P–4
67 SW-SE	King William Island	N.W.T.	68 00–70 00	96 00–104 00	58–P–5
77 NW-NE	Victoria Island East	N.W.T.	70 00–72 00	104 00–112 00	57–P–5
77 SW-SE	Cambridge Bay	N.W.T.	68 00–70 00	104 00–112 00	58–P–5
87 SW-SE	Dolphin and Union Strait	N.W.T.	68 00–70 00	112 00–120 00	58–P–3
95 SE	Simpson-Liard	N.W.T.	60 00–62 00	120 00–124 00	58–4
97 NW-NE	Amundsen Gulf	N.W.T.	70 00–72 00	120 00–128 00	57–P–5
	(2) National Topographic Series Maps *(scale—1:250,000)*				
1 L	St. Lawrence	Nfld.	46°00′–47°00′	54°00′– 56°00′	58–1
73 G	Shellbrook	Sask.	53 00–54 00	106 00–108 00	58–P–1
73 K	Waterhen River	Sask.	54 00–55 00	108 00–110 00	58–P–1
72 E	Foremost	Alta.	49 00–50 00	110 00–112 00	58–1
72 L	Medicine Hat	Alta.	50 00–51 00	110 00–112 00	58–P–1
83 A	Red Deer	Alta.	52 00–53 00	112 00–114 00	58–1
83 G	Wabamun Lake	Alta.	53 00–54 00	114 00–116 00	56–1
83 K	Iosegun	Alta.	54 00–55 00	116 00–118 00	58–1
84 D	Clear Hills	Alta.	56 00–57 00	118 00–120 00	57–P–1
92 J	Pemberton	B.C.	50 00–51 00	122 00–124 00	58–1
92 K	Bute Inlet	B.C.	50 00–51 00	124 00–126 00	57–1
105 O	Niddery Lake	Yukon-N.W.T.	63 00–64 00	130 00–132 00	58–1
106 C	Nadaleen River	Yukon-N.W.T.	64 00–65 00	132 00–134 00	58–1
116 B and C-E	Dawson	Yukon	64 00–65 00	138 00–141 00	58–1
95 I	Bulmer Lake	N.W.T.	62 00–63 00	120 00–122 00	58–2
	(3) National Topographic Series Maps *(scale—1:500,000)*				
41 NE	Sudbury	Ont.	46°00′–48°00′	80°00′– 84°00′	57–1
	(4) World Aeronautical Charts *(scale—1:1,000,000)*				
2007	Eureka Sound	N.W.T.	80°00′–84°00′	71°00′–100°00′	56–1
2008	Robeson Channel	N.W.T.	80 00–84 00	36 00– 71 00	56–1
2034	Thomsen River	N.W.T.	72 00–76 00	112 00–128 00	56–1
2035	Viscount Melville Sound	N.W.T.	72 00–76 00	96 00–112 00	56–1
2060	Victoria Strait	N.W.T.	68 00–72 00	96 00–112 00	56–1
2020	Jones Sound	Canada-Denmark	76 00–80 00	61 00– 88 00	57–1

Number	Name	Location	Latitude	Longitude	Year and Edition
		(5) National Topographic Series Maps *(scale—1 inch to 2 miles)*			
31 G/NE	Lachute	Que.-Ont.	45°30′–46°00′	74°00′– 75°00′	57–3
		(6) Aeronautical Route Charts *(scale—1:1,000,000)*			
ARC 8	Windsor-Quebec	Ont.			
		(7) Columbia River Basin *(scale—1:31,680)*			
MS 12	Kootenay River-Kootenay Lake Area	B.C.	....	....	57–2
MS 22	Upper Arrow Lake Area	B.C.	....	....	56–1
MS 25	Bend Area	B.C.	....	....	57–1
MS 28	Big Bend Area	B.C.	....	....	56–1
MS 29	Big Bend Area	B.C.	....	....	57–1
MS 40	Big Bend Area	B.C.	....	....	57–1
MS 62	Slocan Lake–Slocan River Area	B.C.	....	....	57–1
MS 63	Slocan Lake–Slocan River Area	B.C.	....	....	57–1
MS 64	Slocan Lake–Slocan River Area	B.C.	....	....	56–1
MS 65	Slocan Lake–Slocan River Area	B.C.	....	....	57–1
MS 66	Lardeau River–Duncan River Area	B.C.	....	....	57–1
MS 67	Lardeau River–Duncan River Area	B.C.	....	....	57–1
MS 68	Lardeau River–Duncan River Area	B.C.	....	....	57–1
MS 74	Moyie River Area	B.C.	....	....	58–1
MS 80	Elk River Area	B.C.	....	....	58–1
MS 81	Elk River Area	B.C.	....	....	58–1
MS 82	Elk River Area	B.C.	....	....	57–1
MS 83	Kettle River Area	B.C.	....	....	58–1
MS 84	Kettle River Area	B.C.	....	....	58–1
MS 85	Kettle River Area	B.C.	....	....	58–1
MS 86	Kettle River Area	B.C.	....	....	58–1
MS 87	Kettle River Area	B.C.	....	....	58–1
MS 88	Kettle River Area	B.C.	....	....	57–1
MS 89	Kettle River Area	B.C.	....	....	58–1
MS 90	Castle River Area	Alta.-B.C.	....	....	58–1
MS 91	Castle River Area	Alta.-B.C.	....	....	58–1
MS 92	Castle River Area	Alta.-B.C.	....	....	58–1
MS 93	Flathead River Area	B.C.	....	....	58–1
MS 94	Flathead River Area	B.C.	....	....	58–1
MS 95	Flathead River Area	B.C.-Alta.	....	....	58–1
MS 96	Flathead River	B.C.-Alta.	....	....	58–1
Index					58–1

(8) ATLAS OF CANADA

Number	Name
4	Extent of Mapping Surveys
8	Hydrographic Charts
9	Bathy-orography—Canada
10	Bathy-orography—Eastern Canada
11	Bathy-orography—Western Canada
12	Bathy-orography—Northern Canada
13	Physiographic Regions
14	Physiography of Southern Ontario
16	Bedrock Geology
17	Principal Minerals
18	Earthquakes, Magnetism and Tides
20	Wind and Sunshine
21	Seasonal Temperatures
28	Snow Cover
31	Typical Weather Situations
33	Drainage Basins and River Flow
35	Soil Regions
37	Ranges of Representative Insects, Ticks and Spiders
38	Natural Vegetation and Flora
45	Parks and Faunal Reserves
48	Density of Population, 1951
49	Rates of Population Change, 1851-1951
50	Birth, Marriage and Death Rates, etc.
51	Age and Sex Ratios
54	Other Origins and Citizenship
56	Urban Population
58	Furs, Whaling and Fish Processing
59	East Coast Fisheries
60	West Coast Fisheries
61	Forestry and Woodworking
62	Sawmills
63	Pulp and Paper Mills
68	Farms
69	Agricultural Regions
70	Agricultural Labour Force and Services
71	Food Industries
72	Primary Iron and Steel
73	Non-ferrous Metals—Eastern Canada
74	Non-ferrous Metals—Western Canada
75	Industrial Minerals
76	Mineral Fuels, Pipelines and Refineries
77	Hydro and Fuel Electric Power—Eastern Canada
78	Hydro and Fuel Electric Power—Western Canada
79	Fabricated Metal Industries
80	Textiles, Clothing and Rubber Products
81	Manufacturing Centres
82	Navigable Waterways
83	Railways
84	Railway Freight Traffic
85	Major Roads
86	Civil Airports, Aerodromes and Time Zones
87	Air Lines
88	Air Passenger Traffic
89	Domestic Trade, Finance and Construction
91	Television and Radio
92	Hospitals
93	Education
94	Public Libraries, Museums and Art Galleries
95	Populated Places—Gulf of St. Lawrence Area
96	Populated Places—Great Lakes Area
97	Populated Places—Prairies
98	Populated Places—The Far West
99	Populated Places—Northern Canada
100	Quebec City and Montreal
101	Ottawa and Toronto
102	Winnipeg and Edmonton
103	Vancouver and Victoria
104	Rural Municipalities—Eastern Canada
105	Rural Municipalities—Great Lakes—St. Lawrence Area
106	Rural Municipalities—Western Canada
107	Census Divisions, 1951
108	Federal Electoral Districts, 1952
109	Political Evolution
110	Canada and the World
Foreword	
Contents and Preface	

(9) Miscellaneous

Number	Name	Number	Name
MCR 13	Canada's Natural Resources	MCR 211	Waterton Lakes Park
			Prime Minister's Tour
MCR 58	Canada's Natural Resources (French)		Water Resources Map of Canada
			Air Photo Coverage Map, 1957
			Gazetteer Map of Alberta
			Canada 250-mile

(10) Navigation Plotting Charts

Northern Canada
Western Canada
Winnipeg

(11) Maps of 1:50,000 Series

Number	Name	Location	Latitude	Longitude	Year and Edition
1 M/3	Marystown	Nfld.	47°00′–47°15′	55°00′– 55°30′	57–1
1 M/4	Grand Bank	Nfld.	47 00–47 15	55 30– 56 00	57–1
1 M/7	Baine Harbour	Nfld.	47 15–47 30	54 30– 55 00	57–1
1 M/9	Harbour Buffett	Nfld.	47 30–47 45	54 00– 54 30	57–1
1 M/10	Terrenceville	Nfld.	47 30–47 45	54 30– 55 00	57–1
1 M/12	Gaultois	Nfld.	47 30–47 45	55 30– 56 00	57–1
1 M/16	Sound Island	Nfld.	47 45–48 00	54 00– 54 30	57–1
2 D/5	Burnt Hill	Nfld.	48 15–48 30	55 30– 56 00	58–1
2 D/10	Dead Wolf Pond	Nfld.	48 30–48 45	54 30– 55 00	58–1
2 D/11	West Gander Rivers	Nfld.	48 30–48 45	55 00– 55 30	58–1
11 O/11	Port-aux-Basques	Nfld.	47 30–47 45	59 00– 59 30	58–1
11 O/16	La Poile River	Nfld.	47 45–48 00	58 00– 58 30	58–1
11 P/9	Facheux Bay	Nfld.	47 30–47 45	56 00– 56 30	58–1
11 P/16	D'Espoir Brook	Nfld.	47 45–48 00	56 00– 56 30	57–1
12 A/3	Burnt Pond	Nfld.	48 00–48 15	57 00– 57 30	58–1
12 A/8	Great Burnt Lake	Nfld.	48 15–48 30	56 00– 56 30	58–1
12 A/12	Little Grand Lake	Nfld.	48 30–48 45	57 30– 58 00	58–1
12 A/16	Badger	Nfld.	48 45–49 00	56 00– 56 30	58–1
12 H/10	Hampden	Nfld.	49 30–49 45	56 30– 57 00	57–1
12 I/2	Cat Arm River	Nfld.	50 00–50 15	56 30– 57 00	57–1
12 I/7	Harbour Deep	Nfld.	50 15–50 30	56 30– 57 00	58–1
12 I/10	Torrent River	Nfld.	50 30–50 45	56 30– 57 00	58–1
23 H/9	Grand Falls of the Hamilton	Nfld.	53 30–53 45	64 00– 64 30	58–1
11 E/14-E	Malagash	N.S.	45 45–46 00	63 00– 63 15	57–PR–1
21 G/10	Fredericton Junction	N.B.	45 30–45 45	66 30– 67 00	57–1
21 J/1	Minto	N.B.	46 00–46 15	66 00– 66 30	57–2
21 J/10	Hayesville	N.B.	46 30–46 45	66 30– 67 00	57–1
21 N/9	Grandmaison	N.B.	47 30–47 45	68 00– 68 30	57–1
21 N/16	Wild Goose Lake	N.B.	47 45–48 00	68 00– 68 30	58–1
21 O/2	Serpentine Lake	N.B.	47 00–47 15	66 30– 67 00	58–2
21 O/8	California Lake	N.B.	47 15–47 30	66 00– 66 30	57–1
21 O/11	Kedgwick	N.B.	47 30–47 45	67 00– 67 30	58–2
21 P/6	Tabusintac River	N.B.	47 15–47 30	65 00– 65 30	57–2
21 P/10	Tracadie	N.B.	47 30–47 45	64 30– 65 00	58–1
21 P/14	Grande Anse	N.B.	47 45–48 00	65 00– 65 30	58–1
21 M/1	St. Jean Port Joli	Que.	47 00–47 15	70 00– 70 30	58–1
21 N/4	Ste-Perpetue-de-l'Islet	Que.	47 00–47 15	69 30– 70 00	58–1
21 N/10	Cabano	Que.	47 30–47 45	68 30– 69 00	58–1

Number	Name	Location	Latitude	Longitude	Year and Edition
21 N/14	St. Modeste	Que.	47°45′–48°00′	69°00′– 69°30′	58–1
22 B/5	Lac Humqui	Que.	48 15–48 30	67 30– 68 00	58–1
22 B/9	Berry Mountains	Que.	48 30–48 45	66 00– 66 30	58–1
22 B/12	Sayabec	Que.	48 30–48 45	67 30– 68 00	58–1
22 B/13	Matane	Que.	48 45–49 00	67 30– 68 00	58–1
22 B/15	Mount Logan	Que.	48 45–49 00	66 30– 67 00	58–1
22 C/2	Lac des Baies	Que.	48 00–48 15	68 30– 69 00	58–1
22 C/7 C/6-E	Rimouski	Que.	48 15–48 30	68 30– 69 00	58–1
22 C/8	Ste. Blandine	Que.	48 15–48 30	68 00– 68 30	58–1
24 B/4	Dunphy Lake	Que.	56 00–56 15	67 30– 68 00	57–1
24 B/5	Lac Romanet	Que.	56 15–56 30	67 30– 68 00	58–1
24 B/12	Horseshoe Lake	Que.	56 30–56 45	67 30– 68 00	58–1
24 C/6	Cambrian Lake	Que.	46 15–46 30	69 00– 69 30	58–1
24 C/7	Chakonipau Lake	Que.	56 15–56 30	68 30– 69 00	57–1
24 C/8	Mistamisk Lake	Que.	56 15–56 30	68 00– 68 30	57–1
24 C/10	Lac Patu	Que.	56 30–56 45	68 30– 69 00	58–1
24 C/11	Shale Falls	Que.	56 30–56 45	69 00– 69 30	57–1
24 C/14	Moraine Lake	Que.	56 45–57 00	69 00– 69 30	58–1
24 C/16	Lac Marcel	Que.	56 45–57 00	68 00– 68 30	58–1
24 E/9	Gossen Hill	Que.	57 30–57 45	70 00– 70 30	57–1
24 E/16	Lac Napier	Que.	57 45–58 00	70 00– 70 30	58–1
24 F/2	Lac Jogues	Que.	57 00–57 15	68 30– 69 00	58–1
24 F/3	Lac la Lande	Que.	57 00–57 15	69 00– 69 30	58–1
24 F/6	Limestone Falls	Que.	57 15–57 30	69 00– 69 30	58–1
24 F/7	Lac Herodier	Que.	57 15–57 30	68 30– 69 00	57–1
24 F/8	Lac Souel	Que.	57 15–57 30	68 00– 68 30	58–1
24 F/9	Lac Garreau	Que.	57 30–57 45	68 00– 68 30	58–1
24 F/12	Lower Larch River	Que.	57 30–57 45	69 30– 70 00	58–1
24 K/3	Lac Thevenet	Que.	58 00–58 15	69 00– 69 30	58–1
24 K/4	Lac Gerido	Que.	58 00–58 15	69 30– 70 00	58–1
24 K/5	Canal Lake	Que.	58 15–58 30	69 30– 70 00	57–1
24 L/8	Finger Lake	Que.	58 15–58 30	70 00– 70 30	58–1
31 I/5	Ste-Emelie-de-l'Energie	Que.	46 15–46 30	73 30– 74 00	57–1
31 F/13	Acheray	Ont.	45 45–46 00	77 30– 78 00	57–2
62 F/9	Souris	Man.	49 30–49 45	100 00–100 30	58–1
62 J/4	Moorepark	Man.	50 00–50 15	99 30–100 00	57–1
63 N/3	Sherridon	Man.	55 00–55 15	101 00–101 30	45–PR–1
62 E/7	Lampman	Sask.	49 45–49 30	102 30–103 00	57–1
72 I/9	Edenwold	Sask.	50 30–50 45	104 00–104 30	58–1
73 F/3	Maidstone	Sask.	53 00–53 15	109 00–109 30	58–1
74 O/5-W 74 O/12-W	Nevins Lake	Sask.	59 24–59 45	107 45–108 00	41–PR–1
82 O/6	Lake Minewanka	Alta.	51 15–51 30	115 00–115 30	58–1
82 P/5	Irricana	Alta.	51 15–51 30	113 30–114 00	58–1
83 A/4	Innisfail	Alta.	52 00–52 15	113 30–114 00	57–1
83 A/5	Red Deer	Alta.	52 15–52 30	113 30–114 00	58–1
83 B/1	Markerville	Alta.	52 00–52 15	114 00–114 30	58–1
83 B/8	Sylvan Lake	Alta.	52 15–52 30	114 00–114 30	58–1
83 G/1	Warburg	Alta.	53 00–53 15	114 00–114 30	57–1
83 G/9	Onoway	Alta.	53 30–53 45	114 00–114 30	57–1
83 H/2	Camrose	Alta.	53 00–53 15	112 30–113 00	58–1
83 H/3	Bittern Lake	Alta.	53 00–53 15	113 00–113 30	58–1
83 H/4	Kavanaugh	Alta.	53 00–53 15	113 30–114 00	57–1
83 H/5	Leduc	Alta.	53 15–53 30	113 30–114 00	58–1
83 H/7	Tofield	Alta.	53 15–53 30	112 30–113 00	58–1
83 H/9	Mundare	Alta.	53 30–53 45	112 00–112 30	58–1
83 H/15	Lamont	Alta.	53 45–54 00	112 30–113 00	58–1
83 H/16	Willingdon	Alta.	53 45–54 00	112 00–112 30	58–1
83 P/4	Ranch	Alta.	55 00–55 15	113 30–114 00	58–1

Number	Name	Location	Latitude	Longitude	Year and Edition
82 F/6	Nelson	B.C.	49°15′–49°30′	117°00′–117°30′	58–2
82 L/11	Salmon Arm	B.C.	50 30 –50 45	119 00 –119 30	57–1
82 L/12	Monte Creek	B.C.	50 30 –50 45	119 30 –120 00	58–1
82 L/14	Sorrento	B.C.	50 45 –51 00	119 00 –119 30	58–1
82 L/15	Malakwa	B.C.	50 45 –51 00	118 30 –119 00	58–1
92 H/6-W	Hope	B.C.	49 15 –49 30	121 15 –121 30	57–1
92 H/14-W	Boston Bar	B.C.	49 45 –50 00	121 15 –121 30	57–1
92 I/3-W	Prospect Creek	B.C.	50 00 –50 15	121 15 –121 30	57–1
92 I/10	Cherry Creek	B.C.	50 30 –50 45	120 30 –121 00	58–1
92 I/11	Ashcroft	B.C.	50 30 –50 45	121 00 –121 30	58–1
92 L/1	Schoen Lake	B.C.	50 00 –50 15	126 00 –126 30	57–3

Appendix V

Geological Survey of Canada

(*a*) DISTRIBUTION OF PARTIES, 1958

The functional distribution of parties of the Geological Survey of Canada in 1958 was as follows: bedrock mapping, 43; surficial mapping, 8; ground-water surveys, 2; geophysics, 2; geochemistry, 3; bedrock stratigraphy and palaeontology, 6; mineral deposits and mineralogy, 6; and other functions, 6.

The regional distribution of the parties was as follows:

Franklin	3
Mackenzie and Keewatin	5
Mackenzie and Yukon	1
Yukon	2
British Columbia	9
British Columbia and Alberta	4
Alberta	2
Alberta and Saskatchewan	2
Saskatchewan	3
Manitoba	3
Ontario	9
Ontario and Quebec	1
Quebec	2
New Quebec and Labrador	4
New Brunswick	6
Nova Scotia	5
Prince Edward Island	1
Atlantic Provinces and Quebec	1
Newfoundland	4
Miscellaneous	9
	76

(*b*) GEOLOGICAL MAPS

*—Map is associated with a report, but is also available separately.
A—Geological series (multicolour).
PS—Preliminary geological series.
G—Aeromagnetic series, 1"= 1 m.
WSP—Water supply papers.

Canada

900A Principal mineral areas (8th edn); in cooperation with Mineral Resources Div. 1"= 120 m.

1045A–M1 Metallogenic map uranium in Canada. 1"= 120 m.

1045A–M2 Metallogenic map beryllium in Canada. 1"= 120 m.

MR1 Canadian iron ore and the North American iron and steel industry; prepared for Mineral Resources Div. 1:10,000,000.

Northwest Territories—District of Franklin

3–1958 (PS) Fury and Hecla Strait (part of 47); 1″= 8 m.

4–1958 (PS) Foxe Basin North (parts of 37 and 47); 1″= 8 m.

Northwest Territories—District of Mackenzie

1055A Geological Map of the District of Mackenzie (2 sheets); 1″= 8 m.

2–1958 (PS) Hardisty Lake, West Half (83C, W½); 1″= 8 m.

16–1958 (PS) Fort Enterprise (86A); 1″= 4 m.

620G	Croft Lake (75 A/1)
621G	Scheelar Lake (75 I/2)
622G	Jim Lake (75 I/7)
623G	Schoemaker Lake (75 I/8)
624G	Mossip Bay (75 I/9)
625G	High Island (75 I/10)
626G	Beck Lake (75 I/15)
627G	Beaverhill Lake (75 I/16)
672G	Biblowitz Lake (75 I/3)
673G	Nieznany Lake (75 I/6)
674G	Breithaupt Lake (75 I/11)
675G	Olson Lake (75 I/14)
676G	Logie Lake (75 I/4)
677G	Snelgrove Lake (75 I/5)
678G	Noyes Lake (75 I/12)
679G	Bodie Lake (75 I/13)
680G	Tite Lake (75 B/11)
681G	Geeves Lake (75 B/14)
682G	Dunvegan Lake (75 B/3)
683G	Abitau Lake (75 B/6)
684G	Mansfield Lake (75 G/3)
685G	Cronyn Lake (75 G/6)
686G	Miller Lake (75 G/11)
687G	Lamarre Lake (75 G/14)
688G	Sled Creek (75 J/3)
689G	Huff Lake (75 J/6)
690G	Catholic Lake (75 J/11)
691G	Lake of Woe (75 J/14)
692G	Knobovitch Lake (75 G/2)
693G	Burpee Lake (75 G/7)
694G	McArthur Lake (75 G/10)
695G	Brooks Lake (75 G/15)
696G	Sled Lake (75 J/2)
697G	Timberhill Lake (75 J/7)
698G	LaRoque Bay (75 J/10)
699G	Zucker Lake (75 J/15)
700G	Glass Lake (75 B/2)
701G	Carleton Lake (75 B/7)
702G	Insula Lake (75 B/10)
703G	Sylvan Lake (75 B/15)
704G	Donnelly Lake (75 G/9)
705G	Penylan Lake (75 G/16)
706G	Coventry Lake (75 G/1)
707G	Dymond Lake (75 G/8)
708G	Bouvier Bay (75 B/1)
709G	Moss Lake (75 B/8)
710G	Blake Lake (75 J/1)
711G	Lynx Lake (75 J/8)
712G	McFarlane Lake (75 J/9)
713G	Garde Lake (75 J/16)
714G	Odin Lake (75 B/9)
715G	Hostile Lake (75 B/16)

Yukon Territory

22–1957 (PS) Wolf Lake (105B); 1″= 4 m.

* 8–1958 (PS) McQuesten Lake (106 D/3); 1″= 1 m.

* 9–1958 (PS) Scougale Creek (106 D/2); 1″= 1 m. (Paper 58-4)

British Columbia

*1053A Dewar Creek (82 F/16); Kootenay Dist.; 1″= 1 m. (Mem. 292)

*16–1957 (PS) New Westminster (92 G/2 and part of G/7); New Westminster Dist.; (Surficial Geol.); 1″= 1 m. (Paper 57-5)

17–1958 (PS) Charlie Lake (94A); Peace River Dist.; 1″= 4 m.

WSP 327 Langley Municipality (parts of 92 G/1 and 2); New Westminster Dist.; (2 maps); 1″= ½ m.

Appendix V

Alberta and British Columbia

1039A Alberta and Northeastern British Columbia Oil and Gas Fields (5th edition); 1″= 20 m.

*14–1958 (PS) Beehive Mountain (82 J/2, E½); W. of Fifth Meridian; 1″= 1 m. (Paper 58-5)

Alberta

688A Moose Mountain (82 J/15, W½); W. of Fifth Meridian (repr.); 1″= 1 m.

5–1958 (PS) Livingstone River (82 J/1, W½); W. of Fifth Meridan; 1″= 1 m.

* 6–1958 (PS) Chungo Creek (83 C/9); W. of Fifth Meridian; 1″= 1 m. (Paper 58-3)

716G Colin Lake (74 M/9); W. of Fourth Meridian

717G Cornwall Lake (74 M/10); W. of Fourth Meridian

718G Charles Lake (74 M/15); W. of Fourth Meridian

719G Andrew Lake (74 M/16); W. of Fourth Meridian

Saskatchewan

25–1957 (PS) Uranium City, Sheet 6 (parts of 74 N/9 and 10); 1″= 800 ft.

27–1957 (PS) Wollaston Lake (64L); 1″= 4 m.

1–1958 (PS) Pelican Narrows (63M); 1″= 4 m.

Saskatchewan and Manitoba

1044A Saskatchewan and Western Manitoba, Oil and Gas Fields (4th edition); 1″= 20 m.

24–1957 (PS) • Ledge Lake (part of 63 K/12, W½); W. of Principal Meridian; 1″= 1,000 ft.

Manitoba

26–1957 (PS) Cranberry Portage, West Half (63 K/11, W½); W. of Principal Meridian; 1″= 4 m.

*15–1958 (PS) Shethanei Lake (64I); 1″= 4 m. (Paper 58-7)

646G	Skromeda Lake (54 L/5)
647G	Dickens Lake (54 L/6)
648G	Lofthouse Lake (54 L/7)
649G	Bylot (54 L/8)
650G	Warkworth Creek (54 K/5)
651G	Salmon Creek (54 K/6)
652G	Paragon Lake (64 I/6)
653G	Archer Lake (64 I/7)
654G	Nares Lake (64 I/8)
655G	Stanley River (64 I/12)
656G	Dawes Lake (64 I/13)
657G	Cromarty (54 L/1)
658G	Red Head Rapids (54 L/2)
659G	Wise Lake (54 L/3)
660G	Knight Lake (54 L/4)
661G	Condie Lake (64 I/1)
662G	Allan Lake (64 I/2)
663G	Broad River (54 K/2)
664G	Kelsey Creek (54 K/3)
665G	Fletcher Lake (54 K/4)
666G	Stony Lake (64 J/15)
667G	Overby Lake (64 J/16)
668G	Blyth Lake (64 I/3)
669G	Ryan Lake (64 J/10)
670G	Wilkie Lake (64 J/11)
671G	Tadoule Lake (64 J/9)
720G	Legary Lake (64 I/5)
721G	Cheyne Lakes (64 J/6)
722G	Kinsman Lake (64 J/7)
723G	Porcupine Rapids (64 J/8)
724G	Ashley Lake (64 I/4)
725G	Fox Lake (64 J/1)

WSP 324 Manitou Area, (part of 62G); W. of Principal Meridian; 1"=4 m.

WSP 325 Pilot Mound Area (part of 62G); W. of Principal Meridian; 1"= 4 m.

WSP 326 Brandon-Souris Area (part of 62F and G); W. of Principal Meridian; 1"= 4 m.

Ontario

1062A Geological Map of Southwestern Ontario, Oil and Natural Gas Producing Areas; 1"= 6 m.

1063A Sudbury (41 NE); Sudbury, Algoma, Timiskaming, Nipissing, Manitoulin, and Parry Sound Dists.; 1"= 8 m.

13–1958 (PS) City of Ottawa, West Part (part of 31 G/5); Carleton County; Drift-Thickness Contours; 1"= 1,000 ft.

Quebec

704A Southern Quebec, Centre Sheet (repr.); 1"= 12 m.

705A Southern Quebec, East Sheet (repr.); 1"= 12 m.

1060A Brock River (32J, E½); Abitibi and Mistassini Territories and Abitibi Co.; 1"=4 m.

*18–1957 (PS) Cambrian Lake, East Half (24C, E½); New Que.; 1"= 4 m. (Paper 57-6)

*21–1957 (PS) Ahr Lake (23 O/10); New Que.; 1"= 1 m. (Paper 57-7)

23–1957 (PS) Sakami Lake Area (part of 33); New Que.; 1"= 8 m.

New Brunswick

11–1958 (PS) Napadogan (21 J/7); York Co.; 1"=1 m.

Nova Scotia

1056A Mira (11 F/16); Cape Breton and Richmond Cos., Cape Breton Island; 1"=1 m.

*1058A Truro (11 E/6); Colchester, Hants, and Pictou Cos., 1"=1 m. (Mem. 297).

17–1958 (PS) Heavy Metals in Stream Sediments, Northern Mainland of Nova Scotia (parts of 11 D, E, and F) (2 sheets); 1"= 4 m.

Newfoundland

*1057A Bay of Islands (part of 12 SE); 1"= 2 m. (Mem. 290)

10–1958 (PS) Baie Verte (12 H/16); 1"= 1 m.

*18–1958 (PS) Sunnyside (1 N/13); 1"= 1 m. (Paper 58-8)

Appendix VI

Geographical Maps

The following *Atlas of Canada* sheets were printed in 1958:

(Principal scale in parentheses where applicable)

4. Extent of Mapping Surveys—1955
8. Hydrographic Charts
9. Bathy-orography—Canada (1:10,000,000)
10. Bathy-orography—Eastern Canada (1:5,000,000)
11. Bathy-orography—Western Canada (1:5,000,000)
12. Bathy-orography—Northern Canada (1:5,000,000)
13. Physiographic Regions
14. Physiography of Southern Ontario (1:1,000,000)
16. Bedrock Geology (1:10,000,000)
17. Principal Minerals (1:20,000,000)
18. Earthquakes, Magnetism and Tides
20. Wind and Sunshine (1:20,000,000)
21. Seasonal Temperatures (1:20,000,000)
28. Snow Cover (1:20,000,000)
31. Typical Weather Situations (1:30,000,000)
33. Drainage Basins and River Flow (1:10,000,000)
35. Soil Regions (1:10,000,000)
37. Ranges of Representative Insects, Ticks and Spiders (1:50,000,000)
38. Natural Vegetation and Flora (1:20,000,000 - 1:50,000,000)
45. Parks and Faunal Reserves (1:10,000,000)
48. Density of Population—1951 (1:5,000,000)
49. Rates of Population Change, 1851-1951 (1:10,000,000)
50. Births, Marriages and Deaths, etc. (1:20,000,000)
51. Age and Sex Ratios (1:20,000,000)
54. Other Origins and Citizenship (1:20,000,000)
56. Urban Population (1:10,000,000)
58. Furs, Whaling and Fish Processing
59. East Coast Fisheries (1:10,000,000)
60. West Coast Fisheries (1:5,000,000)
61. Forestry and Woodworking (1:20,000,000)
62. Sawmills (1:5,000,000)
63. Pulp and Paper Mills (1:5,000,000)
68. Farms (1:20,000,000)
69. Agricultural Regions (1:5,000,000)
70. Agricultural Labour Force and Services (1:10,000,000)
71. Food Industries (1:20,000,000)
72. Primary Iron and Steel (1:10,000,000)
73. Non-ferrous Metals—Eastern Canada (1:5,000,000)
74. Non-ferrous Metals—Western Canada (1:5,000,000)
75. Industrial Minerals (1:5,000,000)
76. Mineral Fuels, Pipelines and Refineries (1:10,000,000)
77. Hydro and Fuel Electric Power—Eastern Canada (1:5,000,000)
78. Hydro and Fuel Electric Power—Western Canada (1:5,000,000)
79. Fabricated Metal Industries (1:20,000,000)
80. Textiles, Clothing and Rubber Products (1:20,000,000)
81. Manufacturing Centres (1:10,000,000)
82. Navigable Waterways (1:20,000,000)
83. Railways (1:5,000,000)
84. Railway Freight Traffic (1:5,000,000)
85. Major Roads (1:5,000,000)

86. Civil Airports, Aerodromes and Time Zones (1:10,000,000)
87. Air Lines (1:10,000,000)
88. Air Passenger Traffic (1:10,000,000)
89. Domestic Trade, Finance and Construction (1:20,000,000)
91. Television and Radio (1:10,000,000)
92. Hospitals (1:10,000,000)
93. Education (1:5,000,000)
94. Public Libraries, Museums and Art Galleries (1:2,500,000)
95. Populated Places—Gulf of St. Lawrence Area (1:2,500,000)
96. Populated Places—Great Lakes Area (1:2,500,000)
97. Populated Places—Prairies (1:2,500,000)
98. Populated Places—The Far West (1:2,500,000)
99. Populated Places—Northern Canada (1:10,000,000)
100. Quebec City and Montreal (1:100,000)
101. Ottawa and Toronto (1:100,000)
102. Winnipeg and Edmonton (1:100,000)
103. Vancouver and Victoria (1:100,000)
104. Rural Municipalities—Eastern Canada (1:5,000,000)
105. Rural Municipalities—Great Lakes - St. Lawrence Area (1:2,500,000)
106. Rural Municipalities—Western Canada (1:5,000,000)
107. Census Divisions—1951 (1:10,000,000)
108. Federal Electoral Districts—1952 (1:10,000,000)
109. Political Evolution (1:20,000,000)
110. Canada and the World

Appendix VII

Nature and Regional Origin of Ores, etc., Received for Investigation

Table 1—Ore or Product

Nature of Sample	Yukon	N.W.T.	B.C.	Alta.	Man.	Ont.	Que.	N.B.	N.S.	Nfld.	Total
Copper	....	....	2	....	....	2	2	....	....	....	6
Copper-Nickel	....	....	....	....	....	2	....	....	....	....	2
Nickel	....	....	....	1	....	3	1	....	....	....	5
Lead-Zinc	....	....	....	....	....	2	....	....	....	....	2
Lead-Zinc-Copper	....	....	....	....	....	....	....	1	....	....	1
Copper-Zinc	....	....	....	....	....	1	1	....	....	....	2
Zinc	....	....	....	....	....	1	....	....	....	....	1
Silver-Lead-Zinc	....	....	1	....	....	....	....	....	....	....	1
Gold	1	....	....	....	....	6	1	....	....	....	8
Silver	....	....	....	....	....	2	....	....	....	....	2
Iron	....	....	....	1	....	11	9	....	....	1	22
Iron-Copper	....	....	....	....	....	....	1	....	....	....	1
Iron-Titanium	....	....	....	....	....	....	4	....	....	....	4
Manganese	....	....	1	....	....	....	....	....	....	....	1
Chromium	....	....	1	....	1	....	....	....	....	....	2
Aluminum	....	....	....	....	....	2	1	....	1	....	4
Aluminum-Iron	....	....	....	....	....	....	....	....	....	1	1
Magnesium-Chromium	....	....	....	....	....	....	1	....	....	....	1
Niobium	....	....	....	....	....	2	2	....	....	....	4
Uranium	....	1	....	....	....	1	....	....	....	....	2
Totals	1	1	5	2	1	35	23	1	1	2	72

Nature and Regional Origin of Ores, etc., Received for Investigation

Table 2—Industrial Minerals

Sample	Yukon-N.W.T.	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.	Total
Andalusite	....	....	....	....	....	....	....	....	3	....	....	3
Apatite	....	....	....	....	....	2	4	....	....	....	....	6
Asbestos	1	1	....	....	....	3	12	....	....	....	....	17
Barite	....	1	....	....	....	....	1	2	....	....	....	4
Bentonite	....	17	....	....	....	....	....	....	....	....	....	17
Beryl	....	....	....	....	4	....	2	....	....	....	....	6
Diatomite	....	3	....	....	....	1	1	....	....	....	....	5
Dolomite	....	....	....	....	....	1	2	....	....	....	....	3
Feldspar	....	....	....	....	....	5	1	....	....	....	....	6
Fluorspar	....	1	....	....	....	....	....	....	....	....	....	1
Garnet	....	1	....	....	....	13	....	....	....	....	....	14
Graphite	....	....	....	....	....	6	5	....	....	....	....	11
Gypsum	....	....	....	....	....	1	....	....	1	....	....	2
Kyanite	....	....	....	....	....	1	....	....	....	....	....	1
Limestone	....	....	....	....	....	5	1	....	....	....	....	6
Magnesia	....	....	....	....	....	....	3	....	....	....	....	3
Magnesite	....	5	....	....	....	....	4	....	....	....	....	9
Marl	....	....	....	....	....	5	....	....	....	....	....	5
Mica	....	1	....	....	....	3	2	....	....	....	....	6
Nepheline syenite	....	....	....	....	....	1	....	....	....	....	....	1
Phosphate	....	....	....	....	....	....	11	....	....	....	....	11
Potash	....	....	....	1	....	....	....	....	....	....	....	1
Pyrophyllite	....	3	....	....	....	....	....	....	....	....	20	23
Quartz crystals	....	....	....	....	....	....	5	....	....	....	....	5
Silica	....	5	....	....	2	64	12	....	5	....	....	88
Talc	....	7	....	....	....	16	13	....	....	....	....	36
Zeolites	....	....	....	....	....	....	....	....	1	....	....	1
Aggregates:												
Crushed stone and gravel	....	....	4	....	....	14	7	2	1	....	....	28
Heavy types	....	....	1	....	....	....	2	....	....	....	....	3
Lightweight:												
(*a*) Clays and shales	....	21	....	....	....	19	3	1	....	....	....	44
(*b*) Vermiculite	....	....	....	....	....	11	....	....	....	....	....	11
(*c*) Others	....	....	....	....	....	4	....	....	....	....	....	4
Building stone	....	....	....	....	....	2	....	....	....	....	....	2
Others	....	....	....	10	....	2	1	....	....	....	....	13
Ceramic clays and shales	2	21	....	....	12	61	24	14	88	9	2	233
Refractory materials and products	....	7	....	1	....	7	17	....	....	....	....	32
Structural and other ceramic products	....	....	3	1	....	11	8	....	....	....	....	23
Totals	3	94	8	13	18	258	141	19	99	9	22	684

Appendix VIII

Geological Survey of Canada

Research Grants to Canadian Universities—1958-59

Grants-in-aid from funds provided by Parliament for the support and stimulation of geological research in Canadian universities totalled $50,000 in 1958, $10,000 more than in 1957. The grants were made to ten universities in support of twenty-five research projects. They are awarded on the advice of the National Advisory Committee on Research in the Geological Sciences.

Thirty-eight projects in twelve universities are currently being supported; thirty others have been completed. Since 1951, when the grants were initiated, more than seventy papers recording the results of grant-supported projects have been published in scientific journals.

In 1951 there were just enough deserving applications to use the initial $10,000 grant. This year with a grant of $50,000, there were forty applications totalling almost $100,000. There can be little doubt that the grants are accomplishing their purpose of encouraging, stimulating and improving the quality of geological research in Canadian universities. Not only have they helped to provide needed equipment, but they have enabled the more brilliant students to pursue graduate studies and research in Canada. At the same time, increasing opportunities and facilities for research are attracting further aid from other sources; university-sponsored projects originally supported by these grants have received additional backing of up to $20,000 from charitable foundations and mining companies.

Since effective research stems mainly from personal ingenuity, it is desirable that work on fundamental problems be done by many people with different viewpoints, and with considerable freedom, rather than by a few under centralized control. For this reason, pioneering in new and less tried fields of research has been and will continue to be the role of the universities; and in their laboratories will originate many of the new techniques to be applied in the increasingly difficult quest for, and utilization of, mineral deposits. It is therefore most important that such university research in the geological sciences, which until recently was largely neglected in Canada, be fostered and encouraged by grants-in-aid and similar support.

The following is a summary of the individual grants made to Canadian universities in 1958.

University of Alberta

Problems in Nuclear Geochronology

Applicant—R. E. Folinsbee...Amount, $2,500

For the past three years Dr. Folinsbee has been studying the history of the Yellowknife nucleus and of the Cordillera and related sedimentary rocks of the Western Canada basin, using the potassium-argon, lead-alpha and strontium-rubidium methods to date the ages of the rocks. He will continue this work with the objective of establishing an absolute time scale for post-Cambrian time by dating materials for which there is biostratigraphic control. In particular, he will study the volcanic ash beds in the sedimentary sequence, using potassium-argon and strontium-rubidium methods for determining their ages. (*See also* text—Geological Survey of Canada.)

Heat-flow Measurements in Western Canada

Applicant—G. D. Garland...Amount, $1,000

The flow of heat from the interior of the earth and the regional variation in quantity remain among the most uncertain, yet important of basic geophysical data. A series of determinations will be made in abandoned oil wells in Western Canada, from as far east as possible in the Plains to the Foothills, in order to find if there is any significant difference in heat flow between the interior of the continent and the mountains.

University of British Columbia

Isotope Geology

Applicant—J. A. Jacobs...Amount, $3,000

A National Research Council grant will cover the cost of building a mass spectrometer especially designed for research on geological problems. The first project, which the present grant will support, will be an investigation of the origin of sulphide-ore deposits and the use of isotope ratios of lead in rock minerals to determine the relationships among different rock masses.

Trace-element Content of Some Rocks in Western Canada

Applicant—H. V. Warren...Amount, $3,850

This project involves the study of trace-element relationships between soils and rocks. The investigation involves the development of special chemical techniques supplemented by spectroscopy. Preliminary results of one phase of this investigation suggest that, in the vicinity of mineralization, the readily extractable copper of plutonic rocks is from five to ten times greater than that from rocks unrelated to mineralization. This may provide a technique useful in exploration and prospecting.

École Polytechnique

Mineralogy and Petrography of the Oka Alkaline Intrusions and Study of the Amphibole Minerals

Applicant—Guy Perrault..Amount, $1,000

The alkaline rocks of the Oka district of Quebec are of particular interest because of the deposits of columbium associated with them.

This project includes a detailed study of the mineralogy and petrography of these intrusions, including study of the common rock-forming minerals and the columbium minerals. A study of the amphibole minerals, including precise determinations of their properties, may also be undertaken.

University of Manitoba

Distribution of Nickel, Copper, Cobalt and Iron in Silicate and Sulphide Phases

Applicant—H. D. B. Wilson..Amount, $2,600

This project has grown out of two others recently completed; namely, a study of trace-metal content and major elements in fifty North American ores, and a statistical study of several thousand assays from some Canadian base-metal mines. These studies are thought to indicate some of the controls that determine the metal ratios in the ores at various mines. The present project, involving determination of the distribution coefficients in silicate and sulphide phases by making melts at various temperatures (and possibly pressures), will test these conclusions experimentally in the laboratory.

McGill University

Studies of Terrestrial Thermal Gradient in the St. Lawrence Lowlands of Quebec

Applicants—T. H. Clark and V. A. Saull............................Amount, $2,180

The objectives of the proposed research are (1) to determine depth-temperature curves for a number of bore holes recently drilled in the vicinity of Montreal and the lithology and thermal properties of the strata penetrated by the holes, by examination and testing of the drill cores, and (2) to study the results with particular reference to terrestrial heat flow, artesian water flow, and local and regional rock structure.

Silicate and Sulphide Phase Relationships

Applicants—J. E. Gill, E. H. Kranck, and V. A. Saull .... Amount, $5,000

This project was initiated in 1954. It involves experiments on the behaviour of silicates and sulphides at high pressures and temperatures to find out more about the formation of ores and the metamorphism of rocks.

Current work involves (1) experiments on the hydrothermal transportation of sulphides, (2) experiments to test the efficacy of solid diffusion as an ore-forming process, (3) experiments on the melting of rock materials, and (4) experiments on the volatility of certain sulphides in sulphur vapour. (*See also* text—Geological Survey of Canada.)

Geochemical Study of Anorthosite

Applicant—E. H. Kranck .... Amount, $400

The purpose of this project is to obtain information on the physico-chemical conditions under which anorthosites formed. It will include a study of the cation ratios and the rare diadoke constituents of the major minerals, and of the distribution of the less common accessory minerals in the rock series. It is hoped that these studies will contribute to a better understanding of the distribution of anorthosites in the Grenville province and of the conditions under which they were formed.

Enthalpy Changes in Metamorphic Reactions and their Geologic Significance

Applicant—V. A. Saull .... Amount, $2,240

This project, which was initiated in 1953, involves fundamental research on the changes (metamorphism) that rocks undergo when deeply buried in the earth's crust.

Apparatus has been constructed that will measure the heat developed in any solution process that can be made to occur in a closed system. These data will be used to determine heats of reactions, surface and strain energy of geologic materials. (*See also* text—Geological Survey of Canada.)

Mineralogical and Chemical Investigation of the Relation between Pyrochlore and Betafite

Applicant—John S. Stevenson..Amount, $800

The relationship of chemical composition with the physical and crystallographic properties of pyrochlore and betafite has not been studied systematically and is in doubt. This study will attempt to supply X-ray, density and differential thermal analysis data on pure materials and correlate them with chemical composition, thus solving the relationship of the two minerals.

McMaster University

Geochemical Studies

Applicant—Denis M. Shaw..Amount, $4,000

A program of spectrochemical research on the distribution of minor elements in minerals has been supported at McMaster for the past 7 years. Investigations currently under way include geochemical studies of the sillimanite group and of scapolites, pyroxenes, and calcites. In addition, experimental work on spectrographic analysis in an argon-oxygen atmosphere is in progress, and a statistical-analytical study of the sampling of coarse-grained porphyritic rocks will be made. (*See also* text—Geological Survey of Canada.)

University of New Brunswick

Trace-element Distribution in the Rocks and Ores of the Bathurst District, N.B.

Applicant—W. E. Hale ....Amount, $1,100

The purpose of this project is to find out whether particular trace elements are common to the ores and any specific rocks of the area. It is possible that such a study will reveal some unique similarities between the ores and a specific rock type. This information, in conjunction with petrographic and structural evidence, may clarify the problem of the origin of the large base-metal deposits of the district.

Petrology and Structure of Southern New Brunswick Granites

Applicant—G. S. MacKenzie..Amount, $700

A study will be made of the nature, form and structural relations of granite bodies of this area. In addition to petrographic examination, chemical analyses will be made and the heavy minerals of the granites will be studied and compared with those in adjacent intruded rocks. This project will complement the study by Dr. Hale (above).

Queen's University

Publication of "Canadian Mineralogist"

Applicant—L. G. Berry, Editor..Amount, $1,800

The Mineralogical Association of Canada, which was organized in 1954, will publish the *Canadian Mineralogist* annually. (The second number was published in September, 1958.) Mineralogical studies are of interest to a relatively small group of readers and this makes it difficult to publish such a periodical without financial support for the first few years. This will be on a diminishing scale as circulation, particularly outside Canada, is built up. (*See also* text—Geological Survey of Canada.)

X-Ray Spectrographic Analyses of Minerals and Rocks

Applicant—L. G. Berry..Amount, $3,300

The purpose of this work is to establish methods of quantitative analytical determination of elements in minerals and geological materials by X-ray fluorescent analysis. The following specific projects will be undertaken during the coming year: (1) analysis of garnets from a wide variety of sources; (2) determination of the selenium content of sulphide minerals; (3) analysis of sphalerite as part of a study of the Sullivan ores; (4) analysis of limestones by X-ray fluorescence; and (5) analysis of magnesium, iron, silicon, and other elements in ultrabasic rocks and chromites. Much of this work is complementary to the spectrographic, X-ray, and geochemical research on Canadian rocks, minerals, and ores that is being carried out under the supervision of Dr. J. E. Hawley. (*See also* text—Geological Survey of Canada.)

Spectrographic, X-ray, and Geochemical Research on Canadian Rocks, Minerals and Ores

Applicant—Dr. J. E. Hawley..Amount, $4,200

This project, which has been supported for the past 6 years, embraces a wide range of studies. Included in the studies proposed for 1958-59 are: (1) geochemical studies of granitic rocks of the Grenville province and their comparison with Killarney types and those of part of the Algoma district; (2) further studies of trace elements in copper and gold ores and selenium distribution in Canadian sulphide deposits; (3) study of limestones in the Kingston area; (4) further studies of results of heat treatment of sulphides in ores, in sulphur and H_2S atmospheres; (5) geochemical study of chromite and ultrabasic rocks in Quebec; (6) geochemical study of Sullivan ore minerals; and (7) continuation of the study of high- and low-iron sphalerites etc. to discover reasons for variation in ore types of the Blue Bell lead-zinc deposit in British Columbia and possible formation temperatures. (*See also* text—Geological Survey of Canada.)

Investigation of Internal Structures and Wall Composition of Certain Microfossils

Applicant—Alan McGugan...Amount, $700

Taxonomic descriptions and illustrations of microfossils are limited in general to external morphology. This work will supplement study of obvious external characters with study of detailed internal and wall structure, including the pore distribution in perforate forms. With improved knowledge of the microfaunas, improved correlations of strata will be possible, particularly in interfingering micro-biofacies.

University of Toronto

Annotated Bibliography and Index of Pleistocene Geology of Canada

Applicant—R. E. Deane...Amount, $500

No comprehensive bibliography exists, and a sound program of Pleistocene geology cannot be undertaken without knowledge of what has been done. The bibliography will supplement the recently published Pleistocene map of Canada, and the two will summarize knowledge of Canada's Pleistocene geology and provide a framework for the detailed information that is accumulating.

Lead Isotope Abundance Variations in Lead Minerals from Southern Ontario

Applicant—R. M. Farquhar...Amount, $800

This project includes an investigation of possible lead-isotope variations in the Grenville geological province and in sedimentary rocks of southern Ontario by means of the mass spectrometer and chemical analyses of the leads, and determination of the age relationships among certain suites of rocks from the Grenville geological province by the potassium-argon method.

76101-5—10

Solubility of Metallic Sulphides in Water at Elevated Temperatures and Pressures

Applicant—F. G. Smith .... Amount, $1,770

This project involves direct measurement of the solubility of metallic sulphides to obtain thermodynamical constants and extrapolation of the data to conditions of geological interest.

Geological Age Determinations

Applicant—Dr. J. T. Wilson .... Amount, $4,800

This project has been supported for the past 7 years. A new argon line has been set up, and new methods for improved determination of the age of biotite, feldspar and similar minerals by the potassium-argon method have been developed. Arrangements have been made to collect specimens, and future work will emphasize geological applications.

Microgram quantities of lead from minerals such as feldspar are being successfully extracted and analyzed. The means are thus available to study the relations between lead ores and the lead in surrounding rock bodies, and this is being vigorously pursued because of its interest and potential importance in theories of ore deposition. (*See also* text—Geological Survey of Canada.)

University of Western Ontario

Stratigraphic Correlation of Glacial Deposits between Lake Huron and the St. Lawrence Lowlands

Applicant—A. Dreimanis .... Amount, $260

Previous studies by Professor Dreimanis in areas near Lake Erie and Toronto and in the St. Lawrence Lowlands indicate that certain stratigraphic correlations may be made, but further information is required between studied areas. The work will include lithologic investigation of tills and studies of leaching of soils.

Scale-model Experiments on Electromagnetic Prospecting

Applicant—Robt. J. Uffen .... Amount, $350

Several airborne electromagnetic prospecting devices developed in Canada are in use by the larger mining companies. Interpretation of the field results is difficult and largely empirical.

This project, which was initiated in 1954, will continue scale-model experiments of the electromagnetic response of typical geological structures as an aid to interpretation of field surveys. Work will continue on both phase and amplitude measurements on aggregates of conducting particles.

Methods of Operations Research Applied to Prospecting

Applicant—Robt. J. Uffen..Amount, $1,150

By using the method of operations research which was developed during World War II, Slichter was able to give a method of determining the optimum drilling program on a statistical basis. By substituting various values for the variables involved in drilling programs, such as target size expected or sought, drilling cost, ore value, etc., it will be possible to examine their effects statistically on the "completeness of search", the "discovery-hole economy" and the "prospecting profit ratio". The method can be programmed for solution with a high-speed computor thus permitting rapid evaluation or re-evaluation when new data become available.

76101-5—10½

Appendix IX

PUBLICATIONS AND ARTICLES PUBLISHED

1. Publications

Administrative

Report of the Explosives Division (Calendar Year 1957).
Report on the Administration of the Emergency Gold Mining Assistance Act for the fiscal year ended March 31, 1958.
The Handling of Explosives. (Reprint.)
The Storage of Explosives. (Reprint.)
Annual Report of the Department for the fiscal year ended March 31, 1957.

French Versions

Report of the Explosives Division (Calendar Year 1956).
Report on the Administration of the Emergency Gold Mining Assistance Act for the fiscal year ended March 31, 1958.
Annual Report of the Department for the fiscal year ended March 31, 1957.

Mineral Resources Division

63 Preliminary mineral reviews. (Offset.)
Operators List 1, Part 1, *Metallurgical Works in Canada, Primary Iron and Steel.* (Offset.)
Operators List 3, Part 1, *Milling Plants in Canada, Metallic Ores.* (Offset.)
Operators List 3, Part 2, *Milling Plants in Canada, Industrial Minerals.* (Offset.)
Operators List 4, *Coal Mines in Canada.* (Offset.)
Operators List 5, *Petroleum in Canada.* (Offset.)
Operators List 6, *Ceramic Plants in Canada.* (Offset.)
Memorandum Series No. 137, *Zinc in Canada, with Comments on the World Situation,* by R. E. Neelands and D. B. Fraser. (Offset.)

Mineral Information Bulletins:
MR 27: *A Survey of the Iron Ore Industry in Canada During 1957,* by T. H. Janes and R. B. Elver.
MR 28: *Iron Ore and Other Raw Material Sources for a Primary Iron and Steel Industry in Western Canada,* by T. H. Janes.

French Versions

63 Preliminary mineral reviews. (Offset.)

Surveys and Mapping Branch

Geodetic Survey of Canada

Publ. 16. *Precise and Secondary Levelling in N.S., N.B., P.E.I., and Nfld.,* by G. F. Dalton.
Publ. 16. *Suppl. No. 1 to Precise and Secondary Levelling in N.S., N.B., P.E.I., and Nfld.* (Offset.)
Publ. 21. *Suppl. No. 1 to Precise and Secondary Levelling in Manitoba.* (Offset.)

Canadian Hydrographic Service

Mean Sea Level Observations, I.G.Y., (July-December 1957). (Offset.)
Suppl. No. 1 to British Columbia Pilot, Vol. II, (1953 Edn.).
Suppl. No. 1 to St. Lawrence Pilot, (1957 Edn.).
Suppl. No. 2 to Labrador and Hudson Bay Pilot, (1954 Edn.).
Suppl. No. 2 to Great Lakes Pilot, Vol. II, (1955 Edn.).
Suppl. No. 3 to Newfoundland Pilot, (1952 Edn.).
Great Lakes Pilot, Vol. I, (4th Edn.).
Great Slave Lake and Mackenzie River Pilot, (1st Edn.).

Tide Tables, 1959 (offset):

1. *Atlantic Coast.*
2. *Fleuve Saint-Laurent et Rivière Saguenay.*
7. *Gulf of St. Lawrence.*
8. *Bay of Fundy and Atlantic Coast of Nova Scotia.*
9. *Atlantic Coast of Newfoundland and Labrador.*
10. *Pacific Coast.*
14. *Juan de Fuca Strait to Boundary Pass, B.C.*
15. *Strait of Georgia to Queen Charlotte Strait, B.C.*
16. *Barkley Sound to Dixon Entrance, B.C.*

Canadian Board on Geographical Names

Gazetteer of Canada—Alberta. (Offset.)
Gazetteer of Canada—Northwest Territories and Yukon—Provisional. (Offset.)
Gazetteer of Canada—Saskatchewan.

Geological Survey of Canada

Memoirs:

288: *Surficial Geology of the Lindsay-Peterborough Area, Ontario, Victoria, Peterborough, Durham and Northumberland Counties, Ontario,* by C. P. Gravenor.

289: *Silurian Stratigraphy and Palæontology of the Niagara Escarpment in Ontario,* by T. E. Bolton.

293: *Flora of the Upper Cretaceous Nanaimo Group, Vancouver Island, British Columbia,* by W. A. Bell.

295: *Carboniferous Stratigraphy and Rugose Coral Faunas of Northeastern British Columbia,* by P. K. Sutherland.

297: *Truro Map-area, Colchester and Hants Counties, Nova Scotia,* by I. M. Stevenson.

Bulletins:

38: *Ordovician Cephalopods from Cornwallis and Little Cornwallis Islands, District of Franklin, Northwest Territories,* by Walter C. Sweet and A. K. Miller.

39: *Soil Analyses as a Method of Geochemical Prospecting in Keno Hill-Galena Hill Area, Yukon Territory,* by Robert W. Boyle and C. Brian Cragg.

40: *A Lower Carboniferous Spore Assemblage in Coal from the South Nahanni River Area, Northwest Territories,* by P. A. Hacquebard and M. S. Barss.

41: *Fauna, Age and Correlation of the Jurassic Rocks of Prince Patrick Island,* by Hans Frebold.

42: *Bryozoa (Mainly Trepostomata) from the Ottawa Formation (Middle Ordovician) of the Ottawa–St. Lawrence Lowland,* by Madeleine A. Fritz.

43: *Stratigraphy of the Lewes River Group (Triassic) of Central Laberge Area, Yukon Territory,* by E. T. Tozer.

46: *Contributions to Canadian Palynology,* by J. Terasmae.

Annual Report—Mines and Technical Surveys

Papers (Offset):

57–5: *Surficial Geology of New Westminster Map-area, British Columbia.* (Report and Map 16-1957), by J. E. Armstrong.

57–6: *Cambrian Lake (East Half), New Quebec.* (Report and Map 18-1957), by S. M. Roscoe.

57–7: *Ahr Lake Map-area, New Quebec.* (Report and Map 21-1957), by W. A. Baragar.

57–8: *Alkaline Rocks and Niobium Deposits near Nemegos, Ontario,* by R. W. Hodder.

58–1: *Heavy Metal (Zn, Cu, Pb) Content of Water and Sediments in the Streams, Rivers, and Lakes of Southwestern Nova Scotia* (20P, 21A, B, and H, parts of), by R. W. Boyle, G. F. Koehler, R. L. Moxham and H. C. Palmer.

58–2: *Uppermost Jurassic and Cretaceous Rocks of Aklavik Range, Northeastern Richardson Mountains, Northwest Territories,* by J. A. Jeletzky.

58–3: *Chungo Creek Map-area, Alberta,* by R. J. W. Douglas.

58–4: *McQuesten Lake and Scougale Creek Map-areas, Yukon Territory,* by L. H. Green.

58–5: *Beehive Mountain, Alberta and British Columbia,* by D. K. Norris.

58–6: *Gordon Lake Nickel Deposit, Ontario,* by E. R. Rose.

58–7: *Shethanei Lake, Manitoba.* (Report and Map 15-1958), by F. C. Taylor.

Miscellaneous:

Economic Geology Series No. 18: Niobium (Columbium) Deposits of Canada, by Robert B. Rowe.

Mines Branch

Reports:

855: *The Industrial Minerals of Newfoundland,* by G. F. Carr.

856: *Water Surv. Rept. No. 8: Mackenzie River and Yukon River Drainage Basins in Canada, 1952-53,* by J. F. J. Thomas.

862: *The Canadian Mineral Industry, 1955.* (1st Edn.) (Offset.)

Memorandum Series:

No. 116: *Utilization of Low-grade Domestic Chromite,* by K. W. Downes and D. W. Morgan. (1951.) Reprinted (Offset) 1958.

Miscellaneous:

Conference on Coal-burning Gas Turbines McGill University, Montreal, Quebec, November 22-23, 1956—Proceedings. Compiled and edited by E. R. Mitchell. (Offset.)

French Versions

Report:

No. 863: *The Canadian Mineral Industry, 1955.* (1st Edn.) (Offset.)

Dominion Observatories

Dominion Observatory, Ottawa

Vol. XIV, No. 20:

Bibliography of Seismology, July to December 1956, by W. E. T. Smith.

Vol. XVII, No. 2:

Record of Observations at the Magnetic Observatories Agincourt and Meanook, 1936-1937, by W. E. W. Jackson. (Offset.)

Vol. XIX, No. 4:
Gravity Measurements in Quebec, by L. G. D. Thompson and G. D. Garland.

Vol. XIX, No. 5:
Investigations of Gravity and Isostasy in the Southern Canadian Cordillera, by G. D. Garland and J. G. Tanner.

Vol. XIX, No. 6:
Direction of Faulting in Some of the Larger Earthquakes of 1954-55, by J. H. Hodgson and J. Irma Cock.

Vol. XIX, No. 7:
An Investigation of Magnetic Pulsations at Canadian Magnetic Observatories, by K. Whitham and E. I. Loomer.

Vol. XIX, No. 8:
Direction of Faulting in Some of the Larger Earthquakes, 1955-56, by J. H. Hodgson and Anne Stevens.

Vol. XIX, No. 9:
Gravity Measurements in Southern Ontario, by L. G. D. Thompson and A. H. Miller.

Vol. XX, No. 1:
Dominion Observatory Rockburst Research, 1938-1945, by E. A. Hodgson. (Offset.)

Vol. XXI, No. 1:
Gravity and Magnetic Investigations along the Alaska Highway, by C. H. G. Oldham.

Vol. XXI, No. 2:
Three-Hour Indices of Magnetic Elements, Agincourt, Meanook, Baker Lake and Resolute Bay, by A. A. and M. H. Onhauser. (Offset.)

Vol. XXII, No. 1:
Bibliography of Seismology, January to June, 1957, by W. E. T. Smith.

Seismological Bulletin: April-June 1957. (Offset.)

Astrophysical Observatory, Victoria, B.C.

Vol. X, No. 19:
Four B-Type Model Atmospheres, by Anne B. Underhill.

Vol. X, No. 20:
Homologous Solutions of Equations of Stellar Structure, by G. J. Odgers.

Vol. X, No. 21:
Redetermination of the Spectrographic Orbit of δ' Lyrae, by E. H. Richardson and A. McKellar.

Vol. X, No. 22:
Wave-length Standards for Radial-Velocity Determinations, Spectral Types A3-K8 with Low Dispersion, by R. M. Petrie, D. H. Andrews and J. K. McDonald.

Vol. X, No. 23:
Relative Spectral Gradients as Measured in High-Dispersion Grating Spectra, by Bengt Westerlund.

Vol. X, No. 24:
A Spectrographic Binary in the Pleiades, by Joseph A. Pearce.

Vol. X, No. 25:
The Eclipsing Variable H.D. 190786 (V477 Cygni), by Joseph A. Pearce.

Vol. XI, No. 1:
Victoria Observations of 31 Cygni, by A. McKellar and R. M. Petrie.

Geographical Branch

Geographical Bulletin No. 10: *Manufacturing in Downtown Toronto,* by Donald Kerr and Jacob Spelt. *Le Paysage Urbain de Québec,* by Pierre Camu. *Geographical Aspects of Weather and Climate at Eureka, N.W.T.,* by Victor W. Sim. *Human Geography of the Lower Albany River Basin, Northern Ontario,* by W. G. Dean. *Ice Conditions, Gulf of St. Lawrence, 1956,* by W. A. Black.

Papers (offset):

No. 15: *A Report on Sea Ice Conditions in the Eastern Arctic, 1957,* by W. A. Black.

16: *Ice Conditions in the Gulf of St. Lawrence during Spring Season 1953-1957,* by C. N. Forward.

18: *A Subsurface Organic Layer Associated with Permafrost in the Western Arctic,* by J. Ross Mackay.

19: *Gulf of St. Lawrence Ice Survey, Winter 1958,* by W. A. Black.

Bibliographical Series (offset):

No. 19: *Selected Bibliography of Canadian Geography with Imprint 1956.*

20: *Selected Bibliography on Canadian Permafrost,* by Frank A. Cook.

21: *Canadian Maps 1955-56.*

2. Articles Published in Scientific and Technical Journals

Administration—Mineral Resources Division

Iron Ore and Other Raw Material Sources for a Primary Iron and Steel Industry in Western Canada, by T. H. Janes. *Bull. Can. Inst. Mining Met.,* Vol. 51, No. 577, 1958.

Nickel in Canada, 1957, by R. J. Jones. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Copper in Canada, 1957, by R. J. Jones. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Zinc in Canada, 1957, by D. B. Fraser. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Lead in Canada, 1957, by D. B. Fraser. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Iron Ore in Canada, 1957, by T. H. Janes. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Titanium in Canada, 1957, by T. H. Janes. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Cobalt, Tungsten, Molybdenum, 1957, by R. J. Jones. *Can. Mining J.,* Volume 79, No. 2, 1958.

Silver in Canada, 1957, by D. B. Fraser. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Gold in Canada, 1957, by T. W. Verity. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Uranium in Canada, 1957, by R. A. Simpson. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Petroleum and Natural Gas, 1957, by R. B. Toombs. *Can. Mining J.,* Vol. 79, No. 2, 1958.

Iron Ore in Canada, 1957, by T. H. Janes. *Western Miner and Oil Rev.,* Vol. 31, No. 6, 1958.

Uranium in Canada, by R. A. Simpson. *Western Miner and Oil Rev.,* Vol. 31, No. 6, 1958.

Many New Laws and Court Rulings have Affected Mines During 1958, by E. C. Hodgson. *The Northern Miner,* Nov. 27, 1958.

Prospects for Zinc Refining in Eastern Canada, by D. B. Fraser. *The Northern Miner,* Nov. 27, 1958.

Uranium in Canada, by R. A. Simpson. *Nuclear Energy Eng.,* Vol. 12, No. 127, 1958.

Appendix IX

Surveys and Mapping Branch

Geodetic Survey of Canada

Azimuth Determination without Circle Readings, by R. K. C. Johns. *Bull. Géod.*, No. 45, 1957. Available as Geod. Surv. Reprint No. 1.

Simultaneous Adjustment of Length and Angles in a Triangulation Scheme, by L. A. Gale. *Can. Surveyor,* Vol. 14, No. 5, 1958. Available as Geod. Surv. Reprint No. 2.

Conversion from Shoran to Hiran, by S. Yaskowich. *Can. Surveyor,* Vol. 14, No. 1, 1958.

Geodimeter Base Lines, by H. E. Jones. *Can. Surveyor,* Vol. 14, No. 2, 1958.

Shoran Trilateration in the Arctic Islands, by A. C. Hamilton and J. G. Showler. *Can. Surveyor,* Vol. 14, No. 3, 1958.

Topographical Survey

Simple Adjustment of Survey Figures, by T. Suirna. *Can. Surveyor,* Vol. 14, No. 1, 1958.

Mapping of the Ungava Peninsula, by S. G. Gamble. *Photogrammetric Eng.* Vol. 24, 1958.

Legal Surveys and Aeronautical Charts

The Alberta-Northwest Territories Boundary, by R. W. Clark. *Can. Surveyor,* Vol. 14, No. 5, 1958.

Geological Survey of Canada

Geological Reconnaissance by Helicopter in New Quebec, by K. E. Eade. *Can. Mining J.*, April, 1958.

Patterns Resulting from Glacier Movements North of Foxe Basin, N.W.T., by R. G. Blackadar. *Arctic,* Vol. 11, No. 3, 1958.

A Graduate in Northern Canada—IGY, by R. L. Christie. *U.B.C. Alumni Chronicle,* Summer 1958.

Old and New Ways in Arctic Geology, by Y. O. Fortier. *Can. Geog. J.*, Vol. 57, No. 3, 1958.

Geology and Uranium Deposits of Beaverlodge Region, Sask., by L. P. Tremblay. *Proc. 2nd Internat. Conf. Peaceful Uses Atomic Energy,* Geneva. Sept. 1958.

Geology of the Cassiar Asbestos Mine with Special Reference to Ore Control (Abstract), by H. Gabrielse. *Can. Mining J.*, Vol. 79, No. 4, 1958.

Geology of the Gander River Ultrabasic Belt, Newfoundland, by S. E. Jenness. *Geol. Surv. Nfld.*, Report 11, 1958.

Geology of the Newman Sound Map-area, Northeastern Newfoundland, by S. E. Jenness. *Geol. Surv. Nfld.*, Report 12, 1958.

Mississippian Stratigraphy and Petroleum Possibilities of Central Cape Breton Island, Nova Scotia, by D. G. Kelley. *Trans. Can. Inst. Mining Met.*, Vol. LXI, 1958.

Tectonics of the Shakwak Lineament, Southwest Yukon and Eastern Alaska, by J. E. Muller. *Bull. Geol. Soc. Amer.*, Vol. 69, No. 12, 1958.

Status of Ground-water Studies in Canada, by E. I. K. Pollitt. *Trans. Roy. Soc. Can.*, Vol. 51, Ser. 3, Sec. 4, June 1957.

Geology of the Bathurst-Newcastle Mineral District, New Brunswick, by C. H. Smith and Ralph Skinner. *Trans. Can. Inst. Mining Met.*, Vol. LXI, 1958.

The Kipp Section, by A. MacS. Stalker. *J. Alta. Soc. Petrol. Geol.*, Vol. VI, No. 9, 1958.

Discovery of Fossil *Ceratophyllum demersum* L. in Norhwest Territories, Canada, by J. Terasmae and B. G. Craig. *Can. J. Bot.*, Vol. 36, 1958.

Microforaminifera from Pleistocene Deposits, Prince Edward Island, Canada, by J. Terasmae. *Micropal.*, Vol. IV, No. 4, 1958.

Lead Isotope Studies of Sullivan Mine and Other Deposits in East Kootenay District, Southeastern British Columbia, by R. K. Wanless and G. B. Leech. *Trans. Am. Geophys. Union*, Vol. 39, No. 3, 1958.

The Proterozoic of Eastern Canadian Appalachia, by L. J. Weeks. *Roy. Soc. Can.*, Spec. Pub. No. 2, 1957.

A Source of the Foothills Erratics Train, Jasper, Alberta, by E. W. Mountjoy. *J. Alta. Soc. Petrol. Geol.*, Vol. 6, No. 9, 1958.

Mississippian Stratigraphy of the Central Foothills and Eastern Ranges of the Nordegg Area, Alberta, by W. B. Brady. Guidebook, 8th Ann. Field Conf., *Alta. Soc. Petrol. Geol.*, 1958.

Pocono Paleocurrents in Pennsylvania and Maryland, by B. R. Pelletier. *Bull. Geol. Soc. Amer.*, Vol. 69, 1958.

Operation Mackenzie, Canadian Oil and Gas Industries, by R. J. W. Douglas. Vol. 11, 1958, pp. 51-57; *Can. Mining J.*, Vol. 79, 1958.

Canadian 'Operation Mackenzie', 1957, by R. J. W. Douglas. *Polar Record*, Vol. 9, 1958.

Redescription of *Ctenobolbina Clavigera* (Jones) 1891 from the Middle Ordovician of Ottawa, Canada, by Murray J. Copeland. *J. Pal.*, Vol. 32, No. 1, 1958.

Pre-Carboniferous Faunas, Northern and Central New Brunswick, by L. M. Cumming. Abstr., *Bull. Geol. Soc. Amer.*, Vol. 69, No. 12, 1958.

Stratigraphy and Correlation of the Jurassic in the Canadian Rocky Mountains and Alberta Foothills, by Hans Frebold. *In* "Jurassic and Carboniferous of Western Canada". *Am. Assoc. Petrol. Geol.*, 10-26, 1958.

Mississippian Succession in Mount Head Area, Alberta, by R. J. W. Douglas and P. Harker. *In* "Jurassic and Carboniferous of Western Canada". *Am. Assoc. Petrol. Geol.*, 177-189, 1958.

Megafaunal Zones in the Alberta Mississippian and Permian, by P. Harker and G. O. Raasch. *In* "Jurassic and Carboniferous of Western Canada". *Am. Assoc. Petrol. Geol.*, 216-231, 1958.

The Devonian-Mississippian Boundary in the Alberta Rocky Mountains, by P. Harker and D. J. McLaren. *In* "Jurassic and Carboniferous of Western Canada". *Am. Assoc. Petrol. Geol.*, 244-259, 1958.

Permian Section on Grinnell Peninsula, Arctic Archipelago, Northwest Territories, Canada, by P. Harker and R. Thorsteinsson. Abstr. *Bull. Geol. Soc. Amer.*, Vol. 69, No. 12, 1958.

Die jüngere Oberkreide (Oberconiac bis Maestricht) Südwestrusslands und ihr Vergleich mit der Nordwest und Westeuropos, by J. A. Jeletzky. *Beihefte zum Geologischen Jahr.*, Heft 33, 1958.

Geological History of Aklavik Range, Northeastern Richardson Mountains, N.W.T., by J. A. Jeletzky. Abstr. *Bull. Geol. Soc. Amer.*, Vol. 69, No. 12, 1958.

Common Devonian Fossils from the Alberta Rocky Mountains, by D. J. McLaren. Guidebook, 8th Ann. Field Conf., *Alta. Soc. Petrol. Geol.*, 193-203, 1958.

Devonian of Southwestern Ellesmere Island, Canada, by D. J. McLaren. Abstr. *Bull. Geol. Soc. Amer.*, Vol. 69, No. 12, 1958.

Stratigraphy and Palæontology of the Williams Island Formation, by M. A. Fritz, R. R. H. Lemon, and A. W. Norris. *Proc. Geol. Assoc. Can.*, Vol. 9, 1957.

New Name for an Ordovician Shale in Manitoba, by G. Winston Sinclair and Edward I. Leith. *J. Pal.*, Vol. 32, No. 1, 1958.

Age of the Ordovician Cobourg 'Formation', by G. Winston Sinclair. Abstr. *Bull. Geol. Soc. Amer.*, Vol. 69, No. 12, 1958.

Occurrence of Fish in the Ordovician of Canada, by G. Winston Sinclair. Abstr. *Bull. Geol. Soc. Amer.*, Vol. 69, No. 12, 1958.

Triassic Faunas from the Queen Elizabeth Islands, Arctic Canada, by E. T. Tozer. Abstr. *Bull. Geol. Soc. Amer.*, Vol. 69, No. 2, 1958.

Unusual Pleistocene Fossils from Southeastern Ontario, by Frances J. E. Wagner. *Trans. Roy. Soc. Can.*, Vol. 51, Ser. 3, Sec. 4, 1957.

Plant Spores in Coal from the Horton Group (Mississippian) of Nova Scotia, by P. A. Hacquebard. *Micropal.*, Vol. 3, No. 4, 1957.

Designation of Type Section, Camrose Tongue, Upper Devonian, Alberta, by Helen R. Belyea. *J. Alta. Soc. Petrol. Geol.*, Vol. 6, No. 3, 1958.

Devonian Formations between Nordegg Area and Rimby-Meadowbrook Reef Chain, Alberta, by Helen R. Belyea. 8th Ann. Field Conf., *Alta. Soc. Petrol. Geol.*, 75-106, 1958.

A Geochemical Reconnaissance of Part of Nova Scotia, by R. H. C. Holman and R. W. Boyle. *The Northern Miner*, March 6, 1958.

Geology of the Bathurst-Newcastle Mineral District, New Brunswick, by C. H. Smith and R. Skinner. *Trans. Can. Inst. Mining Met.*, Vol. LXI, 1958.

An Application of Multivariate Variance Analysis to Mineralogical Variation, Preissac-Lacorne Batholith, Abitibi County, Quebec, by K. R. Dawson, *Can. Mineralogist*, Vol. 6, Pt. 2, 1958.

The Composition and Crystallography of Niocalite, by E. H. Nickel, J. F. Rowland and J. A. Maxwell. *Can. Mineralogist*, Vol. 6, Pt. 2, 1958.

Possible Loss of Sodium and Potassium During Fusion of Plagioclase Feldspars, by K. R. Dawson and J. A. Maxwell. *Can. Mineralogist*, Vol. 6, Pt. 2, 1958.

A Canadian Occurrence of Fairchildite and Buetschliite, by K. R. Dawson and Ann Sabina. *Can. Mineralogist*, Vol. 6, Pt. 2, 1958.

Technique for Optical Determination of Iron-bearing Dolomites, by J. E. Howell and K. R. Dawson. *Can. Mineralogist*, Vol. 6, Pt. 2, 1958.

The Compilation of Chemical Analyses of Canadian Rocks and Minerals, by J. A. Maxwell, K. R. Dawson and Margaret E. Tomilson. Abstr. 4th Western Regional Conference, *Chem. Inst. Can.*, Sept. 1958.

Electroanalytical Chemistry, by J. A. Maxwell. *Chem. in Can.*, Vol. 10, No. 1, 1958.

Uranium Deposits of the Bancroft Region, Ontario, by S. C. Robinson and D. F. Hewitt. *Proc. 2nd Internat. Conf. Peaceful Uses Atomic Energy*, Geneva, 1958.

A Genetic Classification of Canadian Uranium Deposits, by S. C. Robinson. *Can. Mineralogist*, Vol. 6, Pt. 2, 1958.

Types and Ore Reserves of Canadian Radioactive Deposits, by J. W. Griffith, A. H. Lang, S. C. Robinson, S. M. Roscoe and H. R. Steacy. *Proc. 2nd Internat. Conf. Peaceful Uses Atomic Energy*, Geneva, 1958.

Mines Branch

Mineral Dressing and Process Metallurgy

*Technical Advances in Milling and Process Metallurgy in Canada during 1957, by L. E. Djingheuzian. *Can. Mining J.*, Vol. 79, No. 2, 1958.

*Forum on the Non-Cataracting Ball Mill, organized and compiled by L. E. Djingheuzian. *Trans. Can. Inst. Mining Met.*, Vol. LXI, 1958.

*The Leaching of Manganese from Pyrolusite Ore by Pyrite, by G. Thomas and B. J. P. Whalley. *Can. J. Chem. Eng.*, Vol. 36, No. 1, 1958.

*Voltaic Cells in Fused Salts, Part III, by S. N. Flengas and T. R. Ingraham. *Can. J. Chem.*, Vol. 36, 1958.

*Voltaic Cells in Fused Salts, Part IV, by S. N. Flengas and T. R. Ingraham. *Can. J. Chem.*, Vol. 36, 1958.

*Voltaic Cells in Fused Salts, Part V, by S. N. Flengas and T. R. Ingraham. *Can. J. Chem.*, Vol. 36, 1958.

*Present and Potential Uses for Coal in the Canadian Metallurgical Industry, by J. H. Walsh, J. C. Botham and H. P. Hudson. *Bull. Can. Inst. Mining Met.*, Vol. 51, No. 550, 1958.

*Corrosion Highlights During 1957, by R. A. Campbell. *Can. Chem. Proc.*, Vol. 42, No. 1, 1958.

*Production of Iron, Silicospiegeleisen and Portland Cement from a Low Grade Ore, by R. A. Campbell, G. N. Banks and R. R. Rogers. *Bull. Can. Inst. Mining Met.*, Vol. 51, No. 553, 1958.

Corrosion Resistance of Five Stainless Alloys in Nitric Acid Containing Chloride, by I. I. Tingley. *Corrosion*, Vol. 14, No. 6, 1958.

*New Direct Reduction Processes Promise Much for Iron Ore, by R. R. Rogers. *The Northern Miner*, Nov. 27, 1958.

*The Composition and Microtexture of an Ulvospinel-Magnetite Intergrowth, by E. H. Nickel. *Can. Mineralogist*, Vol. 6, Pt. 2, 1958.

*The Compound $CaO.Ti_2O_3$, by Norman F. H. Bright, John F. Rowland, and Joseph G. Wurm (Laval University). *Can. J. Chem.*, Vol. 36, 1958.

*Some New Fluoride Complexes of Trivalent Titanium, by Norman F. H. Bright, and Joseph G. Wurm (Laval University). *Can. J. Chem.*, Vol. 36, 1958.

*The Composition and Crystallography of Niocalite, by E. N. Nickel, John F. Rowland, and J. A. Maxwell (Geological Survey of Canada). *Can. Mineralogist*, Vol. 6, 1958.

*The Fabrication and Properties of Uranium Dioxide Fuel, by G. H. Chalder (A.E.C.L.), Norman F. H. Bright, D. L. Paterson (Can. Westinghouse) and L. C. Watson (A.E.C.L.). *Proc. 2nd Internat. Conf. Peaceful Uses Atomic Energy*, Geneva, Sept. 1958.

---

*Reprints Available.

Radioactive Minerals

Radioactive Tracers Find Many Uses in Mining, by G. G. Eichholz. *The Northern Miner*, Nov. 27, 1958.

Industrial Minerals

Flotation of a Canadian Kyanite, by R. A. Wyman. *Mining Eng.*, Jan. 1958.

Industrial Minerals in Canada—1957, by M. F. Goudge. *Can. Mining J.*, Feb. 1958.

Construction Materials—1957, by V. A. Haw. *Can. Mining J.*, Feb. 1958.

Asbestos—1957, by H. M. Woodrooffe. *Can. Mining J.*, Feb. 1958.

Industrial Minerals in Canada, by M. F. Goudge, *Canada Year Book*, 1958.

A Review of Industrial Minerals—1958, by V. A. Haw. *The Northern Miner*, Nov. 27, 1958.

Brucite, by M. F. Goudge. *In* "The Geology of Canadian Industrial Mineral Deposits", publ. 6th Commonwealth Mining Met. Congr., Canada, 1957.

Clays and Shales of Eastern Canada, by J. G. Phillips. *In* "The Geology of Canadian Industrial Mineral Deposits", publ. 6th Commonwealth Mining Met. Congr., Canada, 1957.

Feldspar, by H. S. Wilson and R. M. Buchanan. *In* "The Geology of Canadian Industrial Mineral Deposits", publ. 6th Commonwealth Mining Met. Congr., Canada, 1957.

Quartz Crystals, by V. A. Haw. *In* "The Geology of Canadian Industrial Mineral Deposits", publ. 6th Commonwealth Mining Met. Congr., Canada, 1957.

Clays and Clay Products in Canada, by S. Matthews. *The Clay Products News*, Jan. 1958.

Evaluation of Fireclay Refractories, by S. Matthews. *J. Can. Ceramic Soc.*, 1958 and *The Refractories Journal* (England), Oct. 1958.

The Milling of Asbestos Ores, by H. M. Woodrooffe. *In* "The Milling of Canadian Ores", publ. 6th Commonwealth Mining Met. Congr., Canada, 1957.

Physical Metallurgy

On the Occurrence of Epsilon Carbide in Iron, by F. W. Boswell. *Acta. Cryst.*, Vol. 11, No. 51, 1958.

A Literature Review of Metal Penetration, by A. E. Murton and S. L. Gertsman. *Trans. Am. Foundrymen's Soc.*, Vol. 66, 1958.

Pressure Distribution within a Vacuum Arc Furnace, by J. W. Suiter. *J. Electrochem. Soc.*, Vol. 105, 1958.

*The Measurement of Wall Thickness of Metal from One Side Only of the Direct Current Method, by J. G. Buchanan, F. W. Marsh and R. C. A. Thurston. *Non-Destructive Testing,* Vol. 16, No. 1, Jan.-Feb. 1958.

*The Effect of Different Surface Treatments on the Fatigue Strength of Drill Steel, by T. W. Wlodek. *Bull. Can. Inst. Mining Met.*, Vol. 51, No. 550, 1958.

Studies of Aluminium-Rich Alloys with Transition Metals Manganese and Tungsten, I, by J. A. Bland. The Crystal Structure of (W-Al)-WAl_4, *Acta. Cryst.*, Vol. 11, No. 4, 1958.

Studies of Aluminium-Rich Alloys with the Transition Metals Manganese and Tungsten, II, by J. A. Bland. The Crystal Structure of (Mn-Al)-Mn_4Al_{11}, *Acta. Cryst.*, Vol. 11, No. 4, 1958.

Further Observations on Grain Boundary Melting, by F. Weinberg. *Acta Metallurgica,* Vol. 6, 1958.

*The Effect of Some Gases on the Work of Adhesion Between a Novolak and Quartz, by D. W. G. White and H. F. Taylor. *Trans. Am. Foundrymen's Soc.*, Vol. 66, 1958.

*Desulphurization of Iron and Steel, by S. L. Gertsman. *Can. Metalworking,* Vol 21, Nos. 6 and 7, 1958.

*Effects of Cold Work and Quenching on the Magnetic Susceptibility of a Commercial Titanium Alloy, by Y. L. Yao. *Am. Soc. Metals,* Preprint No. 14, 1958.

*The Effect of Various Factors on the Mechanical Properties of Magnesium Alloy Castings, by J. W. Meier. *Proc. 25th Internat. Foundry Congr.*, Liege, Belgium, 1958.

*A Study of Surface Carbides. Differential Steel Attack and Pore Formation in the Galvanizing Process, by J. J. Sebisty. *Proc. Fifth Internat. Galvanizing Conf.*, Brussels, Belgium, June 1958.

*The Influence of Aluminium, Lead and Iron on the Structure and Properties of Galvanized Coatings, by J. J. Sebisty and J. O. Edwards. *Proc. Fifth Internat. Galvanizing Conf.*, Brussels, Belgium, June 1958.

*Desulphurization of Steel by Injection of Lime and Aluminum-Magnesium Alloy, by D. E. Parsons and S. L. Gertsman. *Am. Inst. Mining Met. Engrs.* Preprint Electric Furnace Conference, Dec., 1958.

How Alloying Elements Affect Steel Forgeability, by G. P. Contractor and W. A. Morgan. *Iron Age,* Vol. 102, No. 20, 1958.

Discussion by H. H. Bleakney of the paper "On a Mechanism of High Temperature Intercrystalline Cracking", by C. W. Chen and E. S. Machlin. *Trans. Am. Inst. Mining Met. Engrs.*, Vol. 212, 1958.

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*Reprints available.

Dominion Observatories

Dominion Observatory

Studies of Some Infrared Fraunhofer Lines, by G. Godoli. *Can. J. Phys.* Available as D.O. Contr. Vol. 2, No. 24.

Meteor Wakes and Their Spectra, by Ian Halliday, *Ap. J.* Available as D.O. Contr. Vol. 2, No. 25.

Standard Time and Time Zones in Canada by C. C. Smith, revised by M. M. Thomson. Available as D.O. Contr. Vol. 2, No. 26.

Meteor Spectroscopy with Transmission Diffraction Gratings, by Ian Halliday. *JRASC*. Available as D.O. Contr. Vol. 2, No. 27.

Forbidden Line of OI, by Ian Halliday. *Ap. J.* Available as D.O. Contr. Vol. 2, No. 28.

The Effect of Solar Flares on the Geomagnetic Field, by R. Pratap. *J. Geophys. Rev.* Available as D.O. Contr. Vol. 3, No. 10.

A Study of the Inconsistent Observations in the Fault-Plane Project, by J. H. Hodgson and W. M. Adams. *Bull. Seismol. Soc. Amer.* Available as D.O. Contr. Vol. 3, No. 13.

An Electrical Recording Magnetometer, by P. H. Serson. *Can. J. Phys.* Available as D.O. Contr. Vol. 3, No. 14.

Direction of Displacement in Western Pacific Earthquakes, by J. H. Hodgson. *Beno Gutenberg Test. Vol.*, Pergamon Press, London, England. Available as D.O. Contr. Vol. 3, No. 16.

The Establishment of a Calibration Standard for Gravimeters in Eastern Canada and the United States. by M. J. S. Innes. *Trans. Am. Geophys. Union.* Available as D.O. Contr. Vol. 3, No. 17.

Gravity Measurements in the Queen Elizabeth Islands of Arctic Canada, by A. M. Bancroft. *Trans. Am. Geophys. Union.* Available as D.O. Contr. Vol. 3, No. 18.

The Relationship between the Secular Change and the Non-Dipole Fields by Kenneth Whitham. *Can. J. Phys.* Available as D.O. Contr. Vol. 3, No. 19.

The Stability of Couette Flow in an Axial Magnetic Field, by E. R. Niblett. *Can. J. Phys.*, Vol. 36, 1958. Available as D.O. Contr. Vol. 3, No. 5.

Dual-Rate Moon Position Camera, by M. M. Thomson. *JRASC*, June 1958.

Canadian Standard of Frequency, by S. N. Kalra, C. F. Patterson and M. M. Thomson, *Can. J. Phys.*

Declinations of Ottawa PZT Stars, by R. W. Tanner. *Trans. Internat. Astron. Union*, 1958.

Notes on Ottawa Mirror Transit Telescope, by G. A. Brealey. *Trans. Internat. Astron. Union*, 1958.

A Gregorian Telescope, by Miriam S. Burland and J. E. Kennedy. *JRASC*, Vol. 52, p. 255.

Radio Astronomy, by J. L. Locke. *Phys. in Can.*, Spring 1958.

Dominion Astrophysical Observatory

Spectra of the Cool Carbon Stars in the λ9,000–λ11,000 Wave-length Region, by Andrew McKellar. *Publs. Astron. Soc. Pac.* Available as D.A.O. Contr. No. 41.

Symposium on Non-stable Stars—The Chromospheric Spectrum and Atmosphere of 31 Cygni, by A. McKellar and R. M. Petrie. *Publs. Internat. Astron. Union.* Available as D.A.O. Contr. No. 47.

Molecules in the Solar System, by Andrew McKellar. *Mem. Soc. Roy. Sci. Liege.* Available as D.A.O. Contr. No. 51.

Evidence for Turbulent Motions in Stellar Atmospheres, by K. O. Wright. *Trans. Internat. Astron. Union.* Available as D.A.O. Contr. No. 52.

Introductory Remarks concerning the Emission Lines in Of and WR Stars, and Some Comments on the Emission Lines in Of Stars, by Anne B. Underhill. *Mem. Soc. Roy. Sci. Liege.* Available as D.A.O. Contr. No. 56.

Observations of H α in the Spectrum of ε Aurigae Obtained During and Outside of Eclipse, by K. O. Wright and R. S. Kushwaha. *Mem. Soc. Roy. Sci. Liege.* Available as D.A.O. Contr. No. 57.

Spectrographic Observations of VV Cephei During Ingress and Totality, 1956-57, by A. McKellar, K. O. Wright and J. D. Francis. *Publs. Astron. Soc. Pac.* Available as D.A.O. Contr. No. 58.

Recent Changes in the Spectrum of 17 Leporis, by K. O. Wright. *Publs. Astron. Soc. Pac.* Available as D.A.O. Contr. No. 59.

The Orbit of the Spectroscopic Binary Delta Capricorni, by MaryJane Stewart. *JRASC.* Available as D.A.O. Contr. No. 60.

Re-examination of the Space Motions and Luminosities of the Stars of the Cassiopeia-Taurus Group, based on New Radial Velocities, by R. M. Petrie. *Monthly Notices RAS.* Available as D.A.O. Contr. No. 61.

An Instrument for Calculating Precession, by D. H. Andrews, *JRASC.* Available as D.A.O. Contr. No. 62.

Geographical Branch

Activities of the Geographical Branch in Northern Canada, 1947-1957, by J. K. Fraser. *Arctic*, Vol. 10, 1957.

International Geographical Union Regional Conference in Japan, by N. L. Nicholson. *Can. Geog. J.*, Vol. LVI, 1958.

Etude préliminaire sur le frasil dans les eaux du Saint-Laurent, by Michel Brochu. *Le Géog. Canadien*, Vol. 11, 1958.

Nouveau système de reconnaissance des glaces de dérive, by Michel Brochu, *Le Géog. Canadien*, Vol. 11, 1958.

Townsites and Urban Land Use in Southwestern Saskatchewan, by M. H. Matheson. *The Can. Geog.*, Vol. 11, 1958.

Geographical Branch Survey on Melville Peninsula, by V. W. Sim, *Arctic Circ.*, Vol. 11, 1958.

The Face of the North, by N. L. Nicholson. *Can. Geog. J.*, Vol. LVII, 1958.

Cryoconite Phenomena in the Thule Area, Greenland, by R. T. Gajda. *The Can. Geog.*, Vol. 12, 1958.

Two New Atlases, by G. Fremlin. *The Can. Geog.*, Vol. 12, 1958.

Use of Punched Cards in Geographic Research, by F. A. Cook. *The Can. Geog.*, Vol. 12, 1958.

Manufacturing in Suburban Toronto, by Donald Kerr and Jacob Spelt. *The Can. Geog.*, Vol. 12, 1958.