CANADA

1957 ANNUAL REPORT

CALENDAR YEAR 1957

Department of

MINES AND TECHNICAL SURVEYS

CANADA

Department of Mines and Technical Surveys

Annual Report

Calendar Year

1957

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THE QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1959

To His Excellency the Right Honourable Vincent Massey, Member of the Order of the Companions of Honour, Governor General and Commander-in-Chief of Canada.

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to lay before Your Excellency the Annual Report of the Department of Mines and Technical Surveys for the calendar year 1957.

Respectfully submitted,

PAUL COMTOIS

Minister of Mines and Technical Surveys

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The Honourable Paul Comtois,
Minister of Mines and Technical Surveys,
Ottawa.

SIR:

I have the honour to submit the Annual Report of the Department of Mines and Technical Surveys, covering the calendar year 1957.

Your obedient servant,

MARC BOYER

Deputy Minister

Contents

Introduction

The year 1957 brought out two facts concerning the Department's work: first, that fundamental research must play a more dominant role in the development of the Canadian mineral economy if Canada is to maintain its present position as a leading world source of the products of the mines; and secondly, that the fast moving pace of developments both on this continent and in outer space have placed new importance and new value on that part of its work not so directly related to mining—its surveying, mapping and charting activities and geographical studies, on the one hand, and its research in astronomy, on the other.

A number of factors are underlining the need for fundamental research in the mining and metallurgical fields. Chief among these are the requirements of modern development programs for more metal and new metals, all of high purity; the growing frequency with which low-grade, complex and refractory ores are appearing on the mineral scene; and the increasing availability, elsewhere in the world, of important new sources of mineral wealth, such as nickel in Cuba.

The Department is thus paying particular attention to research directed to facilitating the discovery of new sources of metals and minerals; to the improvement of extractive processes for winning metals; to improvements in the fabrication of metals; and to the development of new and substitute alloys to meet the specialized uses of today. There is a special need, for instance, for alloys that will withstand extreme ranges of temperature such as in (1) jet engines, rocket carriers, and nuclear reactors, and (2) in equipment for use in the Arctic and outer space.

It is constantly exploring possible new methods of improving its surveying and mapping techniques to produce high quality maps and charts. These are essential not only to mineral but to all resource development, for engineering projects, and for defence and other purposes. In the field, as in the laboratory, the Department is making use of the latest in scientific tools. Its recent adoption of the tellurometer, for instance, is proving highly

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successful and economical in speeding up accurate survey control for mapping. In one project alone in Ungava in 1957, through the use of this instrument, it effected a saving of $125,000 over normal mapping methods in addition to obtaining remarkably accurate basic control.

Since 1952, the growing interest in the resource potential of Canada's Far North has led the Department to give increasing priority to the mapping of these great regions. In 1957, it completed the framework of control for mapping over the 500,000-square-mile-area of the Arctic Islands; it made plans for the start in 1958 of the vertical air photography of the Islands for later topographical mapping; and it explored geologically by helicopter 100,000 square miles of potential oil and gas territory in the upper Mackenzie River basin.

A prime example of the Department's research to facilitate future exploration for mineral wealth is found in its fundamental studies of the ultrabasic rocks of Canada and of the origin of granites in Canada. A very large percentage of the country's metallic-mineral deposits are spatially and geologically related to these two types of rocks, and these studies will, in all likelihood, provide the new concepts on which the mineral searches of the future will be made.

In its research into improvements in extractive processes, the Department is exploring several metallurgical avenues. It is doing considerable work with leaching processes and has developed a process which promises to have application in the treatment of the manganiferous ores of Labrador. This work is especially significant in view of the lack, on this continent, of high-grade deposits of manganese, a vitally important alloying element in the manufacture of steel. The process has yet to be economically evaluated but it appears to be one of the least expensive treatment procedures yet devised for this type of ore.

To develop new and cheaper processes for the extraction of metals, the Department is looking to the application of chemical leaching and pressurized techniques, which have already proved highly successful in the processing of uranium ores. It is exploring the possible application of the novel processes, ion exchange and solvent extraction, developed for uranium production, to the recovery of other metals. In this field, it is probing the possibility of using ion exchange in the recovery of rare earths which to date have proven almost impossible to separate.

To improve methods of production and fabrication, the Department is giving much attention to a problem of great importance and significance to the metals industry today—the need for a better understanding of the factors that are limiting the strength of metals. Theoretically, metals are much stronger than they actually are. The answer is believed to lie in their crystal lattice structures and, when found, will mean (1) the production of metals many times the strength of any now known and, (2) a major stride in technological progress—the production of alloys, tailor-made to specifications.

As a major participant in International Geophysical Year, the Department more than met its commitments to world science through an intensive program of observation and measurement of geophysical phenomena in the fields of geomagnetism, gravity and seismology. This entailed the establishment of additional geophysical stations in various areas of Canada including the Far North.

Highlighting its fundamental studies in these fields were: the development of a highly sensitive magnetometer with which to measure remanent magnetism in rocks to assist it in its studies of the changes in the earth's magnetic field; the completion of a set of pendulums for the determination of gravity values, more accurate than any in the world; and the development of a technique of calibrating seismographs accurately and simply.

In its astronomical research, it has realized real accomplishment in the design and development of new instruments with which to delve deeper into this science. A particular example of its work in this direction is the mirror transit, a new photographic instrument for the accurate determination of star positions. Departmental scientists are now assembling the instrument, the first of its kind known.

The Department plans to bring whole new vistas of outer space into its research orbit by entering the field of radio astronomy. To do this, it is building a radio observatory at Penticton, British Columbia, to house a radio telescope, 84 feet in diameter, which will pick up radio waves from sources beyond the reach of optical telescopes. The new telescope is expected to be in operation in 1959.

In 1957, a major feature of its geographical studies was the carrying out of land-use surveys in parts of Newfoundland and New Brunswick. World regard for the value of such surveys has increased steadily in recent years with the growing realization that great areas of forest land are being denuded and that valuable food-land, essential to man's existence, is being rapidly depleted for industrial and real-estate purposes.

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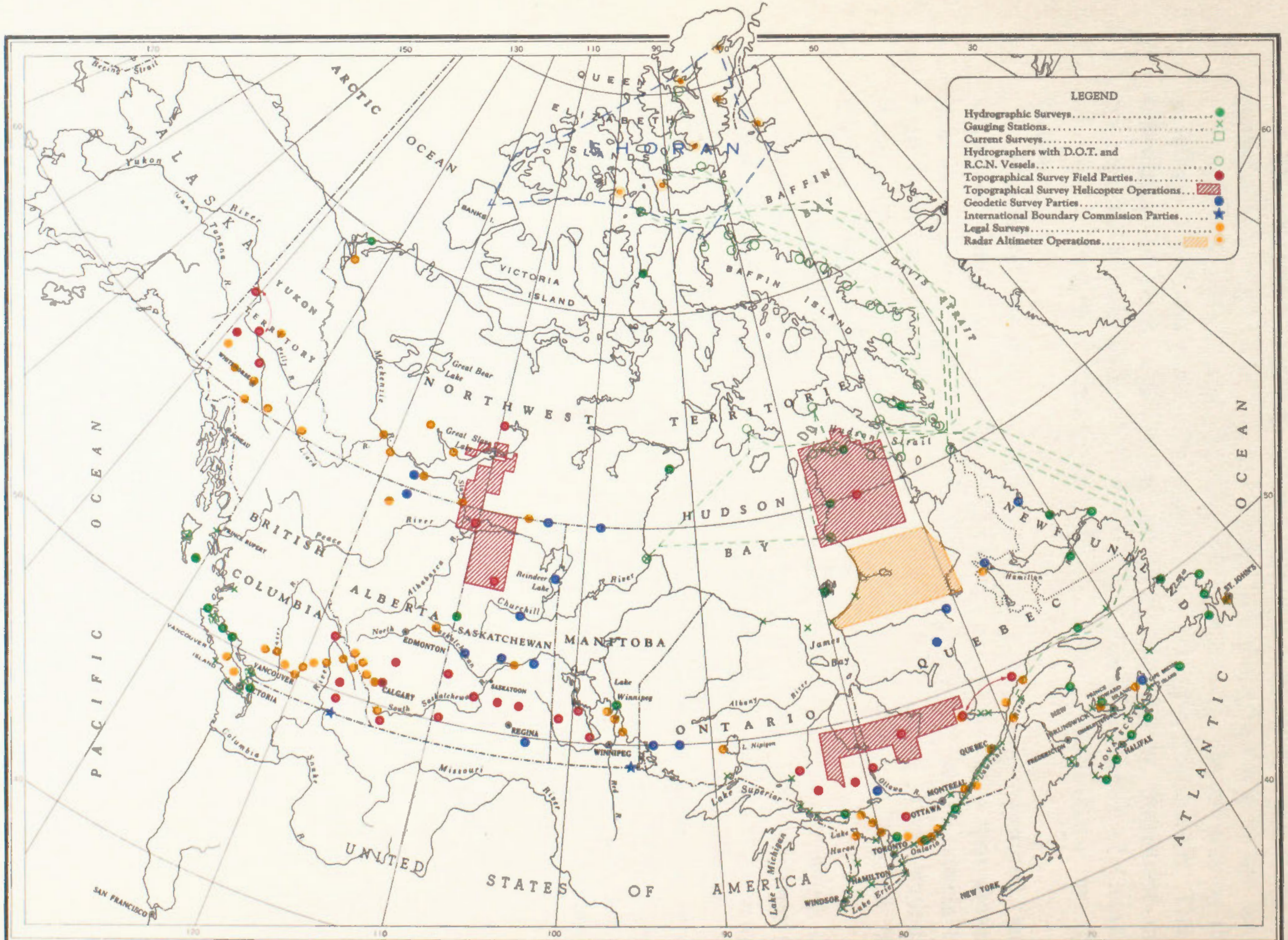
The Department expects to have the new Atlas of Canada ready for publication in 1958. Work on the French edition started late in the year.

Added stimulus is given to research activity in the Department by the awarding of postdoctorate fellowships tenable in the Department. These fellowships are made available through funds provided by Parliament and are awarded in cooperation with the National Research Council of Canada. In 1957, fourteen postdoctorate fellows were accommodated in the Department.

Geological research in Canadian universities was supported and stimulated through the payment of $40,000 in grants-in-aid to nine universities in support of 16 research projects. The grants are made available by funds voted by Parliament and are awarded on the advice of the National Advisory Committee on Research in the Geological Sciences, of which the Director of the Geological Survey is chairman.

The Department is looking to the occupation of its new quarters on Booth Street to take advantage of the added laboratory space provided to expand its research activities in long desired directions. It has, for instance, been severely handicapped for years, in cramped scattered quarters, in carrying out essential supporting geological research in geophysics, geochemistry, mineralogy, etc. Moreover, it has had neither the facilities nor the space with which to obtain the best possible results from its present large-scale aerial reconnaissance mapping of Canada's geology. It expects to occupy its new geological quarters in 1959 and to see the completion of its main building program by 1961.

An account of the major activities of the various Branches in 1957 follows. Unlike previous annual reports of the Department, it is on a calendar year and not a fiscal year basis.



SURVEYS AND MAPPING BRANCH FIELD PARTIES, 1957.

Surveys and Mapping Branch

The heavy demand for maps and charts, vital to many aspects of Canadian endeavour, continued unabated in 1957 and brought an intensification in much of the work of the Surveys and Mapping Branch.

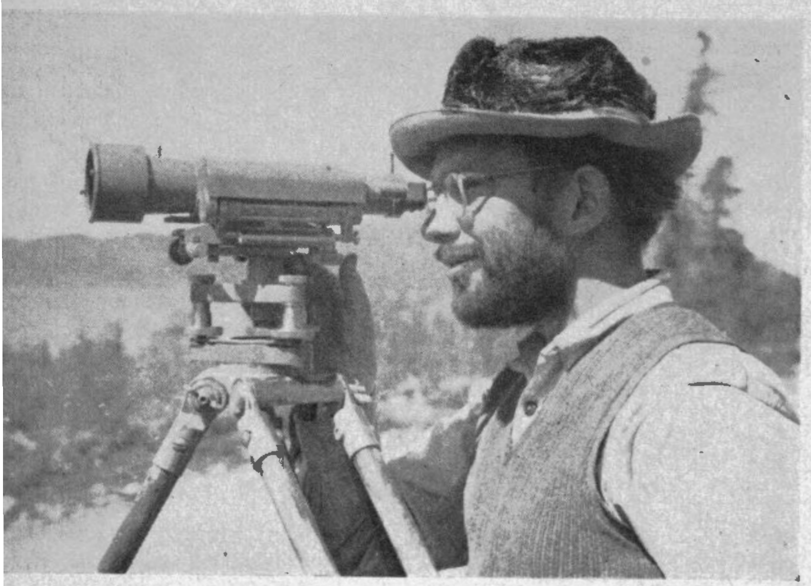
With vast areas to cover, many of them remote, the task at hand was a formidable one and in meeting it the Branch made full use of the aids of modern technology. With the help of shoran, a method of measuring distances electronically, the framework of survey control was extended northward so that no point in Canada is now more than 150 miles from a horizontal control point. Another electronic device, the tellurometer, was applied—it is believed for the first time in the world—to general mapping. Used in the Ungava peninsula, the instrument enabled a large area to be surveyed with considerable savings in time and cost. The two-range Decca for hydrographic position fixing was applied to Canada's Pacific coast for the first time. At home a highly-developed electronic computer was used to cope with some of the ponderous survey mathematics.

This intensified field work has resulted in a voluminous amount of data for compilation and an increasing backlog of maps to be printed. Though a record 1,434 maps and charts were produced during the year, the remaining work load in compilation and reproduction continued to grow.

Geodetic Survey of Canada

In 1957, fourteen field parties of the Geodetic Survey continued to expand the framework of survey control—the basis of all mapping and charting operations in Canada: The shoran program was completed after 9 years of intensive effort; triangulation work was carried out in five provinces with further extension of the control net along the Mackenzie Highway; and precise levelling operations were undertaken in Saskatchewan, Ontario, Quebec and Nova Scotia.

The helicopter again proved its worth in speeding survey work and in by-passing difficult terrain. Supplies can be seen lashed along the side of the machine.



A geodetic engineer takes a sight through a precise level. Precise levelling operations were undertaken in Saskatchewan, Ontario, Quebec and Nova Scotia.

Other data on the Survey's field operations are given in tabulated form in Appendix IV.

Shoran Using shoran the Geodetic Survey extended control to the northern Arctic Islands; latitude 81° 49′ is now the northern limit of the shoran net. The program was carried out in cooperation with the R.C.A.F., the Meteorological Service of the Department of Transport, and the National Research Council. Survey control now extends over Yukon, Northwest Territories (including the Arctic Islands) and northern parts of Alberta, Saskatchewan, Manitoba, Ontario and Quebec.

Triangulation Farther south, the triangulation network was extended in Alberta, Saskatchewan, Ontario, Quebec, Labrador and the District of Mackenzie. This is to provide a basic framework across Canada of points whose latitudes and longitudes are known to high precision. Local surveys, though widely separated, may be accurately related to each other by means of this geodetic network.

In Alberta, the control net along the Mackenzie Highway was extended to a point 50 miles south of the Alberta-Northwest Territories boundary and reconnaissance for this arc progressed to Great Slave Lake.

In Saskatchewan, control was extended from a point 55 miles north of Prince Albert to Lac la Ronge with reconnaissance completed to Reindeer Lake.

In Ontario, the arc of control destined to link Canada's eastern and western networks was extended westward from Sioux Lookout to the Ontario-Manitoba boundary.

In Quebec, control progressed from Lake Mistassini to Nitchequon in the arc which is to be extended to Schefferville, and then to Nain on the coast of Labrador. A party began working from Nain towards Schefferville during the year.

Precise Levelling Precise levelling operations (to establish elevations above sea level) were carried out in Saskatchewan, Ontario, Quebec and Nova Scotia. In Saskatchewan, level lines were completed from Melfort to Carrot River, from Leslie to Prince Albert via Wadena and Nipawin, from Innes to Regina, and from North Battleford to St. Walburg. In Ontario and Quebec, a line from Mattawa, Ontario, to Notre Dame du Nord, Quebec, via North Bay and Timiskaming was completed. On Cape Breton Island, Nova Scotia, lines were carried from southwest Margaree to Ross Ferry via the Cabot Trail, and from Ben Eoin to Port Hawkesbury.

Base Lines and Geodetic Astronomy Base-line measurements at regular intervals in triangulation nets are used to control distances between points which have been carried through the net by means of angle-measurements. A geodimeter, an electro-optical instrument for accurate distance determinations, was used to measure four base lines, two in Ontario and two in Quebec.

Astronomic observations are used to control the direction of triangulation nets and to determine the latitude and longitude of points where triangulation or shoran control is not available. Data for scientific purposes are also obtained when astronomic observations are made at triangulation points. Two such Laplace points were established in Ontario. Five precise latitude determinations were made along the northern boundaries of Manitoba and Saskatchewan to serve as control for the survey of these boundaries which are defined as the 60th parallel of latitude. Two triangulation stations were occupied in Saskatchewan to determine the deflection of the plumb line.

Research Electronics, in one form or another, will play an increasingly important role in geodetic work. The Survey carried out tests with the tellurometer, an electronic instrument for measuring distances, to determine its possible use in Canadian geodetic operations. One of the

Testing a tellurometer, an electronic distance-measuring device of high accuracy. The instrument was put to work in the Ungava Peninsula, in Northwest Territories and on the Prairies with great savings both in time and cost.

mathematical computations occurring frequently in geodetic work was programmed for an electronic computer and it was shown that the machine could be profitably used for a number of time-consuming, routine calculations.

The International Boundary Commission

Two field parties of the International Boundary Commission inspected 60 miles of boundary and fifty-two monuments, and recleared 55 miles of 20-foot boundary vista through forested areas on the Manitoba-Minnesota and British Columbia-Washington sections. An inspection was also made of selected triangulation stations serving as control for the re-establishment of boundary reference monuments flooded by the St. Lawrence Seaway.

The International Boundary Commissioners of Canada and the United States made a joint inspection of the work of field parties and of the condition of vista and monuments on the International Boundary from Pigeon River, Ontario, to Point Roberts, British Columbia.

Late in the year J. E. R. Ross retired as International Boundary Commissioner and was succeeded by A. F. Lambert.

The Topographical Survey

The Topographical Survey recorded an increase in all phases of its work. Field work was conducted in Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, Northwest Territories and Yukon with original surveys controlling a total area of 203,000 square miles for mapping. Map compilation work comprised 248 contour and 25 planimetric map sheets with 244 forwarded for reproduction. Statistical details of field projects and maps compiled are given in Appendix V.

Field Parties Forty-six field officers conducted original surveys for the mapping of 114,000 square miles on a scale of 1:50,000 (detailed mapping) and 89,000 square miles on a scale of 1:250,000 (medium-scale mapping). Three large parties were provided with helicopters for transportation in almost all the medium-scale and more than half the detailed work.

One large, airborne party established vertical control for 1:50,000 mapping in a large block between Cochrane, Ontario, and Lake St. John, Quebec. Another completed surveys for the mapping of Quebec north of latitude 58° at the 1:250,000 scale. Fifty map sheets in a prospective mining belt within this area were more densely controlled for 1:50,000 mapping. The third party laid the foundation for detailed mapping in an area of geological interest east of Great Slave Lake, and then for medium-scale mapping in a large area around and southeast of Lake Athabasca in Alberta and Saskatchewan.

One airborne party enlarged the spirit level net in Northwest Territories to provide basic control for imminent mapping. Totalling 1,050 miles, these routes extended from the Saskatchewan-Northwest Territories boundary to Coronation Gulf with spur connections to existing levels. A considerable amount of time was saved by the transfer of elevations across lakes.

Other operations included levelling along 225 miles of the Yukon River, for the Department of Northern Affairs and National Resources (work that was hampered by abnormally high water) and establishing levels in Quebec for control of barometric heighting.

Two traversing parties on the Prairies continued to correlate the Dominion Lands and the Geodetic Survey systems—a project that, after 3 years, has minimized many problems in map compilation. Nine parties operating in Alberta, Saskatchewan and Manitoba made considerable progress in the survey program for the southern Prairies where water conservation, oil and gas development and other projects have created a heavy demand for detailed maps.

Of five mountain parties, three worked in British Columbia in areas of geological interest at the request of the British Columbia government, and two operated in Yukon Territory for the Geological Survey of Canada.

Three traversing parties extended horizontal control into northern Ontario parallelling developments in forestry and mining. Surveys in winter were undertaken by two traversing parties—one working around the headwaters of the Ottawa River and the other in northern Saskatchewan.

Surveys were made for large-scale plotting of the experimental farms of the Department of Agriculture at Morden, Brandon, Indian Head, Regina, Melfort, Sutherland, Swift Current, Lethbridge and Beaverlodge.

The South African tellurometer, after an intensive period of testing in the spring, was put to work on basic control in the Ungava peninsula, in Northwest Territories, on traverse work on the Prairies and along railway lines in Ontario. It was also used for establishing skeleton control in a photogrammetric test area between Ottawa and Parry Sound. Indications are that the surveyor has been equipped with a remarkably accurate and economical instrument for distance measurement. In the Ungava project alone a saving of $125,000 over normal mapping methods has been credited to the use

It is from aerial photographs that the Branch's National Topographic Series of maps is eventually produced. A method of adjusting aerial photographs relative to one another is to prepare thin cardboard templets which may be assembled to represent the flight lines covering an area.

of the tellurometer. Furthermore the Branch may have the distinction of being the first major organization to apply this new method to general mapping.

Map Compilation Map compilation showed a substantial increase both in terms of map sheets and in the total area concerned. Although the main effort is directed toward contoured mapping at a scale of 1:50,000 or 1:250,000, planimetric mapping, large-scale plotting and preparation of air-photo mosaics are undertaken at the request of other federal and provincial organizations. Only contoured mapping, however, is forwarded for reproduction. The output in 1957 was 229 map sheets at the 1:50,000 scale and 15 map sheets at the 1:250,000 scale for a total of 143,400 square miles. The demand for advance-information prints of new compilations remained high with over 16,000 distributed to government and private organizations.

National Air Photo Library The National Air Photo Library received 34,770 prints (bringing its total on file to 2,620,000) and handled orders for nearly 500,000 prints, enlargements, and diapositives.

Geographical Names The Canadian Board on Geographical Names, a federal-provincial body responsible to the Minister of Mines and Technical Surveys, processed 16,441 names for 155 new and revised maps and charts. The Saskatchewan volume of the *Gazetteer of Canada* series was published and preliminary work on the sixth volume, the *Gazetteer of Alberta,* was completed.

The Canadian Hydrographic Service

In 1957, the Canadian Hydrographic Service, comprising a fleet of seven ships, six large launches and one chartered vessel, carried out surveys on both the Atlantic and Pacific coasts and charted waterways of importance to inland and northern navigation. During the year, 43 new charts and 149 revised editions were published, 704 navigational charts were kept up-to-date and 145,000 charts were distributed. To ensure that all were revised to the date of issue, 1,055,000 hand revisions were made.

Detailed figures on Hydrographic surveys and published charts are given in Appendix IV.

Reading a reversing deep-sea thermometer after the completion of an oceanographic station. This involves determining the temperature and obtaining a sample of sea water from depths of 10, 20, 30, 50, 75 and 100 meters.

Atlantic Coast The C.G.S. *Kapuskasing* carried out extensive soundings along the south coast of Newfoundland covering an area of 25,000 square miles. Though required mainly for defence purposes, the data will be used to improve charts of prime importance to fishermen. A shore-based party from the ship surveyed the vicinity of Malpeque Bay, Prince Edward Island, charts of which will open harbours and bays in the area to shipping.

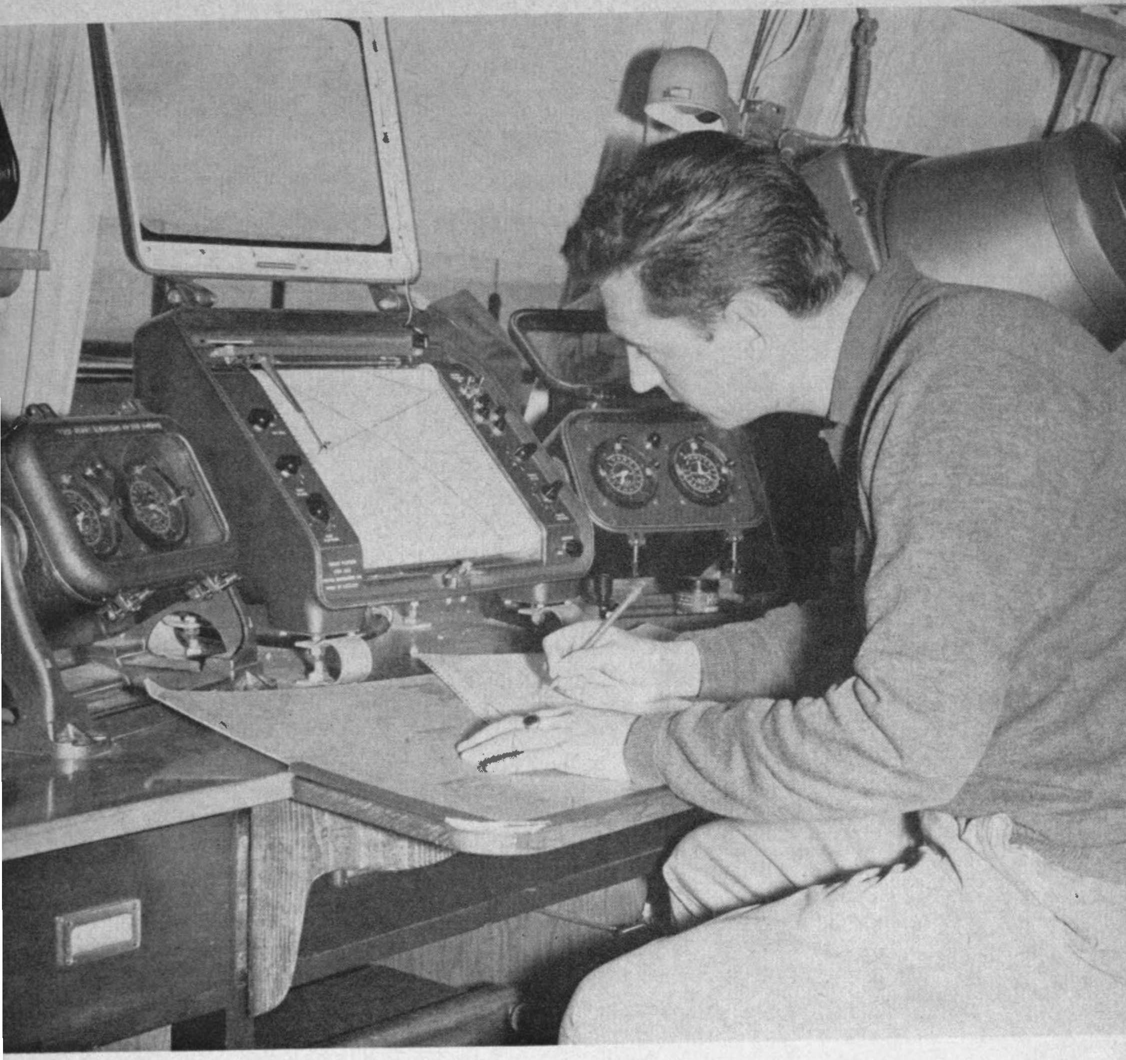
The C.G.S. *Baffin,* commissioned early in the year, was used for Decca soundings on the southeast coast of Nova Scotia after which the ship was accidentally grounded. A coastal-triangulation network and tellurometer traverse were completed between Halifax and Canso.

In another Atlantic coast project, the C.G.L. *Henry Hudson* conducted surveys on the coast of Nova Scotia between Tor Bay and Country Harbour, C.G.L. *Anderson* operated between Lockeporte and Clarkes Harbour, and the C.G.L. *Dawson* continued her soundings of Placentia Bay, Newfoundland. These surveys formed part of the long-term plan of replacing the 100-year-old British Admiralty charts which are no longer adequate. The C.G.S. *Acadia* carried out similar work in the Cape Freels area and surveyed Tilt Cove and Baie Verte, Newfoundland, where mineral developments are in progress. A survey was also made of Newman Sound relative to plans for docking facilities at the proposed National Park headquarters.

The C.G.S. *Cartier* sounded Quetachu Bay, Quebec (where a new dock has been built for shipping fluorspar) and began surveying Chaleur Bay preliminary to the production of modern charts of value to fishing and lumbering industries.

Hudson Bay and Strait Moving northward, the *Cartier* continued her surveys in the Goose Bay and Lake Melville areas of Labrador. The chartered motor vessel *Theron* made further progress in its work around Hopedale and Rankin Inlet, and undertook a reconnaissance of the Belcher Islands, Povungnituk and Deception Bay to assist the planning of mining operations in those areas.

The Arctic A number of charting projects undertaken in 1957 will contribute to Arctic navigation, vital to many aspects of northern development. A party was assigned to H.M.C.S. *Labrador* on her last cruise as a naval vessel; a survey was made of Bellot Strait with the aid of United States naval ships; and work was undertaken in Brevoort Harbour and in the vicinity of Resolution Island.



A hydrographer aboard the *Baffin* records the ship's position as shown by two-range Decca equipment. The Decometer readings give the precise position of the ship while the log provides a continuous graphical record of her course.

A hydrographer was aboard each of the Department of Transport icebreakers *C. D. Howe* and *d'Iberville* to obtain data along the tracks of these vessels for correction of existing charts. One was also assigned to the U.S.S. *Storis* in the Western Arctic.

A tellurometer-equipped shore party established horizontal control in Frobisher Bay thus laying the groundwork for future hydrographic surveys in that area.

Inland Waters The chartered motor vessel *Algerine* was severely damaged by ice en route northward and its hydrographic party was transferred to Lake St. Francis for control surveys of St. Lawrence Seaway areas.

Farther inland, the launches *Egret* and *Petrel* carried out the first complete survey of Lake Simcoe, increasingly used by tourist and other pleasure craft. The party then moved to the Bay of Quinte for soundings of importance to the passage of cement-carrying ships in Telegraph Narrows. Continuing an assignment of several seasons, the C.G.L. *Bayfield* collected information for the revision of *Sailing Directions for Southern Georgian Bay*: and the C.G.L. *Boulton* made considerable progress in the north channel of Lake Huron, an area of increasing importance to commercial shipping for which existing charts, made some 70 years ago, are inadequate. To the west, the C.G.L. *Coot* commenced a new survey of Lake Winnipeg—never fully covered before—to assist the fishing and logging industries.

The launches *Rae* and *Tern* continued charting the approaches to Tuktoyaktuk, N.W.T., an important DEW-line supply base and completed a survey, for defence purposes, of Primrose Lake, Alberta.

Pacific Coast Considerable hydrographic work was undertaken in and around Queen Charlotte Islands. The C.G.S. *Wm. J. Stewart* began sounding Hecate Strait with two-range Decca—the first season this modern electronic position-fixing technique has been used on the west coast. It will shorten considerably the time required to survey this important passage. And the C.G.S. *Parry* made a hydrographic and tidal survey of Skidegate Narrows, frequently used by fishermen. She also completed the surveys of Mackenzie and Actaeon Sounds which are of considerable importance to lumbering operations. The C.G.S. *Marabell* completed the sounding of Bute Inlet, the site of the proposed power development on the Homathko River.

Tidal and Inland Water Levels

The Hydrographic Service established two year-round gauging stations in the Arctic at Resolute and on Brevoort Island as part of the International Geophysical Year's tidal program. The observations will add materially to the understanding of tidal phenomena in an area not previously studied. In all, 110 stations were operated in Canadian waters.

In conjunction with the Atlantic Oceanographical Group, a current and oceanographic survey was made of Passamaquoddy Bay, New Brunswick, to determine the effects of the proposed tidal power project on commercial fishing.

Legal Surveys and Aeronautical Charts

Three main factors contributed to the heavy demand for survey work in 1957: the rapid development of Canada's northland, the increasing value of Indian lands and the increasingly stringent requirements of aerial navigation. In all, 284 survey plans were examined and recorded, 595 legal descriptions were prepared for land transactions and 13,552 reproductions and prints of plans were dispatched. The number of new sheets prepared for the Canada Air Pilot more than quadrupled that of the previous year (*see* Appendix IV.

During the winter, the Branch continued its survey of the Saskatchewan-Northwest Territories boundary and extended the line easterly 63 miles to Selwyn Lake. The 56-mile section of the British Columbia-Yukon Territory boundary between Teslin Lake and Hendon River, originally surveyed in 1899, was retraced and the monuments restored, thus completing the revision of the older survey. Both projects were undertaken with the cooperation of the provincial governments.

Legal surveys were carried out for federal agencies in Yukon and Northwest Territories and in all the provinces except New Brunswick.

As many of the Indian lands of Canada are increasing in value because of their proximity to industrial, agricultural and tourist developments, there is a growing demand for surveys of these areas. The St. Lawrence Seaway and the Trans-Canada Highway are typical projects that have called for legal surveys of Indian-owned territory. Nine field parties carried out surveys in 35 reserves, re-establishing boundaries, subdividing townships, laying out cottage and village lots, and defining Indian holdings.

Keeping pace with northern development, three field parties were engaged in legal surveys of new residential and commercial subdivisions in

Yukon and Northwest Territories. A re-development area at Fort Smith was subdivided into 202 lots mainly for the employees of a lumber company operating in Wood Buffalo National Park. At Aklavik, the remaining seven blocks of the new townsite were subdivided into 156 residential lots; and at Hay River Settlement, 35 new lots were established near the west channel of the Hay River in an area used by fishing boats.

In Yukon, new subdivisions were surveyed in or adjacent to the communities of Whitehorse, MacRae, Watson Lake, Teslin and Haines Junction; and 39 miscellaneous-lot surveys were made along the Alaska Highway and the Whitehorse-Mayo road. Near Mayo, the site of the Northern Canada Power Commission's hydro-electric plant and the right-of-way of the transmission line were surveyed.

Legal surveys were also carried out in nine national parks in British Columbia, Alberta, Ontario, Nova Scotia and Prince Edward Island.

Approximately 13,945 line miles of ground-profile recordings were obtained from radar-altimeter surveys using airborne electronic equipment. The resulting ground elevations provided the basis for contours and spot heights to be plotted on six one-inch-to-eight-mile aeronautical charts.

The *Canada Air Pilot,* produced as a service to, and under the authority of, the Department of Transport was kept up-to-date with amendments issued every two weeks. Included were 87 new and 700 revised sheets.

Map Compilation and Reproduction

The demand for maps and charts continued to grow in 1957 with the number printed totalling 1,434, an increase of 7 per cent over that of the previous year in actual maps and 38 per cent in impressions. The number of topographic maps produced and printed came to 204 (compared to 200 in 1956). Map distribution showed an increase of 113,537 copies over the previous year. The *Atlas of Canada,* a project involving many complex cartographic problems, occupied a large share of the work with 22 maps printed for this purpose alone. (Appendices to this report indicate the type and number of maps and charts printed.)

Even with the Branch operating at peak production, however, the work load in compilation and reproduction exceeded the capacity of both men and equipment. And though a new press was installed at the end of the year, this condition is expected to prevail until larger, better-equipped quarters become available.

Map Compilation In office compilation and revision of small-and-medium-scale maps, major emphasis was given to the 1:250,000, one-inch-to-eight-mile, and 1:500,000 groups. The number compiled came to approximately 80 with a considerable number of miscellaneous maps processed for other government departments.

Map Drafting Production kept pace with that of the previous year, particular attention being given to 1:50,000-scale maps, air overprints and the *Atlas of Canada.*

The eastern, central and most of the western sections of the new 1:2,000,000 map of Canada were completed—three southern sheets that will provide a good general map up to 65° north latitude (at the centre of the map). A new edition of the one-inch-to-sixty-four-mile map of Canada was also in progress.

In 1957 a great deal of time was given to the *Atlas of Canada,* a project calling for difficult and involved cartographic procedures. In order to portray the nation's physical and human resources, many of the maps require a total of twelve individual colours—an unusually large number.

Editing and Nomenclature A new section formed in October 1956 was given the responsibility of checking manuscripts, proofs, and printed copies of maps produced by the Branch and preparing nomenclature lists for maps and charts issued by the Department. The largest single project for the year was the processing of 14,970 names for the 1:2,000,000-scale map of Canada.

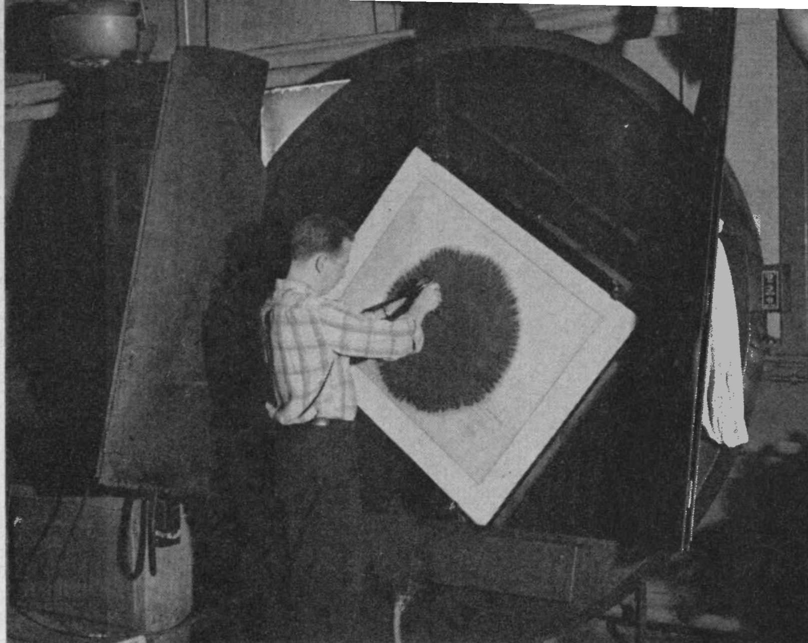
Photo-Mechanical With modern map reproduction increasingly dependent upon photo-mechanical procedures, the work load in this field reached an all-time high. Additional help assigned to the plate-making unit made possible an increase of 17 per cent in output but, generally speaking, the Branch reached the limit of its capacity in photo-mechanical processing. Nevertheless, new techniques that might increase production were constantly under study. Of particular interest was a new process adopted for the production of colour masks whereby the area in colour is stripped from an etched image on the surface-treated plastic sheet.

Printing A stepped-up work schedule led to an increase in printing production both in number of maps involved and number of impressions. The National Topographic Series again took up a large share of the press time with a total of 346 maps printed. The number of hydrographic charts and air overprints came to 249 and 229 respectively.

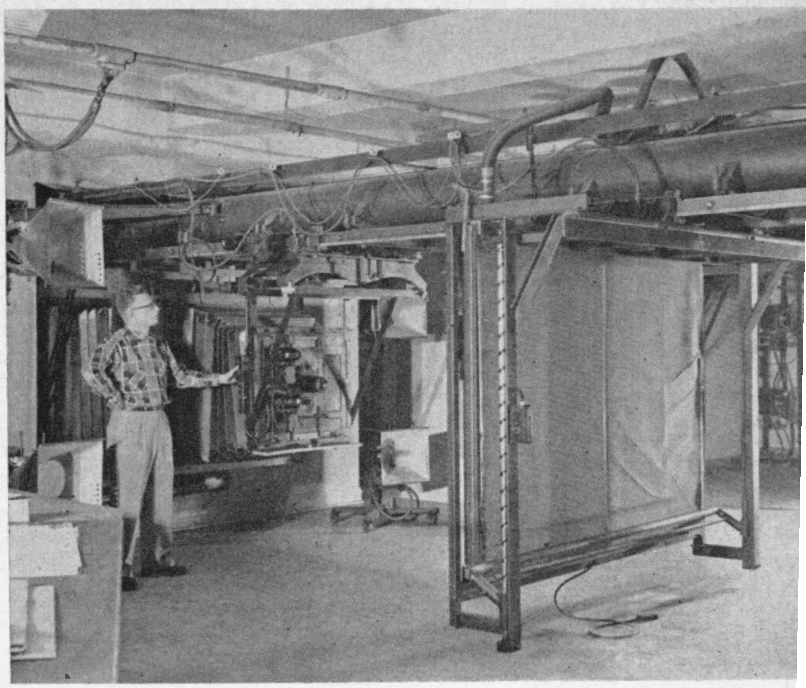
Map Distribution Maps stored (in four separate buildings) totalled 6,362,749 copies, a gain of 35 per cent over 1956. This was partly due to the larger number of aeronautical-chart bases held for overprinting.

The number of maps completely out of stock was reduced to 15.

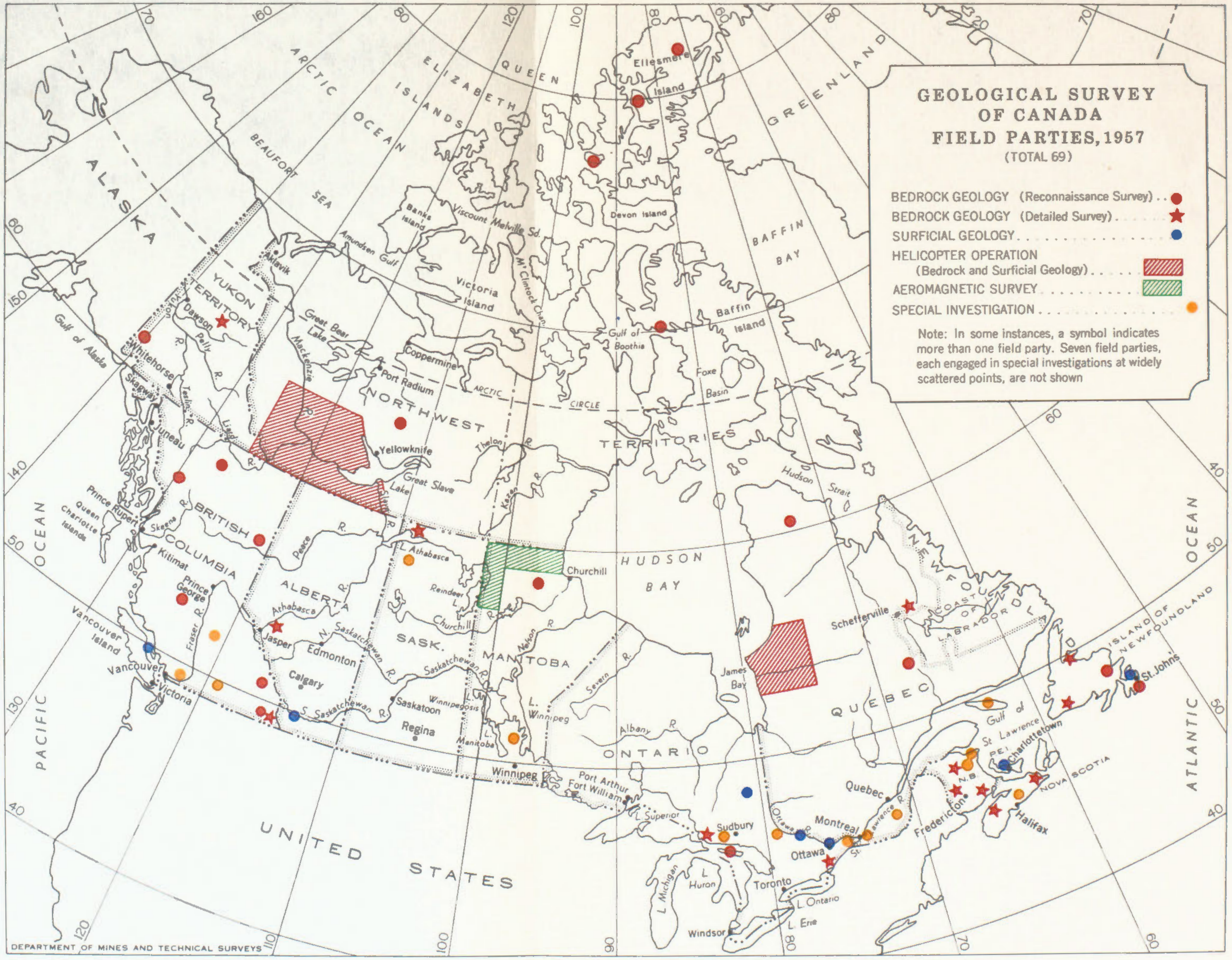
Over 743,000 maps of the National Topographic Series and 171 publications were distributed in response to 29,629 requests. Revenue from sales amounted to $104,436.68.



A technician applies colour emulsion to a sensitized plastic sheet mounted in a mechanical whirler—an important step in making colour proofs for final checking before a map is printed.



A 48-inch copying camera used in making full-sized photographic negatives of maps. This is one stage in the production of lithographic plates from which maps are finally printed.


GEOLOGICAL SURVEY
OF CANADA
FIELD PARTIES, 1957
(TOTAL 69)
BEDROCK GEOLOGY (Reconnaissance Survey)
BEDROCK GEOLOGY (Detailed Survey)
SURFICIAL GEOLOGY
HELICOPTER OPERATION
(Bedrock and Surficial Geology)
AEROMAGNETIC SURVEY
SPECIAL INVESTIGATION
Note: In some instances, a symbol indicates more than one field party. Seven field parties, each engaged in special investigations at widely scattered points, are not shown
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK.
MANITOBA
ONTARIO
QUEBEC
COAST OF LABRADOR
NEWFOUNDLAND
ISLAND OF NEWFOUNDLAND
NOVA SCOTIA
N.B.
P.E.I.
UNITED STATES
GREENLAND
ARCTIC OCEAN
BEAUFORT SEA
QUEEN ELIZABETH ISLANDS
PACIFIC OCEAN
ATLANTIC OCEAN
HUDSON BAY
BAFFIN BAY
ARCTIC CIRCLE
Ellesmere Island
Devon Island
Banks Island
Victoria Island
Baffin Island
Viscount Melville Sd.
M'Clintock Chan.
Amundsen Gulf
Gulf of Boothia
Foxe Basin
Hudson Strait
James Bay
Gulf of St Lawrence
Gulf of Alaska
Vancouver Island
Queen Charlotte Islands
Aklavik
Dawson
Whitehorse
Skagway
Juneau
Prince Rupert
Kitimat
Prince George
Vancouver
Victoria
Jasper
Edmonton
Calgary
Saskatoon
Regina
Winnipeg
Port Arthur
Fort William
Churchill
Coppermine
Port Radium
Yellowknife
Great Bear Lake
Great Slave Lake
L. Athabasca
Reindeer L.
L. Winnipegosis
L. Manitoba
L. Winnipeg
Schefferville
Sudbury
Ottawa
Montreal
Quebec
Toronto
Windsor
Fredericton
Charlottetown
Halifax
St. John's
L. Superior
L. Michigan
L. Huron
L. Ontario
L. Erie
Mackenzie R.
Peace R.
Athabasca R.
N. Saskatchewan R.
S. Saskatchewan R.
Churchill R.
Nelson R.
Severn R.
Albany R.
Ottawa R.
St. Lawrence R.
Fraser R.
Skeena R.
Liard R.
Pelly R.
Teslin R.
Yukon R.
Slave R.
Thelon R.
Kazan R.
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Geological Survey of Canada

Looking to the completion of the initial reconnaissance mapping of Canada at the earliest practicable date, the Geological Survey of Canada in 1957 continued to press forward with the reconnaissance mapping of bedrock in virgin territory. It assigned 29 per cent of its field parties, 37 per cent of available field staff and more than one-half of its field appropriation to such mapping and to aeromagnetic surveys to supplement and facilitate this work. In two major helicopter operations, Mackenzie and Fort George, it carried out reconnaissance mapping over 135,000 square miles of territory and brought to nearly half a million square miles the total area it has mapped in this manner since 1952.

The Geological Survey has now successfully adapted the helicopter technique to the terrain of most of the large unmapped areas of Canada, except the more heavily timbered parts of the Canadian Shield and parts of the Cordillera.

In all, the Survey placed 69 parties in the field in 1957 and completed the mapping of 179,000 square miles in a program second only in size and accomplishment to its 1955 record. In addition to the two major helicopter operations, its field projects included aeromagnetic and geochemical surveys in northern Manitoba and Nova Scotia, respectively; detailed mapping in various areas throughout the country; miscellaneous exploratory and special projects not confined to regular map-areas, and special investigations to solve critical geological problems or to give more direct assistance to mineral exploration. Eleven of the 79 staff geologists in the field were concerned solely with surficial geology, ground-water resources, or engineering geology to obtain data vitally important to national planning and development for engineering projects and for other factors affecting land use.

The parties were distributed as follows:

District of Franklin, N.W.T.	4	Ontario	7
Districts of Mackenzie and Keewatin, N.W.T.	2	Ontario and Quebec	3
Yukon	2	Quebec	3
British Columbia	11	New Quebec and Labrador	4
British Columbia and Alberta	1	New Brunswick	6
Alberta	2	Nova Scotia	4
Alberta and Saskatchewan	1	Prince Edward Island	2
Saskatchewan	2	Newfoundland	5
Manitoba	3	General	7

With the anticipated completion of its new $6.3 million building in 1959, the Geological Survey is also looking to the much needed expansion of its research effort to enable it to fulfil properly its task of carrying on essential supporting research. Of immediate importance is the expansion of certain phases of its laboratory research and other services to realize the best possible results from its extensive program of reconnaissance mapping, and the long overdue expansion of its work in ground-water surveys and surficial and engineering geology.

Grants-in-aid from funds provided by Parliament for the support and stimulation of geological research in Canadian universities totalled $40,000, as in 1956. The grants were made to nine universities in support of sixteen research projects. Details of the grants are given in Appendix IX.

In line with its policy of recent years to provide thesis opportunities for a limited number of promising potential recruits, the Geological Survey engaged seven geology students as seasonal party chiefs on field projects expected to provide material for doctorate theses.

Field Activities

Highlights of the 1957 field program of the Geological Survey of Canada are given below. A more detailed account of this field work may be found in Geological Survey of Canada Information Circular No. 1, January 1958.

Northwest Territories

The Arctic Islands Field work in the Archipelago comprised reconnaissance mapping on a number of the Islands.

One of the parties continued the coastal reconnaissance, commenced in 1956, of parts of the west coasts of Ellesmere and Axel Heiberg Islands, and of the coast of Meighen Island. It obtained precise stratigraphic information that will aid in assessing the oil and gas potentialities of the district.

Another party, attached to Defence Research Board's Operation Hazen, made a geological reconnaissance of northern Ellesmere Island in the vicinity of Hazen Lake. It found that seams of coal outcrop continuously for about 10 miles along the northwest shore of the lake.

A third party completed a coastal reconnaissance of part of Baffin Island along Fury and Hecla Strait and the northernmost shore of Foxe Basin. The rocks are chiefly Precambrian in age and were found to contain a little iron-formation. Preliminary results of the work have been prepared for publication on a scale of 1 inch to 8 miles.

The Survey took advantage of facilities afforded by a shoran station on Cornwall Island to explore Exmouth, Ekins and Table Islands to the south. The field work disclosed that Exmouth and Table Islands are underlain by an almost complete succession of gently folded Triassic rocks about 1,500 feet thick.

The Mainland Nine Survey officers and nine assistants carried out Operation Mackenzie in southwestern District of Mackenzie, the Geological Survey's seventh major reconnaissance survey by helicopter in large, relatively inaccessible areas of Canada. They succeeded in mapping 100,000 square miles of upper Mackenzie River drainage basin (85A to H and J to N, exclusive of the northeast parts A, H, J, and N; 95A, B, C, F to K, N, O and P).*

The area extends from 100 miles within the Mackenzie and Franklin Mountains on the west across the Interior Plains to the Precambrian Shield on the east. Much of it is being explored for oil and gas.

The party mapped the bedrock on a scale of 1 inch to 8 miles in the plains region and 1 inch to 4 miles in the mountainous region; determined the major structural features; measured, described and sampled about 225,000 feet of stratigraphic sections and collected the contained fossils; and ascertained the extent and direction of movement of the Laurentide and Cordilleran ice-sheets and the former position of glacial lakes. So great was the mass of data accumulated that several years' office and laboratory work will be required to prepare it for publication.

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* These numbers and letters identify the areas according to the National Topographic System.

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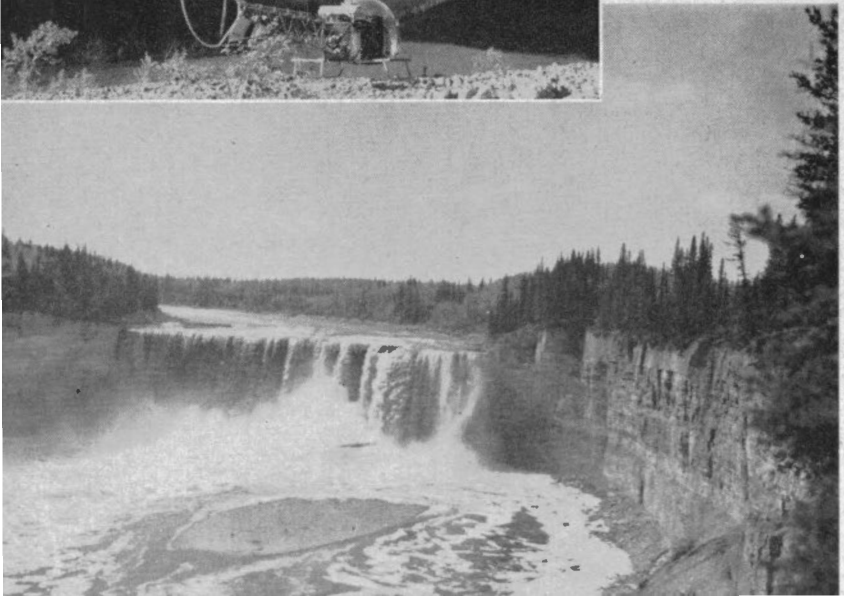
In Operation Mackenzie, Survey geologists mapped 100,000 square miles of territory in the upper Mackenzie River drainage basin. They made routine geological observations from a height of a few hundred feet and checked these by hundreds of ground observations during the course of their aerial traverses. A ground observation is made on Nahanni Plateau about 100 miles west of Fort Simpson.

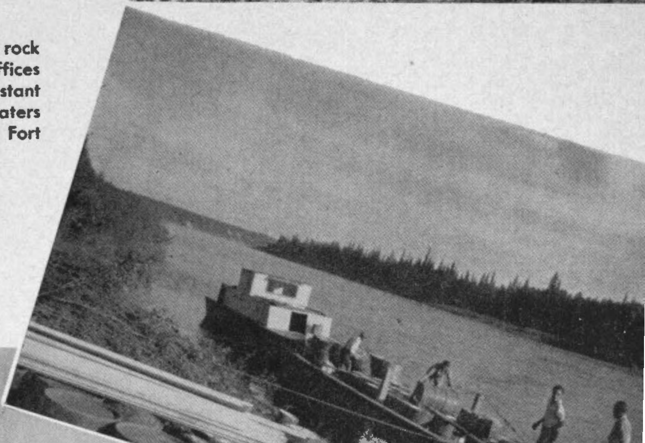
The territory mapped included the First Canyon of the South Nahanni River which is carved to a depth of 3,500 feet in flat-lying Middle Devonian strata.



Survey geologists mapped flat-lying Upper Devonian beds in the vicinity of Alexandra Falls, 109 feet high, on Hay River.

In Operation Mackenzie, the party went into the field before break-up to make as full use of the season as possible. This geologist was set out by helicopter just west of Pine Point on Great Slave Lake to examine the shore eastward to the party's camp at Dawson Landing.

Survey geologists move camp several times during a geological reconnaissance operation by helicopter. In Operation Mackenzie, they did this by means of aircraft, boat and barge.



The geologists brought thousands of pounds of rock samples back to the Geological Survey offices in Ottawa for study. Here a student assistant loads fossils into a packsack near the headwaters of the Ram River about 110 miles west of Fort Simpson.

Stratigraphic relationships and structural features indicate that much of the region may ultimately be productive of oil and gas.

The operation cost approximately $167,000.

In the Canadian Shield of District of Mackenzie, a ground party mapped the greater part of the Fort Enterprise area (86 A) on a scale of 1 inch to 4 miles. Two areas considered favourable for the occurrence of mineral deposits were outlined.

Yukon

Geological mapping on a scale of 1 inch to 1 mile was carried on north and west of the productive Mayo district, and a belt of massive quartzites, up to 2 miles wide and similar to those in which the mines of Galena Hill and Keno Hill occur, was traced for a considerable distance. Mapping on a scale of 1 inch to 4 miles, adjacent to the Alaska boundary, was completed in the north half of the Teepee Lake area (115 F NE¼). This practically completes the standard mapping of the accessible areas along the northeast front of the St. Elias Mountains. The front belt of these great mountains gives every indication of being an important prospecting zone. It is one of amazingly varied geology, containing strata of most of the past geological ages, from the Late Precambrian to the Tertiary, and a great variety of igneous rocks.

A number of copper-nickel properties are already being explored in the belt.

British Columbia

Survey parties continued geological mapping on a scale of 1 inch to 4 miles in the northern part of the province, in the wake of Operation Stikine, to complete the work of the Operation and to use the great wealth of new knowledge gained in the mapping of adjacent map-areas. Operation Stikine, the Survey's first big helicopter mapping project in the Cordillera was carried out in 1956 over 25,000 square miles of territory (104 A, B, G, H, I, and J), the largest unexplored area remaining in British Columbia. In one season, the party succeeded in mapping most of the area but some geological problems were left unsolved, and a few gaps remained to be filled in the resulting geological map. In 1957, the mapping of the Cry Lake (104 I) area, partly done during the Operation, was nearly completed and preliminary exploration was extended into the Kechika (94 L) and Rabbitt River (94 N) map-areas preparatory to further work in 1958.

These areas contain, in the southwest, the Cassiar mineral belt; in the northeast, part of the Rocky Mountains; and in the region between, the north end of the Rocky Mountain Trench. A study of the latter will yield a better understanding of the structure of the continent as a whole.

Mapping was completed and a number of problems solved in the west side of the territory covered in Operation Stikine, particularly in the Telegraph Creek (104 G) map-area. Work in the Iskut River (104 B) map-area was nearly completed, and an aerial reconnaissance was made of the Sumdum (104 F) map-area preparatory to extending the mapping northward along the International Boundary. In 1957 mid-Triassic rocks were identified, for the first time, in northwestern British Columbia. Many mineral deposits were examined, including the porphyry copper type of deposits, to which exploration companies have recently devoted much attention.

In southeastern British Columbia, geological mapping on a scale of 1 inch to 4 miles was commenced in the Fernie area (82 G W½). This area has a variety of mineral resources. It contains the coal-mining town of Fernie, a number of silver-lead-zinc deposits, the old placer gold camp of Fort Steele, and large magnesite deposits. The area also straddles the southern end of the Rocky Mountain Trench in Canada for more than 65 miles. Among the interesting phenomena which Geological Survey parties discovered, contrary to expectations, were several monzonite and syenite bodies that intrude Palæozoic strata within the Rocky Mountains. Aurioles containing contact silicate minerals and hornfels with rusty weathering are associated with them. Here, too, a basal Devonian conglomerate composed mainly of granitic rocks and gneisses suggests the presence of a local elevated area of the Precambrian Shield basement. Another interesting discovery was that of greenstones, tuffs, and breccias of volcanic origin and of post Ordovician, possibly Devonian age, in the Rocky Mountains. Much new and valuable information was gained of structure in the area.

Surficial geological studies were continued on the east-central coastal lowland of Vancouver Island, between Cumberland and Campbell River. The Survey's work has outlined the areal distribution and stratigraphic position of the complex sequence of unconsolidated deposits, and thus supplied the basic data necessary for the full evaluation of engineering, ground-water, and soil development studies.

A party completed ground-water investigations in Sumas and Chilliwhack municipalities, thus bringing to a close the Geological Survey's program of ground-water studies in the lower Fraser River valley. Government agencies, municipal authorities, industries, and individuals have kept constant pressure on the Survey for information gained from these investigations.

Field work was completed in the Charlie Lake map-area (94 A) in northeastern British Columbia. The area is underlain by Lower and Upper Cretaceous shales and sandstones, mainly of marine origin. The formations trend northwesterly and are flexed into open southeast-plunging folds. These structures are productive of oil and gas in the general Fort St. John region.

A Survey officer continued the long-term stratigraphic and palæontological study of the Jurassic formations of British Columbia, working mainly in the Nelson (82 F W½) map-area and the Elk River valley. This project has resulted in significant revisions of the Jurassic stratigraphy and, therefore, in a much better understanding of the general geology, structure, and historical geology of this part of the Cordillera.

The staff of the British Columbia office at Vancouver provided industry and those interested with information on occurrences of metallic and industrial minerals, ground-water supplies, engineering geology, and many other subjects. An all-time high of over 7,300 persons visited the office, and a record 18,520 maps and reports were distributed.

British Columbia and Alberta

A student, working on his doctorate thesis, completed the mapping of the Flathead North map-area (82 G/7 E½). He obtained data on strata ranging from Proterozoic to Lower Cretaceous in age, and particularly on the Devonian reef formations that contain the productive reservoirs at many of the oil fields in the plains area to the northeast. He also studied and mapped structures resulting from two or more phases of deformation. The area contains coal deposits and structures thought to offer oil and gas possibilities.

Alberta

A party commenced the geological mapping of the Miette (83 F/4) map-area which embraces the eastern Rocky Mountains and the Pocohontas coal basin. The work will furnish information on the stratigraphy and structure of the Palæozoic formations on several of the mountain ranges which are types different from those farther south in the province.

Another party completed the mapping of the unconsolidated deposits in the west half of the Fort McLeod area (82 H W½) in the southwestern corner of the province. It recognized five distinct till sheets representing major glacial advances, and possibly three different glacial ages, and found that the extreme southeastern, southwestern and northwestern corners of the map-area were not overridden by glacial ice. It outlined, over considerable distances, several buried valleys that are potential sources of ground water.

Geologists of the Western Oil and Natural Gas office at Calgary continued to study the subsurface stratigraphy of the four western provinces and of Yukon and Northwest Territories. Their investigations involve examination of cuttings from wells in the Survey collection, of cores stored in several localities in the region and, in some cases, of exposed sections, to enable comparison of surface and subsurface data. These studies have helped to throw light on problems concerned with the location and extent of reservoirs for natural gas and oil.

In another project—the study of the subsurface formations of Upper Devonian age beneath the plains of Alberta—the Calgary office geologists have achieved a better correlation with the exposed formations in the mountains. Formations of this age hold the productive reservoirs at several of the oil fields in Alberta. This work adds greatly to the existing knowledge of the character and distribution of these reservoir rocks and is, therefore, an aid in the exploration for oil and gas.

They continued work leading to the subsurface mapping of Lower Cretaceous rocks in Saskatchewan, investigating the thickness, character, and distribution of formations of this age to facilitate exploration for oil and gas in these strata.

Alberta and Saskatchewan

The Survey renewed its comprehensive study of the rocks of the Athabasca group, which it suspended temporarily in 1953. These strata underlie a large area south and southeast of Lake Athabasca. The study is expected to reveal their character, age, source, and economic possibilities. Another field season is required to complete the study.

Saskatchewan

Two parties continued detailed mapping and structural studies in adjoining parts of the Beaverlodge area north of Lake Athabasca: one in the area containing the Ace-Fay mine of the Crown-owned Eldorado Mining and Refining Limited, and the other, the property of Gunnar Mines Limited.

Since the start of the projects in 1952 and 1954, respectively, five preliminary maps with marginal notes have been published on a scale of 1 inch to 800 feet. Other preliminary and two final maps are being prepared for publication. So numerous are the problems concerning the nature and origin of the ore deposits and their host rocks, and the structural and other factors affecting the localization of the ore in these areas, that only such detailed and painstaking geological studies can provide the effective guidance needed for carrying out exploration programs at the various producing mines and the numerous prospects.

Manitoba

A Survey party geologically explored the Shethanei Lake area (64 I), about 5,000 square miles in extent, as part of a continuing reconnaissance survey of potential prospecting fields in the northern part of the province. About two-thirds of the area was found to be essentially devoid of outcrops. A report, accompanied by a map on a scale of 1 inch to 4 miles, will describe the principal geological features, mineral occurrences, and formations that offer promise to prospectors.

Another party made a detailed study of the stratigraphy and fauna of the Ordovician rocks on the west shore of Lake Winnipeg. This work will clarify the Ordovician succession, and provide a section with which rocks penetrated by wells to the west in Saskatchewan and to the southwest in the Williston Basin area may be correlated and compared. The results of the study of the contained fauna will furnish comparative material useful in the study of Arctic faunas of the same age.

The Geological Survey continued the aeromagnetic survey of northern Manitoba (54 M; 64 F, K, N, O, and P), commenced in 1956, to provide an interim substitute for geological maps and to guide and supplement the geological mapping planned for that area during the next few years. In record time, it completed 60,000 line-miles of aeromagnetic surveying at a line spacing of one-half mile and at a terrain clearance of 1,000 feet. A nearly circular aeromagnetic anomaly of some 10,000 gammas in intensity covering an area of about one square mile was detected near Great Island on the Seal River. Although such an intense anomaly is undoubtedly caused by a concentration of magnetite, the tonnage, grade and detrimental impurities of the deposit cannot be estimated satisfactorily from the aeromagnetic data. Such information can be obtained only by ground examination and diamond drilling.

Ontario

Geological mapping on a scale of 1 inch to 1 mile was continued in the Echo Lake area (41 J/12) north of Lake Huron. The project was started in 1956 to carefully restudy the region lying west of the Blind River uranium-mining district. This region was mapped, on a reconnaissance scale only, many years ago. The restudy of the rock formations and their stratigraphic succession is expected to aid in understanding the geological history of the region as a whole, which in turn will be of material assistance to prospectors.

A revision of the geological mapping of the Westport area (31 C/9) in the southeastern part of the province was commenced. The resultant report, accompanied by a map on the scale of 1 inch to 1 mile, will contain not only the results of the current study but those of the work done in the area many years ago.

Detailed studies of the surficial deposits in the Chalk River area were begun to gain a better understanding of the factors governing the movement of ground waters, which may play an important role in the disposal of radioactive wastes.

The Survey completed the geological study and mapping of Manitoulin Island. The Island is underlain by Ordovician and Silurian rocks consisting mainly of marine limestone and shale. The work has revealed the presence of both reservoir rocks and structural features favourable to the accumulation of oil and gas, and one live oil seep was observed. The resultant map will aid exploration for oil and gas on the Island.

Survey geologists continued to study the origin and distribution of the Blind River uranium deposits, and published an interim report during the year. This project is particularly important because the Blind River area contains the largest known reserves of uranium ore in the world, other than the by-product ores of South Africa, which are dependent upon gold production. The Blind River ores, although low in grade, also contain large amounts of thorium, and new uses recently announced for this metal have attracted attention to the possibility of producing thorium from these ores. Great interest in production from the Blind River deposits, their future possibilities, and their geology, particularly their origin, has been aroused in other countries. The work being done on the ores by the Geological Survey and by others has thrown light on these matters but, because of the unusual complexity of the ores and conflicting geological evidence, all problems will probably

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not be solved for some time. The Survey's work has contributed much data on the location and amount of the thorium content, and has included an independent estimate of the probable uranium reserves of the district. This is based partly on geological evidence.

Quebec

A helicopter-supported party of three geologists commenced a geological reconnaissance, Operation Fort George, of a virtually unknown area (23 W½, 33) of about 120,000 square miles in the northern part of the province. One of the largest unmapped parts of the Canadian Shield, the area lies between James Bay and Hudson Bay, and the Labrador Trough. The party succeeded in mapping about 35,000 square miles of the region in 1957. Preliminary results have been published on a map called 'Sakami Lake area'. About 750 square miles of greenstone with minor sedimentary rocks and iron formation occur mainly as two easterly trending bodies in the southern third of the mapped area. Two more field seasons will be required to complete the project.

A Survey geologist made a ground-water survey of the eastern half of that part of the Lachine (31 H/5) map-area lying south of the St. Lawrence River. This work is part of a program of ground-water studies on Montreal Island and the St. Lawrence Seaway route. The areas along the seaway route are expected to become heavily industrialized in coming years, and information on sources of ground-water supplies back from the river will be in great demand by industry requiring quantities of such water. The water-bearing capacities and the qualities of water stored in the bedrocks exposed in the area vary greatly. The Survey has provided new data on the locations of faults in the area, that have a marked bearing on the supply of ground water.

A stratigraphic and palæontological study of the Upper Ordovician and Silurian rocks of Salmon River, Anticosti Island, was commenced. This is a continuation of a similar study made along the Jupiter River to the southwest by the Geological Survey in 1942. The present work, together with that of 1942, will furnish information on a complete section across the centre of the Island, and make possible a description of the stratigraphy and structure of that section. These data will prove valuable in assessing the oil and gas possibilities of the Island.

The Survey began a systematic study of the ultrabasic rocks of Canada to establish the reasons why deposits of chromite, asbestos, magnesia, nickel, etc., are usually associated with them. During the initial work on the Mount Albert pluton in Gaspé peninsula, a hill of fresh dunite was mapped. The principal constituent of this hill proved to be forsterite. Subsequent tests have shown that this forsterite may be a suitable substitute for chromite in the manufacture of refractory bricks. Chromite, at present, is imported from foreign sources.

A Survey geologist completed a three-season study of the correlation of aeromagnetic data with geology in the Eastern Townships to obtain and present data concerning the interpretation of aeromagnetic maps. The project has involved the study of 31 one-mile map-areas for which Geological Survey aeromagnetic maps are available, and for most of which, conventional geological maps on the scale of 1 inch to 1 mile are also available. In most instances, it was found impracticable and inadvisable to attempt geological interpretations of the magnetic data without adequate knowledge of the local characteristics of the rocks concerned. Here and there, the field work resulted in the refinement of the geological maps. The project involved, in part, the collection and measurement of magentic susceptibilities of more than 1,000 rock samples. An analysis of these data has shown that while it is impossible, for instance, to differentiate magnetically between certain volcanic and ultrabasic rocks, many other useful differentiations can be made from magnetic data. On the whole, the investigation has corroborated the Survey's current policy that, in so far as is practicable, aeromagnetic mapping should precede geological mapping if the latter is to achieve maximum quality and economy.

Quebec and Newfoundland

Two field parties continued mapping the rocks of the Labrador Trough which contains important deposits of iron ore. This work is part of a long-term project to provide maps of the entire Trough as soon as practicable. One party studied the geology of the Mount Wright (23 B W½) map-area. The Survey expects to complete the mapping of this area on a scale of 1 inch to 4 miles in one more season. The second party commenced the geological study and mapping of the Marion Lake (23 I/13) map-area for publication on the scale of 1 inch to 1 mile. This work is expected to provide the critical stratigraphic and structural data required to maintain the quality of the Survey's 4-mile mapping of the Trough.

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New Brunswick

Six parties continued geological mapping in the country west of Bathurst and Newcastle to assist in the search for zinc-copper-lead ore deposits in the region. Projects completed for publication comprised about 8 square miles, centred on the No. 12 orebody of Brunswick Mining and Smelting Corporation Limited, on the scale of 1 inch to 1,000 feet; the California Lake (21 O/8) map-area on the scale of 1 inch to 1 mile; and the Big Bald Mountain (21 O/1) map-area, except for a few small gaps that remain to be studied in 1958.

Nova Scotia

Geological mapping on the scale of 1 inch to 1 mile was nearly completed in the Nictaux-Torbrook district. Although a considerable amount of iron was produced in this area in the past century and early in this century, work was undertaken here primarily to obtain answers to problems which would affect the interpretation of the geology elsewhere in the Maritime Provinces. It is hoped to obtain the date of the granitic invasions of the Maritime Provinces, the age of the Meguma series, and the times and intensities of the early Palæozoic orogenies from data obtained in this study.

A party continued the geochemical reconnaissance of Nova Scotia, by means of analysis of stream waters and sediments, which the Geological Survey started in 1956. Work in 1957 covered most of that part of the mainland lying between a line connecting Windsor and Lunenburg and a line connecting Truro and New Glasgow. The reconnaissance resulted in the location of several areas in which the copper, lead and zinc content of the waters and sediments is anomalously high. Many of these areas are grouped along the contact of the Horton and Windsor formations. This contact is, therefore, a favourable locale for prospecting. Results of this form of geochemical reconnaissance add materially to the usefulness of geological maps, and such surveys could well prove to be a valuable extension of the Survey's regular geological mapping.

The continued geochemical study of barite deposits near Walton has shown that geochemical prospecting of soil may be used to trace underlying barite deposits. Investigations of the dispersion of copper, lead, and zinc, made during this study, indicate that these metals may be associated with barite deposits.

Prince Edward Island

Two parties continued the mapping of the bedrock and surficial deposits of the province, commenced in 1953. The survey, when completed, will afford the first accurate classification of the unconsolidated materials from which the soils of the Island were derived, and will furnish vital information to the province's agricultural industry.

Newfoundland

Survey geologists completed mapping the bedrock of the Whitbourne (1 N W½) map-area, which includes the greater part of the Avalon Peninsula, on the scale of 1 inch to 4 miles, and continued mapping the area's surficial geology on the same scale. The value of the latter survey became apparent during the summer of 1957 when the specialized knowledge gained during the survey led to the discovery of much needed shale-free gravel from a deposit at Seal Cove.

General

A Survey geologist studied important iron deposits in Quebec, Newfoundland, and Labrador as part of a long-term investigation of the geology of Canadian iron ores. The primary purpose of this project is to obtain information useful in prospecting for, exploring, and evaluating iron deposits. The study will also provide data on present and possible future sources of iron ore.

Another geologist commenced a long-term investigation of Canadian beach sands and placer deposits with the study of beach deposits in the Maritime Provinces. The project has been undertaken to provide comprehensive data on valuable minerals that might be found in such deposits and to try to improve present knowledge and techniques for prospecting for and testing these deposits.

Many prospects in Ontario and Quebec that were considered possible occurrences of 'rare earth' minerals were examined because of the increased interest in possible sources of rare earths. This interest is based largely on demand for the heavier metals in the rare earth series, which are in short supply and occur in unusual minerals. The results of this study are not yet available.

Working in Northwest Territories, Manitoba, Ontario, and Quebec, a geologist completed a comprehensive investigation of the geology of Canadian lithium deposits, commenced in 1953. The data obtained will form the basis of a report of the Survey's Economic Geology Series, which will prove helpful in prospecting for and evaluating lithium deposits.

A Survey geologist studied chromite deposits in Manitoba and Quebec to complete the data required for a report on the geology of Canadian chromite deposits.

Research

The spacious modern new building which will house the Geological Survey and which is to be fitted with the latest in scientific equipment will permit the Survey to expand its programs of applied and fundamental research in long desired directions. Such research enhances the ability of its geologists to map and explain the geology of Canada.

The highlights of the Survey's research effort in 1957 are given below.

Stratigraphy and Palaeontology

For details or research projects relating to crude petroleum see Field Activities—Alberta.

The staff of the Coal Research Laboratory at Sydney, Nova Scotia, continued detailed petrographic and palynological (spore) studies of Nova Scotian and western Canadian coal seams to assist in the development of eastern and western Canadian coalfields. It carried out a petrographic study of coals as a contribution to a Mines Branch investigation into the causes of outbursts in coal mines in Western Canada. These outbursts hinder the optimum extraction of valuable coal seams. A knowledge of the petrographic constituents of coals subject to such violent stress phenomena will contribute to an understanding of these phenomena.

Another study concerns the possible effect of the petrographic composition on the coking characteristics of coal. This is part of a cooperative study with the Mines Branch of Bellevue No. 1 Seam of West Canadian Collieries, Blairmore, Alberta, to determine the coking characteristics of the seam. Certain petrographic constituents of coal have better coking characteristics than others. Also, a stronger coke can be produced by blending one petrographic constituent with another. Such studies are valuable in determining (1) the best coking characteristics of coals, and (2) what coals to blend to obtain good quality metallurgical coke. Also in cooperation with the Mines Branch, the staff is carrying out petrographic studies of Sydney coking coals to examine the possibilities of improving the strength of metallurgical cokes used at the Sydney steel plant.

The Survey's Sydney office geologists undertook a spore investigation of the coal seams of the Pictou coalfield to: prove or dispose a correlation between the Stellarton and Westville coals, a factor of importance in establishing the remaining reserves of the Pictou field; and to determine the vertical distribution of spore genera in coals of the Pictou group.

At the request of the provincial Mines Branch at Fredericton, New Brunswick, they are carrying out a spore investigation of coals from the general Minto area of New Brunswick in an effort to solve stratigraphic problems concerning the Pennsylvanian rocks in that province. Preliminary results indicate the possibility, by this method, of determining the relative stratigraphic position of the several coal seams in the Minto, Chipman, and Beersville areas. This would provide valuable information in establishing the true sequence of the associated rocks.

Spore studies carried on at Sydney have been used to determine the approximate age of coal samples, and therefore of the associated rocks, submitted by Survey field officers. A sample of carbonaceous material from West Devon Island, District of Franklin, for instance, has been dated as probably Upper Cretaceous.

In 1957 the Survey prepared 46 reports on fossils.

Geophysics

The Survey is working on aeromagnetic interpretation, palæomagnetism and magnetic properties of rocks, magnetic resonance as a means of detection and non-destructive analysis of minerals and rocks, seismic reflection and shallow refraction, a pulsed method of electromagnetic prospecting, and radio frequency field strength measurements as a means of mapping near surface conductivity.

It is using the airborne magnetometer to improve the quality and usefulness of geological maps by flying the areas to be mapped and providing its field geologists in advance with the results of the surveys. For details of its work in the field see Field Activities—Manitoba, and Quebec.

The Survey began a study of the usefulness of treating aeromagnetic data analytically through the use of an electronic computer service obtained on contract. By this means, it constructed a second derivative map of the Eastern Townships area, which bears a better correlation with mapped geology than does a total field map. The effect from the deeper lying magnetic material is suppressed by this treatment.

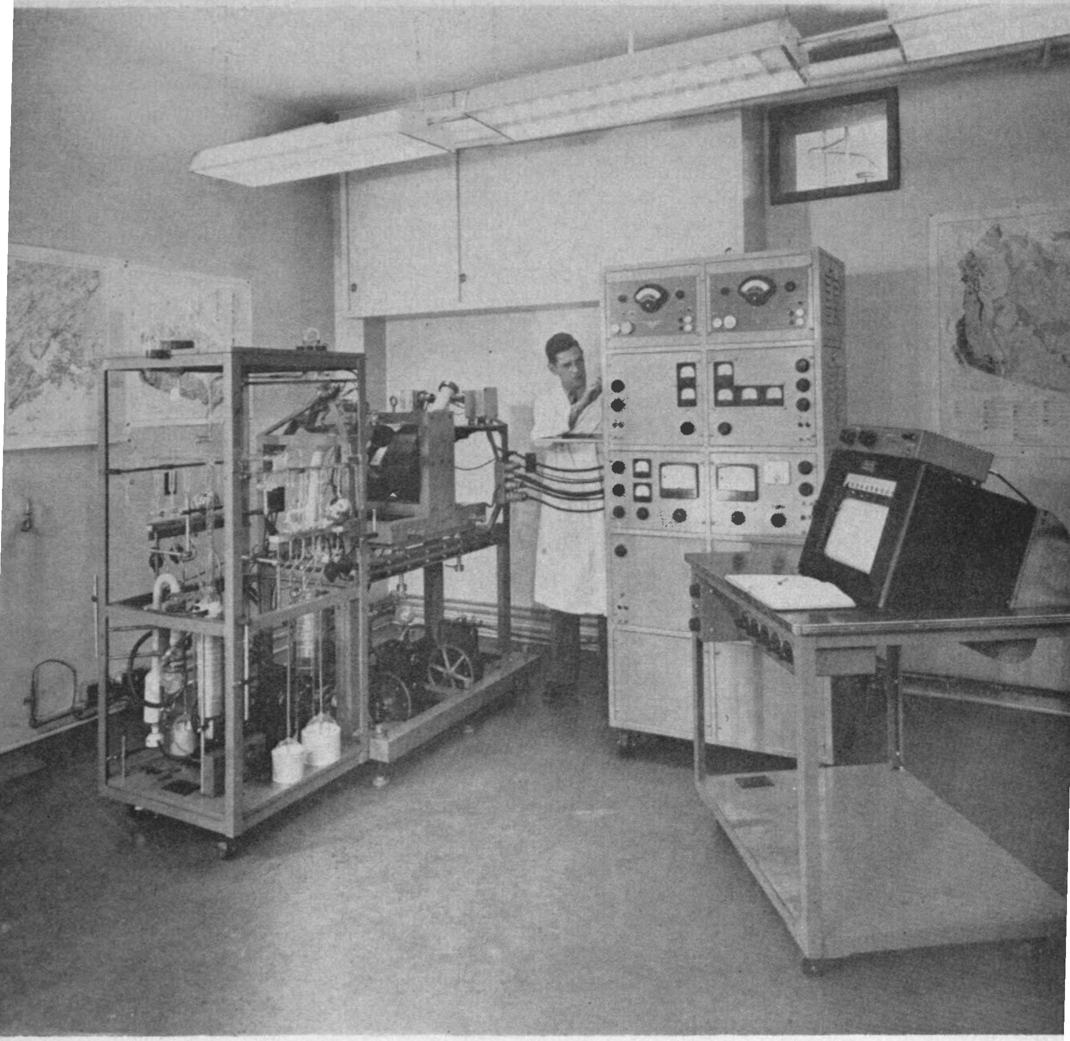
In cooperation with the Dominion Observatory, it commenced a study of the magnetic properties of rocks for three purposes. First, it is possible that the characteristic direction of the remanent magnetization of stably magnetized rocks can be used as an independent means of correlating Precambrian rock formations. Secondly, further palæomagnetic studies of dated rock formations should throw more light on the controversial question of continental drift. Finally, a comprehensive study of magnetic remanence, susceptibility, and thermomagnetic properties ought to show to what extent remanence should be considered in the interpretation of aeromagnetic surveys.

Mineralogy

Survey scientists are using isotopic analysis, made on the mass spectrometer, for studies of the source and migration of petroleum, of the origin and correlation of metallic mineral deposits, and of the absolute age of minerals and rocks. In a study of the isotopic composition of lead in ores from the Sullivan mine and other deposits in southeastern British Columbia, they found that lead in different minerals and from all parts of the Sullivan mine is constant in its composition. Isotope ratios of lead from the other deposits fall into two groups, one equivalent to the Sullivan and the other distinctly different. It seems probable, therefore, that, in that area, lead was introduced from two different sources and probably at different times. Such work narrows down the search for additional deposits to those structures and rocks in the favourable range of age.

In another project, they proved that the isotopic composition of sulphur from all minerals and all deposits of the Yellowknife camp to be very similar to that of meteorites, with little variation. This is indicative of deposition at relatively high temperatures. In contrast to this, the isotopic composition of sulphur from sulphides and sulphates in strata of the Golden Spike oil field, Alberta, exhibits wide variation, with remarkably abrupt changes that coincide with changes in strata.

The Survey made diverse petrographic investigations for such organizations as Fisheries Research Board, Department of National Defence, Mines Branch, National Research Council, National Gypsum (Canada) Limited, and the National Museum of Canada. Of particular interest were petrographic contributions to (1) the studies of rockbursts being made by the Mines Branch in certain coal mines in Eastern and Western Canada, and (2) the identification of mud coatings on the ice of Foxe Basin.



A mass spectrometer is used at the Geological Survey to determine the absolute age of rocks and minerals. Most rocks contain varying amounts of uranium and thorium, which decay at a known rate to form different types of lead. By determining the kinds and amounts of lead and the quantities of uranium and thorium in a rock, scientists are able to establish its age. Measurements of the amounts of potassium and argon in rocks are also used to determine age.

The new laboratories for crushing, sizing, and mineral separation markedly facilitated the preparation of samples in adequate amount for rock and mineral analysis, isotopic analysis, age determination, etc., thus removing the previous bottleneck in this field.

To satisfy the requirements for rock analyses in sufficient quantity for comparative studies, the Survey adopted a rapid method of analysis developed by the United States Geological Survey. This new method is only slightly less accurate than the best established method, but four times as rapid.

Geochemistry

For details of the Survey's work in geochemical reconnaissance see Field Activities—Nova Scotia. Such reconnaissance is proving to be a valuable complement to geological mapping by helping directly to define geographical areas and geological environments favourable for prospecting.

In 1957, the Geological Survey set up a small laboratory for rapid semi-quantitative determination of specific elements in samples of stream sediments and soils. The high productivity and consistent accuracy of the laboratory have made possible precise geochemical studies, on a statistical basis, which can not be achieved by other techniques. The methods used in the laboratory were largely developed at the Imperial College, London.

Mineral Deposits

The Survey carried out 62 complex mineral separations on large fine-grained ore samples and made 336 thorium analyses, work which was of vital importance to its study of the characteristics and origin of the Blind River ores (*see* Field Activities—Ontario). It also did 567 radiometric assays for uranium and 40 identifications of radioactive minerals, partly for prospectors and partly in connection with Survey field investigations.

It commenced the compilation of a new series of maps to be called 'metallogenic' maps. The first maps in the series will deal with uranium, beryllium, and niobium. Each map is planned to show the Canada-wide distribution of known occurrences of a particular metal, classified according to geological types of deposits. These maps are expected to provide not only scientific data to aid in the understanding of the distribution of various metals and types of deposits, but also to aid prospectors in selecting favourable and possibly favourable areas of a particular kind. Marginal notes

The Survey's rock and mineral analysis laboratory makes detailed chemical analyses of specimens brought in from the field by Survey geologists. Such analyses aid in geological and geochemical interpretation. The laboratory made over 2,700 determinations on samples of rocks, minerals and soils in 1957.

will include selected references to published literature and, where no references are available, the names of the discoverers of the deposits or of others who may be consulted.

As agent for the Atomic Energy Control Board, the Geological Survey received reports of uranium discoveries and of work done on properties in advanced stages of exploration or in production. This information was supplemented by field examinations of several deposits and incorporated in the confidential inventory of radioactive mineral deposits of Canada.

Mines Branch

Investigations undertaken by the Mines Branch in 1957 covered a vast range of technical projects of importance to the advance of fundamental research; to the processing of ores, industrial minerals and fuels on a commercial scale; and to the theory and practice of physical metallurgy.

Some projects reflected the need—in the face of a base-metals price decline—of improving existing ore-processing techniques. Others pointed the way to new recovery methods for the development of low-grade deposits. Of samples under investigation for ore dressing, about half were iron ores of low grade, iron-titanium and copper-nickel ores.

Having solved the principal problems in uranium ore treatment, the Branch gave more emphasis to research on thorium and the rare earths, and to the improvement of current uranium extraction processes. Also under investigation was the use of modern chemical, physical and radiometric methods in the production of metals, and of radioactive tracer techniques in metallurgical work.

Work in physical metallurgy embraced a wide field of fundamental and applied research as well as technical service to industry. Basic studies were undertaken on the crystal structure of metals and the design of titanium alloys. Projects in applied research sought to improve Canadian zinc products and to develop better welding techniques in subzero temperatures. Typical services included the investigation of component failures in aircraft, ships, motor vehicles and industrial equipment. The Branch also continued its work in nuclear metallurgy for Atomic Energy of Canada Limited and other organizations.

Research continued on the use of aggregates in the preparation of concrete, the construction of roads, and in special applications. Practical methods were evolved for milling and concentrating a number of non-metallic minerals of commercial value. Other investigations pursued the development of high-temperature refractories and ceramic electronic components.

To offset the loss of established markets in coal, the Branch sought less conventional and permanent uses of the fuel: for example, in various metallurgical processes and for the production of thermo-electric power. Also under investigation were techniques for improving the quality of Western Canada's low-grade crude oils and high-sulphur bitumens.

Mineral Dressing and Process Metallurgy

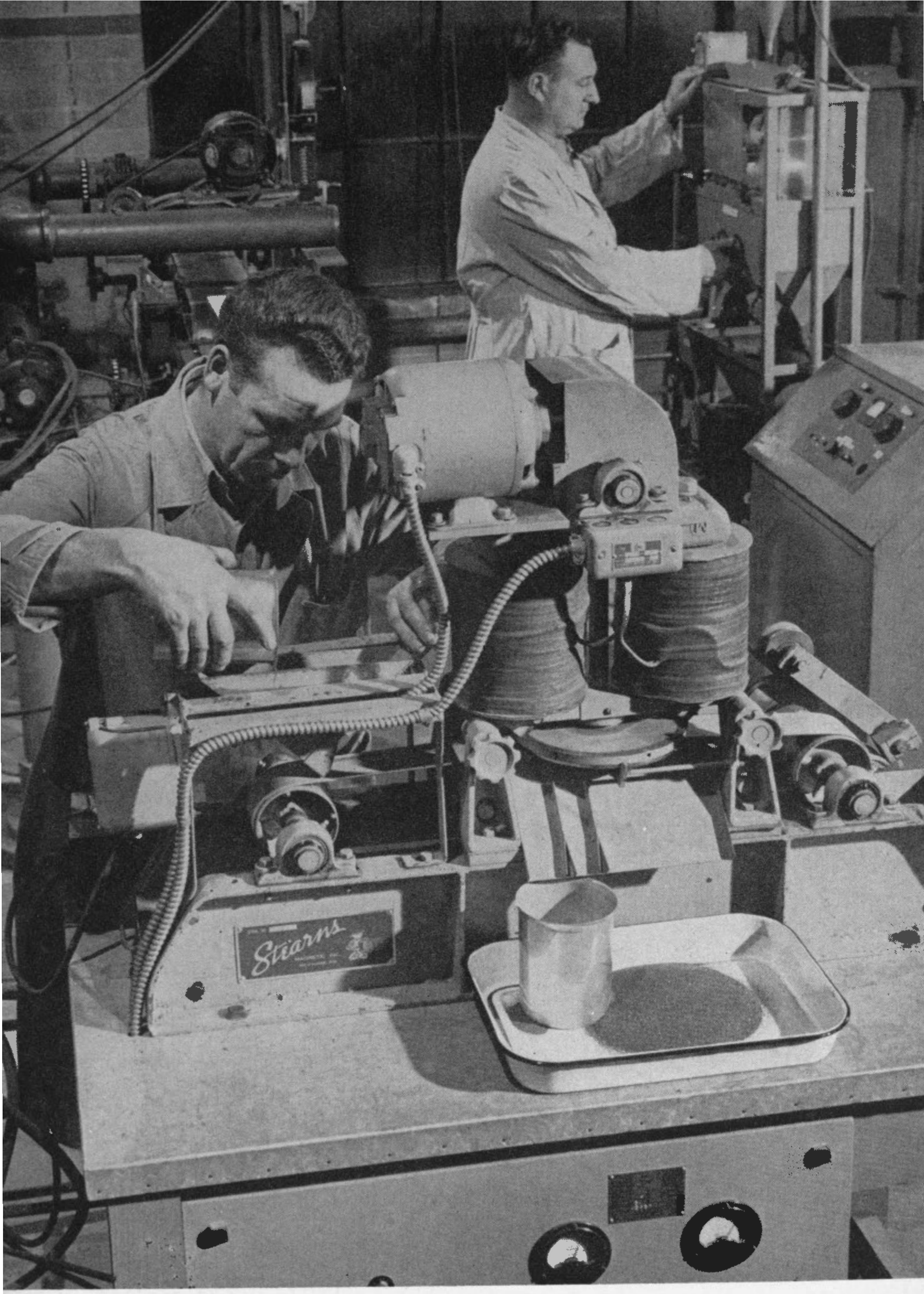
In 1957 most of the investigations in mineral dressing and process metallurgy concerned base-metal and iron ores. Of sixty-four samples investigated, sixteen were iron ores of low grade, eight iron-titanium and seven were copper-nickel ores. Metallurgists of twenty-three companies collaborated with Branch engineers on various projects including pilot-mill runs on ore shipments up to 100 tons, of which more than half involved copper-nickel ores.

Copper-Nickel Ores With Manitoba increasing in prominence as a nickel producer the Branch treated a 100-ton shipment of low-grade copper-nickel ore from that province on a pilot plant scale. Bulk concentrates were roasted and experiments carried out to determine the best smelting conditions. A matte containing about 30 per cent nickel and 27 per cent copper was produced to meet the exact specifications required for economical extraction of these metals.

Iron-Titanium Ores Interest in the iron-titanium ores of Quebec continued at a high level. The Branch carried out pilot-plant runs on 25 tons and developed a mill flowsheet to obtain ilmenite concentrates carrying between 48 per cent and 50 per cent titanium dioxide, and rutile concentrates with 91 per cent titanium dioxide.

Iron Ore The Branch conducted magnetizing roasting tests on a low-grade iron ore from Quebec-Labrador. Resulting concentrates contained about 71 per cent iron and 1.5 per cent silica, similar in composition to Brazilian lump ore and could, therefore, be converted by pelletization to a direct-charging ore bringing a price of about three times that of the normal 54-per cent variety.

Copper-Nickel-Cobalt-Silver Prompted by the decline in base-metal prices, the Branch undertook a critical examination of the leaching procedure in use at one of the mills with a view to improving extractions of copper, cobalt, nickel and silver. Extensive



Samples of iron titanium ores were among those investigated by the Branch in 1957. Shown above is the equipment used in the concentration of ilmenite. A high-intensity magnetic separator is seen in the foreground.

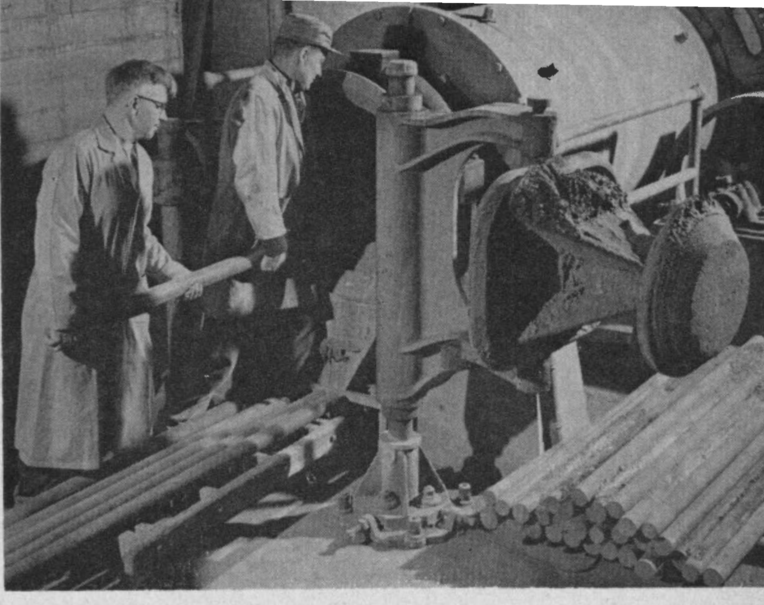
research showed that virtually complete extraction of the valuable metals could be made by increasing process temperatures and pressures.

Manganese Ores With no commercial-grade manganese ore deposits on the North American continent, the problem of utilizing Canada's low-grade reserves, of which there are an abundance, is a matter of strategic importance. The Branch's recently-developed leaching procedure was applied to an iron ore from Ontario which leaves, after beneficiation, a waste product bearing only 3 per cent manganese. It was found that pyrite, a cheap and abundant mineral, could be used to produce a leaching liquor that would remove manganese almost selectively from the waste product. While further study is required, this method seems likely to become the most economical for low-grade manganese ore.

Electrolysis With the increasing application of electro-winning and electro-refining of metals in molten salt solutions, the Branch felt that more fundamental information on the chemistry of the electrode process would be of value. Accordingly a program was launched with the aim of simplifying cell designs to accommodate specific chemical reactions and of making valid predictions on the separation of metals from solution. Standard electrode potentials were measured for silver, copper, nickel, cobalt, zinc, thallium and chromium and the thermodynamic properties of the cell reactions calculated.

Sintering Work continued on the sintering behaviour of compressed uranium-dioxide shapes for use in the Nuclear Power Demonstration Reactor at Des Joachims, Ontario. Factors under study included: the deleterious effect of carbon, the effect of additives and of various atmospheres. The Branch devised a procedure more economical than the hydrogen sintering at 1600-1700°C. In addition the micronizing process was investigated as a possible stage in the preparation of reactor-grade uranium dioxide and was shown to have considerable promise. In this field the Branch continued to collaborate with and assist other agencies in government and industry.

Corrosion As the Canadian uranium industry increases in importance, more attention is being focused on its various processing problems, one of the most serious of which is corrosion. In the case of one prominent producer, equipment was examined, the process thoroughly investigated and recommendations made for solving the corrosion problem.



developing practical ore processing methods the Mines Branch at times makes use of equipment similar to that used in industry. Shown here is a 3′ x 6′ Marcy rod mill.

Assistance to Industry Investigations in physical and crystal chemistry have been of value both to fundamental research and in solving certain process problems. A project of particular interest concerned quality control in the manufacture of refractory brick. A study of reactions occurring during the manufacture and application of the brick showed that such phenomena as slumping, marking and sticking were due to a type of spinel compound, formed under certain conditions, adversely affecting the properties of the product.

Mineralogical studies were carried out on material from Canadian deposits with a view to improving metal-recovery techniques. A case in point involved titanium and the difficulties encountered in concentrating the ore of that metal. Tests were conducted on samples from several localities and the trouble was traced to a particular type of titanium-iron spinel, the composition of which makes attempts at mechanical beneficiation impossible. Other means of recovery must now be found.

Another vital problem involved the presence of iron in zinc concentrates; smelters are penalized if its proportion rises beyond a fixed limit. Moreover, establishing the amount of iron in the sphalerite itself is important in flotation control. It was therefore desirable that an efficient method of determining the iron content of small grains of sphalerite be found and in this the Branch had considerable success: By a combination of techniques the iron content of sphalerite can now be established within $\pm$ 1 per cent.

Chemical Analysis Research in the analytical chemistry of niobium was continued with particular emphasis on the determination of this element in ores by X-ray spectrography.

Radioactive tracer techniques were applied to the investigation of the fire-assay procedure for precious metals. The results of this work have been informative, showing, for example, that in the case of silver, the greatest loss of precious metal is to the cupel.

General As in previous years, assistance was given to the Canadian Government Specifications Board in its efforts to formulate new specifications and to improve existing ones.

Radioactive Minerals

While applied research of specific benefit to uranium producers occupied a considerable share of the year's program, there was a marked increase in the number of investigations of fundamental import. The Branch conducted pilot-plant runs and solvent-extraction studies for the recovery of uranium and thorium and sought to develop new applications of radioactive tracers in metallurgical work and in other fields. Also undertaken were basic studies of such radioactive minerals as britholite, pyrochlore and brannerite.

In all, 816 samples of ore, products and other materials were received for investigation in 1957. Of these, 773 were for assaying only, 9 were for mineralogical examination and assaying, and 34 were for treatment analysis including mineralogical and assay work. Of the last group, 2 samples came from Northwest Territories, 2 from British Columbia, 10 from Saskatchewan, 18 from Ontario and 1 from Newfoundland. The Branch also treated a sample from Australia.

Ore Treatment In 1957 the Canadian uranium industry continued its rapid rate of growth. Several companies applying processes pioneered by the Branch went into production during the year. These included Consolidated Denison Mines Limited, the Nordic plant of Algom Uranium Mines Limited, Faraday Uranium Mines Limited; Rayrock Mines Limited, Lorado Uranium Mines Limited, Northspan Uranium Mines Limited and Can-Met Explorations Limited.

Others had yet to go into operation. The Branch carried out pilot-plant work and studies in acid pressure leaching, solvent extraction and ion exchange for Rexspar Uranium and Metals Mining Company Limited; and in flotation, acid leaching, solvent extraction and ion exchange for Amalgamated Rare Earth Mines Limited. Extended pilot-plant studies of solvent-extraction processes for recovery of uranium and thorium were undertaken for Quebec Metallurgical Industries Limited.

Field Work Engineers in the field advised a number of companies on milling procedure. Work continued at Port Radium where Eldorado Mining and Refining Limited, a crown corporation, was building a solvent extraction plant—the first in Canada to employ this process for recovery of uranium from ore leach liquors. The plant went into operation early in 1958.

Considerable laboratory work was done on the recovery of thorium concentrates from leach liquors. At the end of the year plans were made for a pilot-plant study at one of the mills of a promising solvent extraction process for recovery of thorium from waste solutions remaining after the extraction of uranium.

Mineralogy Detailed mineralogical examinations were made of radioactive ores from various Canadian deposits to provide data for developing practical recovery procedures.

Work on several projects, started during the previous year, was continued and three new investigations begun. This included work on britholite, pyrochlore and brannerite. By producing brannerite synthetically, the Branch hopes to establish its exact composition and determine whether it is one of the ore minerals at Blind River, Ontario, one of the world's leading uranium camps. The possible occurrence there of other recoverable minerals, or of valuable constituents that might be recovered from waste materials, was also under investigation.

The Branch completed a total of fifteen mineralogical investigations during the year and issued eleven reports. Three mineralogical investigations and five research projects were in progress at year's end. In all there was a decrease in the number of routine ore studies and an increase in the number of fundamental research projects.

Physics and Electronics The demand for standard radioactive ore samples for calibration of assay equipment has increased steadily. One hundred thirty-five were distributed mainly to Canadian mines but some to companies in Australia, Tanganyika, Italy and Finland. The Branch made 1,200 radiometric assays during the year and carried out intensive research on the use of gamma-ray spectrometers in uranium and thorium determinations, the analysis of airborne dust samples and in various laboratory investigations.

Radioactivity has become a valuable tool in many fields. The Branch designed and built an automatic inspection device for Canadian Arsenals Limited. It advised on industrial applications of radioactive isotopes and set up counting equipment to assist the Geological Survey of Canada in the age determination of zircon minerals. Extensive work was carried out in measuring the attachment of radioactive tracers to mineral particles—of importance to mineral-flotation research. A new method of using a radioactive timer for measuring the viscosity of ground-ore slurries was also under investigation.

The UNESCO International Conference on "Radio-Isotopes in Scientific Research", Paris, 1957, was attended by one of the senior officers.

Chemical Analysis In routine assays there was not the volume of previous years when the ore-treatment laboratory carried out continuous pilot plant runs for a succession of uranium mines. Instead, the work covered a broad range of research, some of which was of a more fundamental nature. During the year 7,306 assays were completed on 4,935 samples, involving 9,587 determinations many of which were both difficult and time-consuming.

In 1957, the Branch sought to develop improved analytical methods in determinations of silica, ammonia, nickel, chromium, niobium, zirconium, rare earths, thorium, uranium and of organic solvents used in extraction procedures.

General A manual compiling all analytical methods used by the Mines Branch in uranium ore processing has been prepared. Intended primarily for the benefit of the Canadian uranium industry, it includes sections on laboratory planning, sampling and errors, uranium ore chemistry, uranium recovery and an extensive bibliography.

Ten technicians from private industry used Branch laboratories to study various aspects of uranium ore processing and radiometric or chemical analysis.

Physical Metallurgy

Activities in physical metallurgy in 1957 included fundamental research on the properties and behaviour of metals; development of new alloys; the improvement of metal-working, welding, and foundry techniques; and technical service to industry.

Investigation Non-destructive testing was an important aspect of the work. This included the ultra-sonic inspection of raw steel and aluminum bronze for the occurrence of flaws; the study of wear and service failures in various machine components; and sonic velocity measurements to determine the tensile strength of rock—data that will permit more effective use of explosives.

Of considerable value in non-destructive testing is the crack-depth indicator developed by the Branch for the early detection of incipient cracks caused by fatigue. The instrument was used to study the initiation of cracks in jet-engine turbine blades, to investigate defects occurring during the rolling of silicon-bronze plate and to test many other metal components and pieces of equipment.

Of interest to the lumber industry is a project to develop a more efficient circular saw, one that would reduce waste in log cutting operations. Tests were carried out under working conditions on a 48-inch circular saw plate operating at 700 revolutions per minute with the object of designing a 30-inch model of smaller thickness to operate at more than five times the speed.

One of the prime needs of newsprint manufacturers is a more durable fourdrinier wire screen, the device used to feed watered pulp to the paper machine. In cooperation with the Canadian Pulp and Paper Research Institute, the Branch continued to investigate the factors affecting the service life of fourdrinier wires under increased paper-machine speeds and showed that wear was the principal cause of failure. Moreover, an apparatus was designed to test the wear resistance of various alloy wires under working conditions. Also investigated were the fundamentals of wearing phenomena and the mechanical properties of single strands and woven wire cloth.

Engineers examined faulty welds in boiler-economizer units aboard several destroyer-escort vessels where serious leaks had occurred. They not only advised on the action necessary—a complete re-welding of all the joints—but appraised the welding procedure and examined radiographs of the re-welded joints.

A project in ferrous metallurgy has made possible a reduction in the cost of highway snow removal. The first stage in a program to evaluate the wear characteristics of snow-plow shoes produced from five different materials was completed. Nickel-hardened iron and chilled nodular iron were found to be less subject to wear and, in the long run, less costly than the cast irons in general use. The Branch also recommended design changes that would increase the efficiency of the snow-plow shoe and reduce its weight.

Field inspections and metallurgical examinations were made of "forward" and "aft" wing-hinge fittings from R.C.N. Banshee aircraft. Detection of fatigue cracks in the forward hinge fittings resulted in their redesign and replacement with recommendations made for changes in the manufacturing procedure.

Another project concerned the development of a lightweight ladder of sufficient strength to meet public safety requirements. Load-deflection tests were conducted on sample lengths of magnesium-base alloy and laminated rail with the aim of producing a composite ladder of the required load-bearing characteristics.

The Branch was consulted by the St. Lawrence Seaway Authority on the welding, casting, forming, and designing of various units such as lock gates, stop logs, lifting booms, segmental cast-steel girders, and steel for barges. Plants manufacturing some of these were visited and advised on production problems.

Engineers also visited several shipyards to examine production radiographs and to instruct naval and company personnel on inspection methods.

A unique investigation was carried out on an iron specimen from an historical site in the province of Quebec. Metallurgical examination showed that the sample was a primitive form of wrought iron which had been reduced and forged on the north shore of the St. Lawrence River at some time early in the nineteenth century.

Much of the work in mechanical testing involves the establishment of specifications and standards. A major project, previously reported, was the determination of conversion factors to correlate elongation values of steel tension test pieces to British and United States' standards. A similar program was carried out in 1957 on specimens of wrought copper, magnesium and aluminum-base alloys.

Development The Branch continued its program to improve the quality of zinc and its products. The work again involved pressure-die-cast alloys with tests to determine the effect of certain additives and rolling trials to ascertain whether the alloys may be used in the manufacture of wrought products.

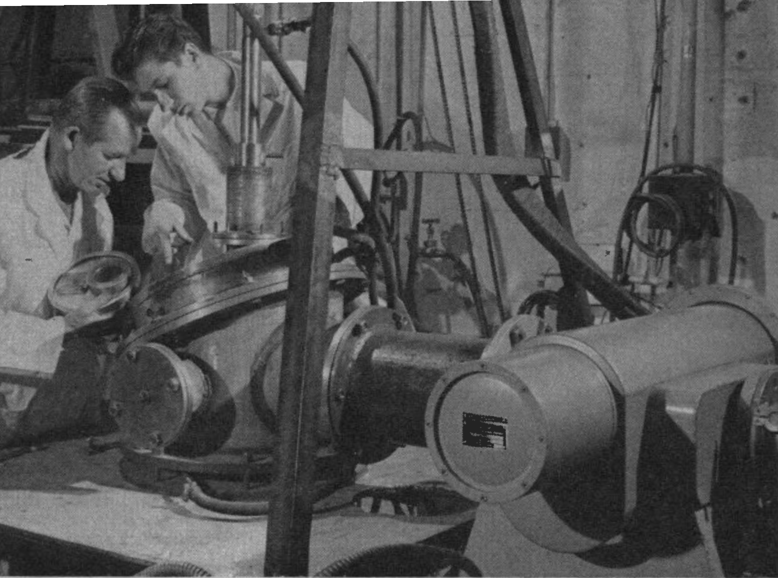
Further studies were made to improve the quality of galvanized coatings with apparatus for the work designed and built at the Mines Branch. Given special attention were such factors as the composition of the galvanizing bath—especially the lead and aluminum content—the immersion time and temperature and the surface finish of the steel. Both studies were conducted in cooperation with the Canadian Zinc Research and Development Committee.

Research was continued on the application of spiral rolling and differential plastic deformation to drill pipes. The four different models of spiral-rolling machines developed for these projects are covered by Canadian Patent No. 538222. Being used to test the finished product were three types of laboratory drilling machines developed by Mines Branch engineers. The entire project should lead to a durable and economical attachment for efficient mine drilling operations.

Techniques were developed for melting a wide variety of metals and for producing titanium alloys. The study of pressure distribution within a consumable-electrode, arc-melting furnace was completed. This work established a method for determining by calculation the correct electrode size, furnace size, pumping capacity, and operating pressure for furnaces of this type and of any capacity.

A method was developed for improving the quality of reclaimed motor-vehicle components. It is common practice to restore used steel parts to their former dimensions by electro-plating with chromium and sometimes with nickel, but these electro-deposits create serious tension stresses that reduce the fatigue-strength of the component. After investigating the problem it was shown that shot-peening—a process commonly used in metal work—prior to electroplating would counteract this effect.

The rapid development of northern areas has created a demand for data on the welding of structural steel in Arctic temperatures. The Branch conducted a series of tests in a refrigerated room and showed that welding under temperatures down to —80°F. was no more difficult than welding a slightly greater thickness of steel under normal conditions. As part of the



The Mines Branch has developed techniques for melting a wide variety of metals and for producing titanium alloys. Of considerable value in this work is the consumable-electrode arc furnace designed and built by the staff. The equipment, shown here as technicians prepare it for a melt, can produce ingots up to $4\frac{3}{4}$ inches in diameter.

project an instrument was developed for accurate measurement of transverse contraction caused by cooling and to indicate any occurrence of cracking in the weld.

In the field of military materials the Branch's success in producing lightweight base plates for the three-inch mortar has lead to the development of larger units both of forged aluminum and cast magnesium. Initial service tests and firing trials on the larger plates were extremely encouraging.

Because small quantities of entrapped gas affect the behaviour of metals—both ferrous and non-ferrous—under stress, gas analyses are an important aspect of the research work in physical metallurgy. In 1957 the Branch's gas analysis laboratory was equipped with a vacuum hot-extraction apparatus for rapid determination of the hydrogen content of steel. The unit, designed and built by the staff, permits fast, accurate tests to be carried out at low cost. Gas analyses were made of various metals including cobalt, nickel, copper, titanium and a number of steels.

Another investigation concerned the design of jumper pins used by the Canadian Army Signals Engineering Establishment in driving holes for signal-wire poles. While being driven into the ground the pins failed, their heads disintegrating; but a hollow pin with a welded head and point designed by the Mines Branch gave excellent results.

Other projects undertaken by the Branch included a critical study of aging treatments in precipitation-hardening of an aluminum-magnesium casting alloy; research toward the development of an alloy-steel chain for marine applications; development of a practical means of welding the thin-walled, copper-nickel-iron piping used in vessels of the Royal Canadian Navy; and providing special materials for Atomic Energy of Canada Limited. In addition, the Atomic Energy Divisions of Canadian Westinghouse Company Limited and Canadian General Electric Company Limited were given advice and technical help on nickel-iron and zirconium alloys.

Research Fundamental to the study of alloys is the constitutional diagram —a graph showing the number, composition and proportion of alloy constituents at any given temperature. The Branch determined the titanium-rich corner of the titanium-aluminum-molybdenum constitutional system for temperatures of 800°C., 900°C., and 1000°C., and the resulting diagram will be used to design an alloy of certain specific properties. The aim of this work, however, is not so much to arrive at a specific alloy composition but rather to test an alloy-design method making use of constitutional-diagram data.

Basic research continued on the viscosity, fluidity, and hot-tearing characteristics of various alloys; and on factors affecting grain size, mode of solidification, and the mechanical and physical properties of cast alloys.

In the X-ray laboratory new advances were made both in the theory and technique of determining crystal structures and atomic distribution in crystals. This knowledge is fundamental to an understanding of the forces holding solids together.

Imperfections in metals were observed directly by new techniques in electron microscopy. Since flaws control the ductility and yield strength of

Because small quantities of entrapped gas affect the behaviour of metals—both ferrous and non-ferrous—under stress, gas analyses are an important aspect of research in physical metallurgy. A technician is conducting a test to determine the hydrogen and nitrogen content of steel.

all metals and alloys, the fact that they can now be observed and studied directly will greatly further our knowledge of mechanical metallurgy. It has already led to a better understanding of the mechanical behaviour of iron.

Other fundamental projects concerned flow and fracture phenomena in metals. Particular attention was given to the strength and embrittlement of aluminum in creep-rupture tests and the effects of its main impurities, iron and silicon.

Industrial Minerals

Interest in industrial minerals continued at a high level with a heavy demand for research in this field. Over 1,500 samples were received of which 607 were subjected to laboratory milling tests. Another 293 were examined in the mineralogical laboratory and over 1,300 chemical determinations were made (Appendix VIII, Table 2 presents an analysis by province of the samples under investigation). Technical enquiries received and replied to amounted to 1,731. Three monographs were published during the year—two on industrial waters and the third dealing with the industrial minerals of Newfoundland.

Milling Milling and beneficiation work was undertaken on material from deposits of barite, feldspar, fluorite, garnet, kyanite, pyrophyllite, quartz, and spodumene. In each instance a practical process yielding a product of marketable grade was developed on a laboratory scale.

Work is proceeding on processes for the recovery of zeolites from amygdaloidal basalt in Nova Scotia. Though no practical methods of recovering them from natural deposits is presently known, the flotation studies underway here show considerable promise. Synthetically-prepared zeolites have been used for some time in water softening and, more recently, for purifying high-energy fuels. A process for the concentration of naturally-occurring zeolites may provide the foundation for a new industry.

Assistance continued to be given to a company formed to develop the newly-discovered kyanite deposits of the Sudbury district. Research on methods of floating kyanite from its gangue minerals has now enabled an excellent recovery—consisting of 99 per cent kyanite—to be made. This is of a greater degree of purity than any other produced on this continent.

Another project concerned the possibility of recovering potash from deep-seated deposits by solution. The mineral occurs in rich beds extending across the central part of Saskatchewan.

Non-Metallic Minerals Field and laboratory studies were carried out on the occurrence, recovery and use of non-metallic minerals. An example of this work is the comprehensive study undertaken of asbestos fibre to correlate the mineral's physical and chemical properties with its performance in industry.

Fifty-three samples of sand and sandstone from deposits in various parts of Canada were examined and processed as part of a project to locate possible sources of low-iron silica for the glass industry.

With the approaching depletion of deposits of high-grade gypsum in several areas, attention was directed to methods of beneficiating material from low-grade deposits. In this research, air classification was successfully employed to remove certain impurities from a large deposit in Ontario, permitting it to be used as a source of raw material for the production of high-quality finishing plaster.

Construction Materials Research for the construction industry was concentrated mainly on problems associated with aggregates used in concrete. A serious problem in several parts of Canada concerns an unfavourable reaction, between cement and certain kinds of rock used for aggregate, that causes the concrete to swell and crack after a relatively short period. Extensive investigations are being made to explain this phenomenon and to find ways and means of overcoming it.

Work on lightweight aggregate was continued with emphasis on newly-discovered sources of raw material. Studies were made of fly ash, an industrial waste from steam-generating plants using coal as fuel. Laboratory work showed that a lightweight product of good quality could be made from this material. Bulk samples of waste shale from stripping operations in the Minto coal field of New Brunswick also yielded lightweight aggregate of good quality.

An investigation was started on the possibilities of producing a lightweight cellular concrete directly from Nova Scotia oil shale and limestone. A major advantage is that the oil in the shale would supply part of the fuel required in the calcining stage of the process. Cellular concretes weighing about 40 pounds per cubic foot and possessing excellent insulating properties can be made by this process.

Research was undertaken on the production of heavy concrete which has been found effective in shielding personnel and equipment from the effects of radiation from nuclear reactors. Ferrophosphorus, a by-product of

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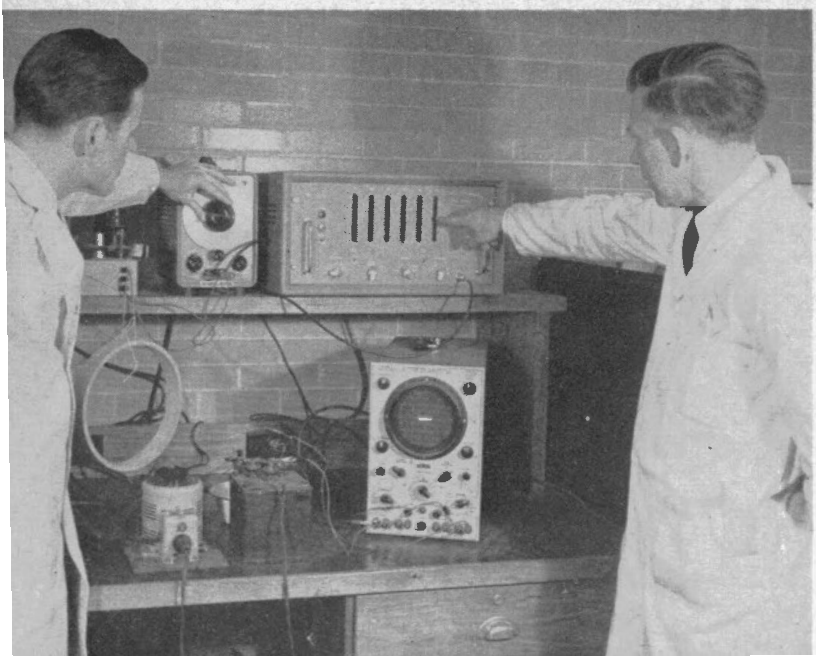
the phosphorus industry was used to produce a concrete weighing 300 pounds per cubic foot. Ilmenite, an abundant mineral in Eastern Canada, gave a concrete weighing 240 pounds per cubic foot.

Industrial Waters Surveys of the chemical quality of water in the major watersheds of Canada, in progress since 1948, were nearly completed. Seven reports on the survey have been published; two others were completed during the year and will shortly be available. In 1957, special surveys of irrigation and glacial waters in British Columbia were undertaken for the federal Department of Agriculture and the University of British Columbia. Studies were continued of boiler waters and boiler-water treatment for Canadian and United States military establishments in Northern Canada.

Specialized research work concerned analytical methods for determining minor chemical constituents present in most waters; a study of water-corrosion problems; and technical assistance to industry, municipal and provincial governments. More than 1,300 water samples were analyzed during the year.

Ceramics Work in ceramics covered a wide range of products and processes. A project for the development of high-temperature ceramic products and a study of clay mineralogy were initiated. In the latter work, 175 samples of Canadian clays and shales were examined by X-ray diffraction, by differential thermal analysis, and by other techniques. The project is designed to further a basic study of Canadian clays and to assist the Canadian clay-working industry in solving its problems.



Ceramic electronic components promise to have wide applications in sound detecting and other military application and in industry as well. Here Branch engineers are checking the activity of a piezoelectric ceramic developed in its laboratories.

Work on barium-titanate products for use in piezoelectric devices was continued. The Naval Research Establishment at Dartmouth, Nova Scotia was supplied with a large number of discs for experimental work, and assistance was given to a Canadian company producing this type of ceramic. Research was also initiated on the development of magnetostrictive materials which have similar applications to barium titanate.

Research on the use of Canadian kyanite as a raw material for the production of super refractories was continued and high-alumina bricks were developed possessing outstanding refractory properties.

Fuels

With the coal mining industry suffering the loss of a substantial portion of its market, the Branch continued to evaluate every possibility whereby technology might contribute to new and permanent uses of Canadian coal. Major emphasis was given to research on the use of coal for the production of thermo-electric power, in various metallurgical processes and in other applications.

Also sought were techniques to improve the quality of low-grade Canadian crude oils and high-sulphur bitumens occurring in substantial quantities in Western Canada.

In all, the fuels laboratories dealt with 1,969 solid, liquid and gaseous samples, involving 25,573 determinations. Samples of mine air, analyzed for reasons of safety, came from both coal and metal mines and represented a wide range of atmospheres contaminated with explosive gases, blasting fumes and diesel exhaust. Determinations for the *Analysis Directory of Canadian Coals* included 148 samples of commercial coal collected, mainly by divisional officers, from 28 mines in the Atlantic provinces and from 15 mines in Alberta and British Columbia. The technical staff also investigated and was consulted on the efficient use of fuels.

The Electrical Certification Laboratory continued to be used for the testing and certification of electrical equipment operated in hazardous (explosive gas) locations.

Petroleum Research

The key to improved oil refining procedures lies in the discovery of better methods of catalyzing the chemical reactions involved. To develop this new scientific frontier a laboratory was constructed for research on the effect of intense gamma radiation upon solid catalysts as well as upon the reacting hydrocarbons. Work is now in progress on a study of the decomposition of hydrocarbons—a project that will open new areas of research on coal and oil.

Of considerable interest to the petroleum industry is a project to develop better methods of removing sulphur from distillate oils. Hydrodesulphurization was studied from two points of view: understanding the chemical mechanism of sulphur removal from pure compounds, and establishing the optimum conditions for the production of gasoline and diesel oil from a given crude, or distillate. Having demonstrated that high-quality diesel oil can be produced under hydrogen pressures of 10,000 pounds per square inch, the fuels staff evolved a system of determining, from accumulated experimental data, the best operating conditions for producing these fuels in any proportions.

Extensive work was undertaken to improve the techniques of making hard pitch from low-grade, western Canadian crudes. This project, designed to give immediate assistance to small refiners, promises to make available a cheap source of asphalt for road construction in Northern Canada. Moreover, it is forseen that great savings can be achieved through the eventual use of Athabasca bitumen.

Considerable progress has been made toward the development of a satisfactory method for characterizing and classifying oils and bituminous substances by a new ring-analysis technique. The technique was successfully tested on pure compounds of known structure and should offer a systematic means of studying naturally-occurring hydrocarbons.

Research on Coal

Evaluation of Coal Tar Pitches Because carbon and products of coal are required by a number of Canadian industries (aluminum manufacture, for instance, requires large quantities of coal tar pitch) an investigation was undertaken of the chemical constitution of pitches. Infrared absorption studies were made of numerous pitches and pitch fractions for a detailed insight into their structure. This research, which has resulted in a much better understanding of the chemical requirements of good pitch binders, earned the Bituminous Coal Association Award for 1957.

Cyclone Smelting For some years experiments have been conducted in cyclone smelting with the objective of producing pig iron by the direct use of coal fines in low-cost equipment. With consideration

In their search for practical methods of refining low-grade oils and bitumen, technicians make use of a hydrogenation pilot plant. Seen here is the plant's electrically heated, insulated reaction chamber as it is lowered into the outer pressure vessel.

being given to an oxygen-enriched blast, a study was begun of the gas phase reduction of ore particles in a small-scale apparatus.

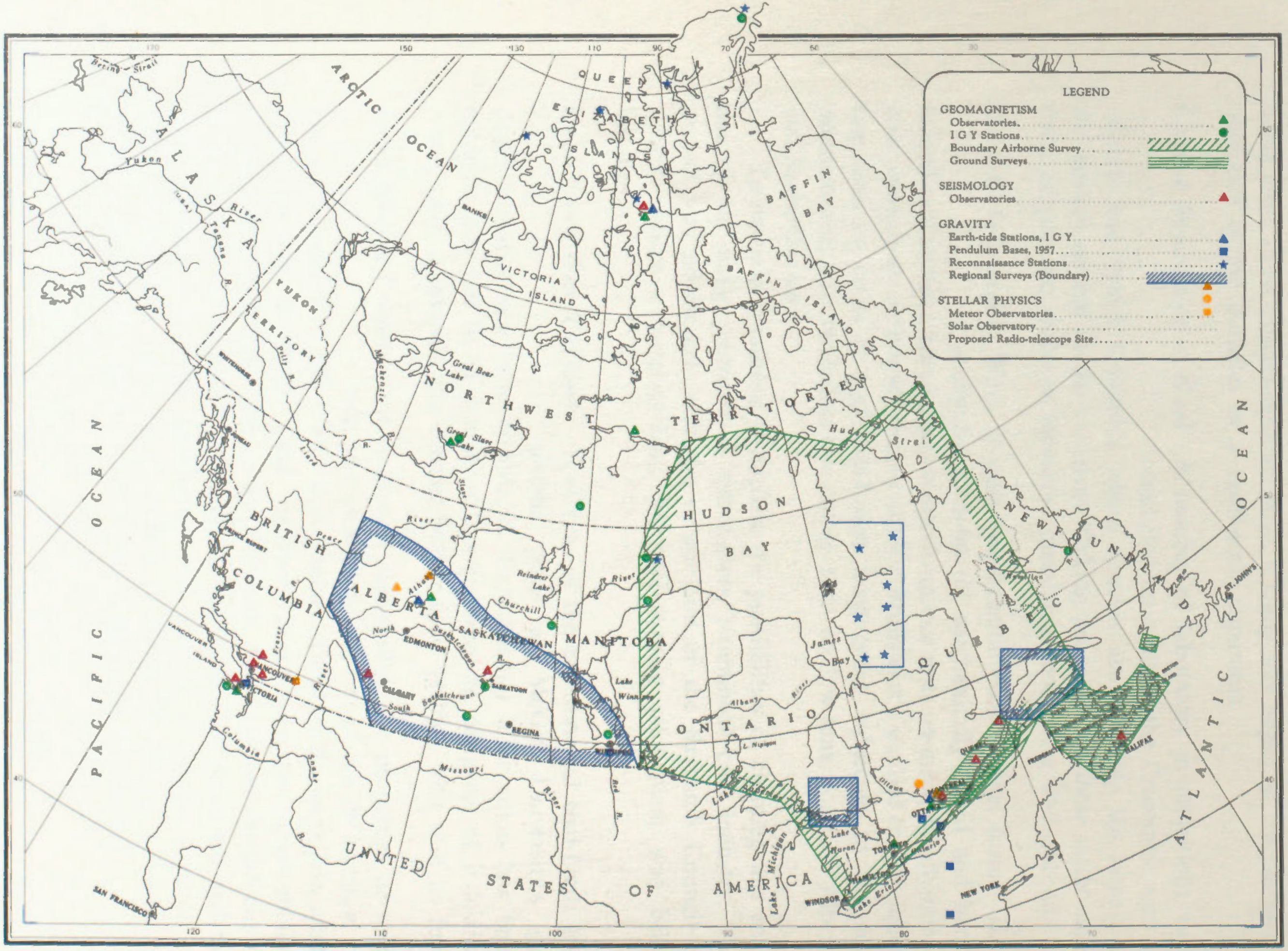
Coking Properties of Coal A number of laboratory investigations were conducted on coals of the Crowsnest area of Alberta and British Columbia where reserves are probably the largest in the western section of the continent. Coking properties of these coals make them of possible value in industrial metallurgy both here and abroad.

Coal Beneficiation Work in coal beneficiation took several forms: size-comparison studies of mechanically-mined and hand-loaded coal in Nova Scotia; cleaning-performance tests on mechanically-mined coal; storage-characteristics studies of New Brunswick's washed coal; briquetting tests on coals of high ash-fusion temperature subjected to chemical pretreatment; and binderless-briquetting tests on low-rank coals of Alberta and Saskatchewan.

Technicians continued to explore the possibilities of cleaning fine coal, one of the major problems of the western bituminous coal industry. The project was undertaken with the cooperation of the Research Council of Alberta where a water-cyclone, fine-coal-cleaning pilot plant was being installed.

Coal-Fired Gas Turbine Trial runs of the experimental coal-fired, gas-turbine plant at McGill University's gas dynamics laboratory were completed. Experimental information has been obtained that will be of considerable importance to designers of industrial power units employing the exhaust-heated cycle turbine with coal as fuel.

Deep Mining Project The fuels staff also studied the properties of mine rock and took measurements of the deformation of strata, the strength of pillars, etc., in coal mines. These studies were principally concerned with the "bump" and "outburst" phenomena that makes mining at depth both hazardous and costly. Although the work was carried out in Alberta, Nova Scotia and Newfoundland, the techniques developed and the data collected have wider applications and will aid in the investigation of many ground-stress and rock-mechanics problems. Assistance in some of these studies was provided by the Nova Scotia Research Foundation.



THE DOMINION OBSERVATORIES COMPRISE, THE DOMINION OBSERVATORY AT OTTAWA, THE DOMINION ASTROPHYSICAL OBSERVATORY AT VICTORIA, BRITISH COLUMBIA, AND THE AUXILIARY OBSERVATORIES AND OUTSTATIONS SHOWN ABOVE.

Dominion Observatories

The Dominion Observatories study astronomy and the physics of the solid earth, subjects apparently unrelated but which have this in common—they both apply the methods of physics to the study of man's physical environment. The stars and the earth provide a laboratory on the grandest scale—a combination of physical conditions, of temperature and of magnetic and gravitational field, which cannot be duplicated by man. Much of the Branch's work is in fundamental research, but it also deals with the severely practical problems of earthquakes, magnetic declinations, and the determination of accurate time.

The Branch operates two main observatories, the Dominion Observatory at Ottawa and the Dominion Astrophysical Observatory at Victoria, and the large number of auxiliary observatories and out-stations shown on the accompanying map. The Victoria Observatory is concerned chiefly with astrophysics, although it provides facilities for seismological and magnetic work. The Observatory at Ottawa does work in astronomy and astrophysics and in three branches of geophysics: gravity, geomagnetism, and seismology.

Observatory scientists in 1957 made a major contribution to the accurate determination of gravity values by their completion of a set of pendulums more accurate than any in the world. In another project, they have designed and are now assembling a new photographic instrument, the mirror transit, the first of its kind known, which will give the positional astronomer a valuable assist in the accurate determination of star positions. Looking to the study of the stars and of the outer atmosphere beyond the reach of traditional astronomy, the Observatory is expanding its astronomical research to include radio astronomy. This penetrates the curtain of atmospheric and interstellar dust and receives a much greater range of wave-lengths, increasing by as much as ten times the distance men can see by traditional astronomy methods.

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Much Branch activity in 1957 centred about participation in the International Geophysical Year which was set up to provide world-wide observations and measurements of geophysical phenomena. Most geophysical phenomena affect the whole world, and they can be understood only if they are observed all over the world, at the same time, with similar instruments; all of which requires a very high degree of international cooperation. The International Geophysical Year—the IGY—began on July 1, 1957, and will continue throughout 1958. Some 50 countries are participating in the IGY program.

The most spectacular event of IGY so far has been the launching of the Russian *sputniks*. Thinking had been in terms of a United States satellite, and as it was not expected to be visible from Canada, no preparation had been made for this sort of observation. However, the Branch quickly set up a volunteer observing program. It made timed theodolite observations and obtained photographs of the first, and later of the second, object against a fixed background of stars. These data, combined with those of other observers, allowed IGY mathematicians to compute the orbits of the satellites and to provide observers with accurate forecasts. In a short time, the Branch was supplying IGY data centres regularly with information on the orbits, and keeping the press in Ottawa and throughout Canada informed on times that the objects would be visible over particular cities.

The precise determination of the orbits is of great geophysical interest for they are influenced by anomalies in the earth's gravity, and the rate at which the objects slow down indicates the density, and possibly the electrical and magnetic properties, of the upper atmosphere. Astronomy is thus providing data for geophysics.

Dominion Astrophysical Observatory, Victoria, and The Stellar Physics Division, Dominion Observatory, Ottawa

The astrophysicist is interested in the composition and physical conditions of stars and of other materials of outer space. His chief tool is the spectrograph, which breaks the light from the star or other source into a spectrum. The lines in this spectrum tell the astrophysicist the material of which the star is made and the physical conditions of the material. The displacement of the lines from their normal positions gives the velocity of approach or recession of the star or source. Clouds of interstellar material between the source and the observer modify the spectrum and these modifications make possible detailed study of the clouds. A second tool of the astrophysicist is the photometer which allows him to study the variation in the light sent out by stars and to compare the luminosities of different stars.

A new tool, the radio telescope, has been added to those available to the astrophysicist. It has been found that radio waves are reaching the earth from many parts of the universe. Much of this radiation comes from sources which are invisible with optical telescopes, some of it from sources beyond the range of even the greatest optical reflectors. The Branch is entering this fascinating field of research with the construction at Penticton, British Columbia, of a parabolic antenna 84 feet in diameter. When completed this will be one of the largest radio telescopes in North America. The new telescope will also extend viewing time considerably for it permits viewing in cloudy or rainy weather and in full sunlight, when optical observations are impossible. It is expected to be in operation in 1959. A senior member of the Observatory staff has been studying the operation of the giant radio telescope at Manchester, England, in preparation for the operation of the Branch's new telescope.

The two sections of the Branch studying astrophysics have different facilities and study different problems. The Dominion Astrophysical Observatory uses its 73-inch reflecting telescope for the study of distant stars. The Dominion Observatory at Ottawa does not possess a large telescope and concentrates instead on the study of the sun and of meteors.

In 1957, the Dominion Astrophysical Observatory used its 73-inch telescope to obtain 1,528 photographs of stellar spectra for various projects. It is particularly interested in studying the properties of large double stars, especially the gravitational and tidal effects which they exercise on each other. It also studies variable stars to investigate conditions in the outer layers of stars, to study the past history of stars as revealed by their motions, and to study the way in which stars have been formed. These studies are valuable because they allow the physicist to understand the behaviour of atoms at pressures and temperatures much more extreme than are possible in the laboratory.

The operation of the 73-inch telescope must be carefully programmed. Each scientist has one or more problems for which he is allotted certain observing periods with the telescope. Many programs go forward at the same time, each observer obtaining data and reducing it in a systematic

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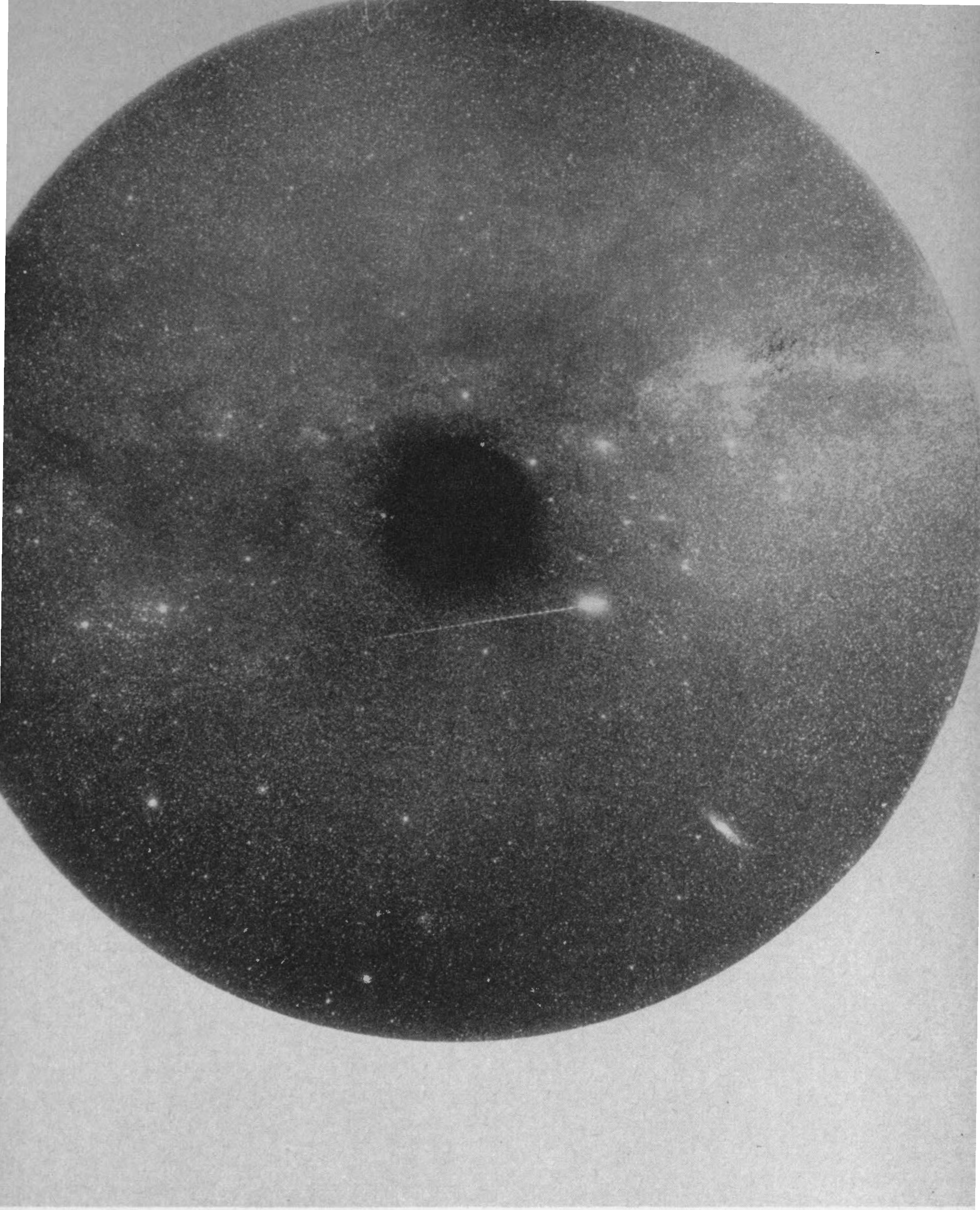
way. Many of the problems could be studied with a smaller telescope and, for this reason, the Dominion Astrophysical Observatory plans to acquire a 48-inch reflector.

The Astrophysical Observatory played host to more than 22,500 visitors during 1957.

Solar physicists at the Dominion Observatory at Ottawa had a particularly busy year. The maximum of the sunspots cycle occurred during the year, and the number of large spots and solar flares is expected to be very large in the period immediately following. As these flares are responsible for auroral and magnetic disturbances, Observatory physicists have a broad observation program in hand during IGY—work which is fundamental to IGY work. They are taking photographs of the sun at half-minute intervals throughout every clear day, with a special filter which permits the flares, which are normally invisible, to be photographed and timed. The observations of the flares are reported to central IGY agencies where they are available for comparison with records of magnetic and ionospheric observations. Observatory physicists are also obtaining spectra of the sunspots and of the solar limb, which provide data on the physical make-up of the solar atmosphere. It is hoped that these studies will pave the way to the forecast of optimum radio frequencies for radio communications and similar purposes.

The Dominion Observatory at Ottawa has under way a three-pronged program of study of meteors and meteor craters: (1) meteor photography and spectroscopy at Ottawa and at Meanook and Newbrook in Alberta, (2) observations of all meteor showers, and (3) a systematic search for fossil meteor craters. The observatories at Meanook and at Newbrook, Alberta, are equipped with the most modern meteor cameras, synchronized to obtain simultaneous photographs of meteors. A study of these photographs makes it possible to determine the rate at which meteors slow up on entering the earth's atmosphere. This information is valuable in the design of guided missiles and similar problems. During meteor showers, observations are carried out at Ottawa and spectrographs are operated both in Ottawa and in Alberta. The spectrograms thus obtained give information on the nature and condition of the material making up the meteor and the luminous trail behind it.

The Observatory is carrying out a search for meteor craters, very old craters which have been covered with sedimentation over a period of hundreds of thousands of years, to permit comparative studies of the topography of the earth and the moon. For many years it has been uncertain whether the



This bright meteor was photographed at the Branch's observatory at Newbrook, Alberta. A rotating shutter in the camera interrupts the trail 60 times per second. The shutter mount obscures the small central region. The meteor moved from left to right and ended in a bright flare. The spiral nebula in Andromeda is prominent in the lower right. The Milky Way is also seen on the right above the meteor.

craters on the moon are the result of volcanic eruption or of meteoric impact. Many astronomers favour the latter hypothesis. In 1957, Branch scientists studied, by means of diamond drilling, a suspected meteor crater, discovered earlier at Holleford, about 20 miles northwest of Kingston in southeastern Ontario. The crater is filled with limestone but, on the supposition that it is of meteoric origin, Observatory mathematicians had computed the depth to the original surface. Three holes were drilled, one close to the centre of the crater, one near the inside of the rim, and one near the outside of the rim. The depth of the limestone in these holes agreed almost exactly with the mathematical forecast. Beneath the limestone, a great thickness of shattered rock was found, lending strong support to the theory of meteoric origin.

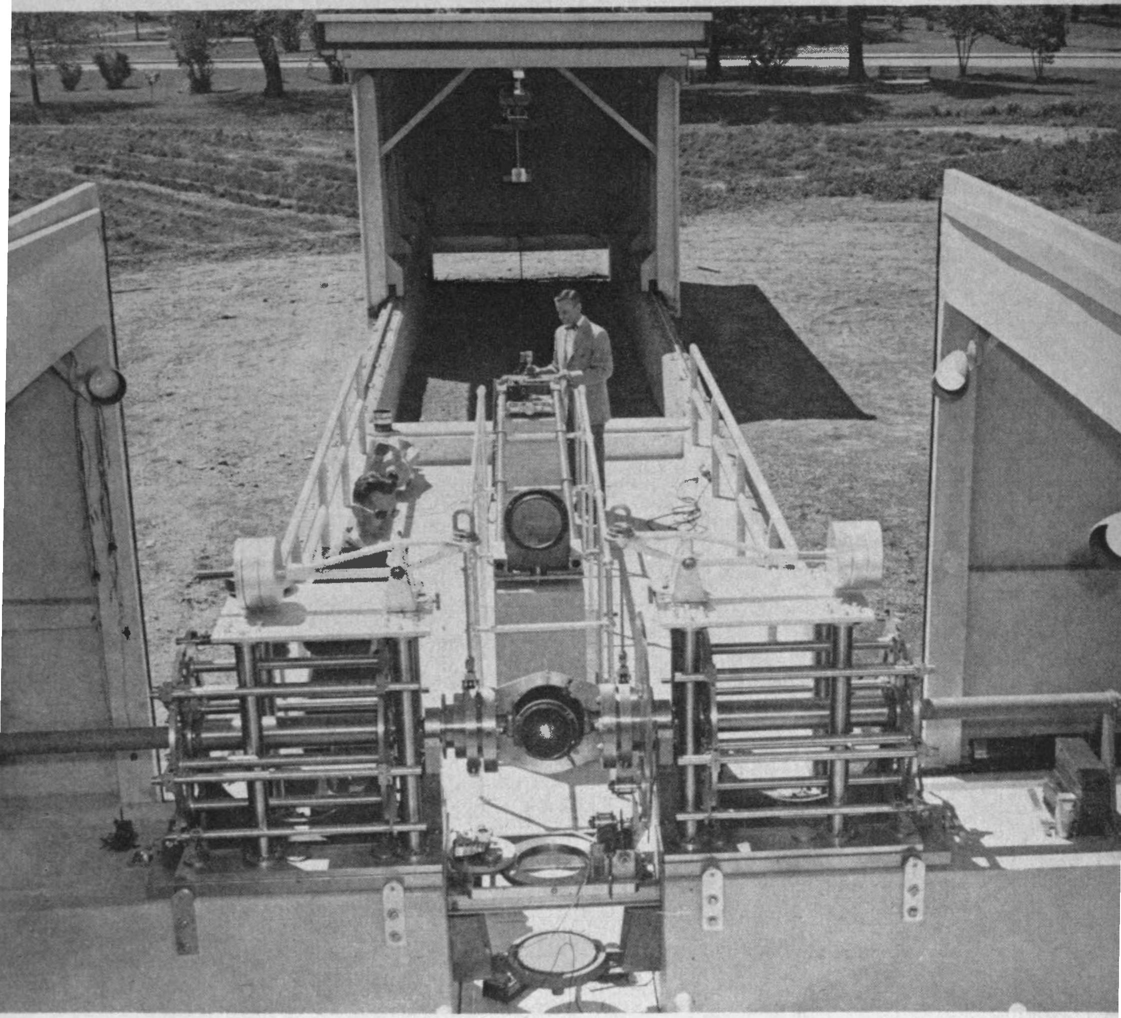
Dominion Observatory, Ottawa

Positional Astronomy

The astrophysicist is interested in *what* stars are, the positional astronomer in *where* they are. The work of the positional astronomer falls into two parts: in the first, the positions of accurately known stars are used to determine the correct time, and in the second, precise astronomic methods are used to determine the positions of less well known stars for application in navigation, surveying, and fundamental astronomical research.

Observatory scientists maintain the Canadian time service. They use the stars to rate, to within one ten-thousandth of a second, a set of standard clocks maintained by the Observatory, and distribute the time from this standard to Canada by means of short- and long-wave radio and by telegraph. They compare the time of these clocks with the stars by means of a special telescope called the photographic zenith telescope, which photographs the transits of well located stars as they pass directly over the Observatory. This has two advantages: it is easier to maintain a telescope in the vertical than it is to measure angles, and the use of photography eliminates human error. In all, 3,377 stars were photographed by the instrument in 1957 and used for determinations of accurate time.

In their work on the determination of the precise location of stars, Observatory scientists measure the times of transit of stars, and compare them with the transit of stars which are already well located. In 1957, they observed 8,835 transits. They do this visually with a telescope set up to swing in the meridian through the Observatory. It requires many observations



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, the first of its kind known. It brings to the determination of star positions the same sort of accuracy which the photographic zenith tube brings to the determination of time.

and the use of elaborate statistical methods to determine star positions with sufficient accuracy, and observatories throughout the world cooperate in carrying out the various programs. Some of the programs provide locations of additional stars for time determination, others for use by surveyors, and still others to help astrophysicists by measuring the rate at which star positions change over the years. There are 6,402 stars in the current program.

The Observatory made much progress in the preparation for the use of the new photographic instrument, the mirror transit, which it has designed to meet the need for the high accuracy required in the determination of star positions. This new instrument is as accurate in this work as the photographic zenith tube is in the determination of time. The building for the mirror transit has been completed and the instrument itself is being assembled.

The rotating earth, which provides man with his basic clock, is not as accurate as previously supposed. It slows down a little in the spring and speeds up again in the autumn, and it wobbles on its axis so that the latitudes of observing points vary slightly. The Observatory contributes to the study of these phenomena by reporting its observations of latitude variations and time determinations regularly to international offices. In addition, it is one of 20 observatories cooperating in a special IGY program of securing accurate, timed photographs of the moon against the background of stars. Aberrations in the earth's rotation have a negligible effect on time measured in this way, and the program will ultimately provide information on the rate at which the earth is slowing down, on the distance between points on the earth's surface, and on whether continents are drifting towards each other. (Geologists have thought for many years that continents may have drifted over great distances during geologic time; for example, it is thought that Africa and South America may once have been a single land mass.) If this drifting is still occurring, the great accuracy of the moon-camera method should detect it. Positional astronomy will thus help the physicist by defining the basic unit of time and, at the same time, may provide the geophysicist with an answer to this fascinating question of continental drift.

Geomagnetism

The Observatory continued to carry out a many-sided program of work in geomagnetism. The study of the earth's magnetic field is a never-ending task as the field varies from point to point; fluctuates, at a given point, from day to day; and over the years, shows a progressive change.

One of the Observatory's major projects is centred on research into the source of the earth's magnetic field and the causes of its variation. The methods of the research are partly mathematical and partly experimental, but a knowledge of the magnetic field all over the world is necessary to the solution of the problem. Canada's responsibility in the matter is particularly heavy because the north magnetic pole lies within its borders, and detailed magnetic surveys must be provided for all of Canada and repeated at regular intervals. In this work, the Observatory uses the unique three-component airborne magnetometer which it developed a few years ago. In 1957 it used the instrument to survey Ontario and Quebec. Previously, it had carried out magnetic traverses over the Atlantic.

Magnetic measurements have a very practical value in topographical mapping, for air and marine navigation charts, and for the use of land surveyors and commercial prospecting agencies. During 1957, the Observatory supplied 1,221 items of magnetic data to mapping agencies and issued detailed declination charts for the three Prairie Provinces.

A most interesting way in which to study the changes of the magnetic field is through research in fossil magnetism. Observatory scientists have built a highly sensitive magnetometer with which to measure remanent magnetism in rocks. When igneous rocks solidify, or when sedimentary rocks are laid down, the individual particles tend to align themselves with the magnetic field. By measuring the remanent magnetism in these rocks, it is possible to map changes in the magnetic field throughout geologic time. The Observatory's new magnetometer is so sensitive that it will detect the magnetic properties in a piece of cellulose tape.

In the earth's magnetic field, there are several sorts of rapid variations, all of them connected with extra-terrestrial agencies, particularly of sun spots. To study these variations, the Observatory maintains seven magnetic observatories throughout Canada where it obtains continuous records of all the magnetic components. It interprets these records, sends the results to several central agencies, and compares data with groups studying the upper atmosphere. The study of sources of magnetic disturbances is a major project of the IGY program of work. These disturbances are of interest, for instance, to radio astronomers whose instruments are affected by severe storms, and to prospectors who use magnetic instruments in the search for orebodies and who must be able to correct them for the daily variations. To assist in unravelling the several sources of disturbances, the Observatory supplied magnetic instruments of its own design to 11 stations (*see* map) set up especially for the period. Data from these stations have been supplied regularly to IGY centres and to the Observatory, but reduction cannot be completed until more data have been accumulated.

Gravity

The value of gravity varies from place to place and, at a given place, from time to time.

The time variation is due to the tidal effects of the sun and moon. The variation is not large, but it provides important data on the rigidity of the earth. For this reason, the IGY program calls for the continuous recording in the time variation at a number of points. The Observatory adapted two of its gravity meters to meet its commitments in this direction. It is operating one of the instruments at Ottawa and the other, in succession, at Resolute, Meanook, and Baker Lake.

The variation of gravity from point to point is of much more practical importance. Every particle of matter attracts every other particle, so the value of gravity depends on the latitude of the point, on the density of distribution of surface hills and hollows, and on the structure and density of the rocks underlying the point of observation. When latitude and surface effects have been allowed for, the gravity data provide information on sub-surface structures, which may have commercial importance; when these effects have been removed, the remaining data give information on the shape of the earth.

Five field parties extended Canada's regional network of gravity measurements in the Prairie Provinces, in northern Quebec, and in Gaspé through the establishment of about 750 new stations. In this work, the Observatory aims to cover Canada with a reconnaissance grid of gravity meter stations and to carry out detailed surveys in areas of economic interest. The reconnaissance grid now covers the southern half of Canada, with a few measurements in the Arctic Islands. The detailed coverage is well advanced, for example, in Alberta where the oil companies have made many of their observations available for coordination by the Observatory. The grid is also approaching final form in the southern Cordillera, southern Ontario, and in the Maritime Provinces. The Observatory is proceeding with the structural interpretation of the data in these and other areas, and obtaining much information of geological interest. It has completed the final reduction of the data to give geodetic information for the Prairie Provinces.

Gravity data provide information on subsurface structures and on the shape of the earth. It is very difficult to determine the absolute value of gravity. The Dominion Observatory in 1957 made a major contribution to the accurate determination of gravity values by its completion of a set of pendulums more accurate than any in the world.

A Dominion Observatory geophysicist has an interested audience as he determines the value of gravity at Resolute on Cornwallis Island. He is using a North American gravimeter. Accurate pendulum measurements are used as control for gravimeter surveys.

A program commenced at the Observatory some years ago to modify pendulum equipment to obtain greater accuracy was completed with the development, by Observatory scientists, of the most accurate set of pendulums yet devised. These pendulums have greatly simplified the establishment of calibration lines needed to determine the scale constants of gravity meters which, because they depend on a spring or some equivalent device, are subject to drift. Many countries have asked to have their bases tied in to the world network with these pendulums, but work within Canada will have to be done first.

Observatory scientists designed and constructed a gravity meter with which to make measurements under unstable conditions such as on ice sheets or ships at sea. The meter depends upon the measurement of the frequency of a vibrating string, and averages out disturbing accelerations. The present standard instrument for measuring gravity at sea is a set of special pendulums, designed by a Dutch geophysicist. The new vibration gravity meter has been tested against these pendulums in a Dutch submarine beneath the Caribbean Sea, and the results of the two methods are now being compared.

Seismology

The first responsibility of international seismology is to locate earthquakes. This is done by the pooling of information from stations all over the world. Canada discharges its obligation to international seismology by maintaining 11 seismograph stations across the country. The network reaches from Halifax to Victoria, with a concentration of stations in the St. Lawrence valley and in British Columbia, and stretches in the north to Resolute on Cornwallis Island. All Canadian stations contribute to the international program. About 2,000 of the many earthquakes which occur each year are located by this international program. The Observatory publishes regular lists of earthquake epicentres in British Columbia, and it has started a similar program for eastern Canada.

Observatory scientists are using near earthquakes and blasts to study the structure of the earth's crust to a depth of about 25 miles. This study is important in Canada because the waves from nearby earthquakes travel in these layers, and the determination of the structure by controlled blasts makes it possible to locate Canadian earthquakes much more precisely. In this connection, the proposed destruction of Ripple Rock off the southeastern coast of British Columbia in 1958 is expected to provide a great deal of valuable data on structure in Western Canada. The Observatory has set up seismograph stations as far away as Alberta to record the event. It has completed preliminary preparations, including the study of local structure in parts of British Columbia by means of depth charges to assist in interpreting the results of the blast.

In its research on the mechanism of earthquakes, the Observatory continues to study world earthquake records in an attempt to determine the nature of the faulting in every large earthquake, regardless of location. The results of this study have been quite surprising. Most large earthquakes occur in regions of active mountain building, and are presumably the result of the same forces. Since mountains are obviously something pushed up, it has been supposed that the displacement in earthquakes is largely vertical; instead it is largely horizontal, a most puzzling conclusion.

The Observatory has broadened its program of work in seismology considerably during IGY. It has constructed a very much enlarged seismograph station at Resolute, equipped it with the most modern seismographs, and provided facilities in it for the instruments of two United States IGY projects. It has perfected a technique of calibrating seismographs accurately and simply, and has used this to calibrate all Canadian instruments. This in turn has allowed the Observatory to provide IGY data centres with accurate data on microseisms, the small disturbances on seismograms caused by meteorological conditions, such as wind over oceans. These disturbances are not well understood, and it is hoped that, by pooling information from all over the world and comparing it with the large amount of weather data available during IGY, a final answer to the cause of microseisms may be found.

Geographical Branch

The growing awareness of the value of land-use surveys in pointing the way to the optimum utilization of Canada's land resources was reflected in the work of the Branch in 1957. Major projects included a number of such surveys on the island portion of Newfoundland to assist in the planning of public works programs and, in northern Canada, terrain analysis studies of the Yukon coast, of Melville and Foxe peninsulas and of northern Foxe Basin in line with the growing interest in the Far North.

Branch work on the preparation of the new Atlas of Canada neared completion. The Atlas is expected to be ready for publication by the end of 1958.

A steady increase was noted in the number of research enquiries (as distinct from research projects) received from other government departments, particularly from External Affairs, National Defence, and Northern Affairs and National Resources.

Three Branch officers are attending classes in scientific Russian at Carleton University. The Branch now has staff with a working knowledge of Spanish, Portuguese, Italian, French, German, Polish, Russian, Chinese and Japanese.

Land-use Surveys

In Newfoundland, Branch geographers began a five-year land-utilization mapping survey of the island portion of the province in cooperation with the provincial Department of Mines and Resources. They carried out surveys in a number of areas and prepared, in manuscript form, 33 land-use maps on a scale of 1:50,000 and 59 on a scale of 1:16,400, covering the whole of the

Avalon Peninsula. These surveys are being used in the planning of provincial parks and recreation areas, as background information for urban and rural planning boards, for the control of quarry operations, and for numerous other purposes.

In December, the Senate Committee on Land Use met in the Branch to hear of the Branch's work and the results achieved in land-use mapping, and to become acquainted with similar work carried out by geographers in other parts of the world.

The Branch continued the preparation of comprehensive reports on land utilization and the economic geography of Newfoundland on the basis of previous field studies. These were carried out in collaboration with the federal and provincial Departments of Fisheries in connection with the redevelopment of the province's fishing industry. The reports will indicate (1) the most favourable locations for the concentration of mechanized fishing activities, and (2) ways in which other natural resources can be put to more advantageous use.

A report on land utilization in the upper Saint John River valley in New Brunswick is nearing completion. It will be valuable as an aid in the planning of the orderly development of the agricultural and forest resources of the area.

As the coordinating agency in Canada for the UNESCO Advisory Committee on Arid Zone Research, the Branch completed its preliminary field investigation of the influence of the semi-arid environment on occupation and settlement in southern Saskatchewan, with emphasis on patterns of land utilization. The resultant data will prove valuable in planning the development of these regions, and to UNESCO in formulating research and development plans for similar environments in other parts of the world.

Land-use surveys of cities and towns were continued mainly for civil defence purposes for the Department of National Health and Welfare. Large scale, hand-coloured maps were completed for Hamilton, showing present land-use and fire susceptibility, and a start was made on the mapping of the day-time population distribution. In Toronto, the Branch carried out a geographical analysis of the relationship between land use and manufacturing. It completed seven hand-coloured maps on a scale of 1:50,000 for each of the cities of Winnipeg, Toronto, Montreal and Quebec.

During the year, the Director was appointed a member of the Committee on Land Use of the Conservation Council of Ontario.

Canada is a land of mountains and muskeg, of prairie, forest, and farmland, and of lakes and rivers. Here a Branch geographer stands deep in a swamp in northern Manitoba and examines an aerial photograph during a terrain analysis study of the area.

In August, he gave a paper on land-use mapping in Canada at the Regional Conference of the International Geographical Union, which was held in Tokyo and Nara, Japan.

Terrain Analysis in Northern Canada

Field surveys were carried out (1) along the Yukon coast, (2) in western Melville Peninsula, (3) in the Cape Dorset area of Foxe Peninsula, and (4) on Baffin Island in the vicinity of Fury and Hecla Strait to obtain data on the extent and nature of land forms, the degree of drainage, and the chief types of vegetation and their relationsihp to permafrost phenomena. These data are valuable in planning the location of new settlements, airfields, mining communities, and new roads. At times they lead to the disclosure of regions affording greater subsistence potentialities for the coastal inhabitants. In the survey of the Yukon coast, the Branch schooner *Tuhlik* was used to make observations of river channel profiles and turbidity, coastal retreat and post-glacial submergence, and water salinity. The origin of an organic layer close to the permafrost table was also investigated.

In western Melville Peninsula, on Foxe Peninsula and in northern Foxe Basin, Branch geographers obtained data on surface conditions for the preparation of photo-interpretation keys. These permit a fairly rapid interpretation of conditions over wider areas from aerial photographs. Branch geographers also studied and mapped the distribution and resources of the Eskimos in these areas. A report, in memoir form, was completed on the Anderson River map-area in northern District of Mackenzie in Northwest Territories.

In the office, references to terrain data were remapped on the latest editions of the one-inch-to-eight-mile map series. Four maps, showing land forms, surface deposits, vegetation and water features, were prepared, in manuscript form, for each of 18 map-areas in the Canadian north. These data provide a rapid reference to all published material on northern terrain. They also indicate the unknown for future field investigation.

A study of the coasts and landing beaches in selected areas of northern Canada was continued, mainly for the use of the Defence Research Board and the Canadian Hydrographic Service.

Atlas of Canada

Work was continued on the new Atlas of Canada. The Atlas will show the nature and extent of Canada's physical and human resources and their

Interest in Canada's Far North is increasing steadily. Included in the Department's mapping, charting, and other activity in these regions is the study of ice conditions.

A Branch geographer writes up his notes near Darnley Bay in northern District of Mackenzie, Northwest Territories, while his Eskimo guide packs up.

development and organization. It will consist of 110 sheets of maps in full colour bound in loose-leaf form. At the end of 1957, those sheets of the English edition, which remained to be printed, were in the final stages of reproduction. The preparation of the French edition was started late in the year.

The Branch Director was appointed a corresponding member of the International Geographical Union's Commission on National Atlases.

Canadian Ice Distribution

A study of ice distribution in the lower St. Lawrence River was made to assist in formulating methods of calculating the ice potential of the Gulf of St. Lawrence and of the estuary of the river and to determine the feasibility of year-round navigation. The project has particular reference to the north shore where important mineral, pulp and paper, and other industrial developments are taking place and to the possibility of increasing the accessibility of these areas by water during the winter months. A Branch officer participated with the Defence Research Board, the Royal Canadian Navy and the Royal Canadian Air Force in an aerial survey of the Gulf, and a second continued to make a study of ice conditions around Rivière du Loup. The Branch established a 750-mile network of 30 ice-reporting stations on the St. Lawrence River from Quebec City eastward to Blanc Sablon, with the cooperation of the Department of Transport.

One geographer made ice-distribution observations in northern Canadian waters from the Department of Transport ship, *d'Iberville*, to gather data on the nature of the ice en route and to assist the ship's staff with ice reporting.

Over 4,000 bibliographical references to ice distribution in the inland waters of Canada were extracted from publications for use as required by other government departments.

Technical Services

Fifty-eight sheets were drafted for the Atlas of Canada. The Branch collaborated in the production of The Times Atlas—Volume V—The Americas, edited by Dr. John Bartholomew, by scrutinizing those sections dealing with Canada and supplying additional data where necessary.

In all, 127 maps and figure drawings were produced to illustrate Branch reports, and 18 maps and diagrams were drawn for other government departments and agencies. One large wall map, approximately three feet square, adapted from the Atlas of Canada, showing the distribution of Aboriginal Tribes and Linguistic Families, was prepared especially for the Post Office Department for the Fourteenth Universal Postal Congress.

Reference Services

Over 7,000 sheets, including several hundred Russian, Hungarian, and Japanese sheets, were added to the map collection, bringing the total to 120,000.

Some 1,200 books, pamphlets, and atlases were acquired, bringing the number of volumes in the Branch's book library to 18,100.

A total of 2,200 photographs was added to the ground photograph library which now contains 20,200 prints.

Administration

The year saw a marked improvement in the personnel staffing picture in the Department. Qualified candidates were found for many of the positions which, because of a lack of suitable applicants, had remained unfilled for some years, particularly in the scientific and technical fields. However, despite the improvement in the situation in 1957, shortages of qualified personnel still exist in certain fields. The Department, for instance, finds it especially difficult to meet specific needs for scientific and technical personnel, possessing highly specialized backgrounds, in radioactive chemistry, ground-water geology, mass spectrometry, palynology, hydrography, etc.

In all, 301 new employees were added during 1957 to fill vacancies created by separations, retirements and the establishment of new positions. Of these, 35 per cent were in the professional-scientific group, another 35 per cent in supporting technical staff, and the remainder in the clerical-stenographic group. Separations during the year amounted to 176, or 58 per cent of the number of new employees, in contrast to the years immediately preceding 1957 when new appointments numbered only slightly more than separations.

In conjunction with the Civil Service Commission, the Department in 1957 developed a common classification series for scientists in its three major research branches. The new series is designed to overcome the difficulty which has been experienced for some years in according parallel treatment as regards compensation to similarly qualified officers in these branches. The difficulty stemmed from the fact that different classifications with differing salary ranges were in effect in each branch. The new series—Scientific Officer, Mines and Technical Surveys—with six levels, is already in use.

The only major organizational change was the transfer of the Mineral Resources Division from the Mines Branch to Head Office.

Mineral Resources Division

The tremendous growth of Canada's mineral industry in recent years has given rise to a widespread interest, both at home and abroad, in the development of the country's mineral resources. The resultant increase in the demand for the economic services provided by the Division on the development, utilization, and conservation of these resources, more particularly of the metallic and energy mineral resources, has necessitated a broadening of the scope of these services over the years, and on April 1, 1957, was followed by the transfer of the Division from the Mines Branch to the head office of the Department. The Division originated in the Geological Survey of Canada in 1886 and it had formed the nucleus of the newly created Mines Branch in 1907.

Division activity in 1957 reflected both the continued growth of certain sectors of the industry and the effect of the general industrial slowdown on others. The value of mineral production rose to a new high of $2.134 billion and the industry accounted for 39 per cent of the value of the country's export trade. However, a weakening in world mineral markets resulted in certain cutbacks in production and some mine closures, bringing the industry face to face with problems greater and more serious than at any time since the end of World War II. The Division gave much attention to these problems, including such matters as the possible imposition of increased United States tariffs and/or import quotas on lead and zinc, and the economics of marketing Western Canada's supplies of crude petroleum and natural gas. The Division also continued to assist the Royal Commission on Canada's Economic Prospects and gave considerable help to the Royal Commission on Energy, which was appointed during the latter part of 1957.

United States Tariff Commission Hearings on Lead and Zinc

As the United States absorbs about 65 per cent of Canada's exports of zinc and about 35 per cent of its lead exports, the Canadian Government and the mineral industry are vitally interested in that country's activities in such fields as tariffs, import quotas, subsidies, stockpile programs, and stabilization plans. During 1957, the United States government was under considerable internal pressure to increase tariffs and/or impose import quotas on foreign lead and zinc. Late in the year, the United States Tariff Commission began an investigation of lead and zinc tariffs under the Escape Clause of the 1951 Trade Agreements Extension Act. The Division, in collaboration with the International Trade Relations Branch, Department of Trade and Commerce, assisted the Canadian Metal Mining Association in the preparation of factual material for the brief which the Association presented to the Commission. Division officers followed the situation closely and on two occasions attended hearings of the House Ways and Means Committee and the Tariff Commission in Washington as observers.

A continuous study was made of the Canadian lead and zinc industry and its relation to the world lead and zinc industry. Some of the available resource data on zinc is contained in a report, "Zinc in Canada with Comments on World Conditions", which will be published early in 1958.

Consulting Services The Division provided a wide range of mineral economics consulting services to government and to industry. These included: the provision of background material on zinc and fluorspar for public hearings on rolled zinc and fluorspar tariffs for the Tariff Board; analyses of the life expectancy of certain mining communities in respect of mortgage guarantees for housing projects for Central Mortgage and Housing Corporation, and an economic analysis of the Bathurst-Newcastle, New Brunswick, lead-zinc mineral-producing area for the Department of Public Works relative to a request from industry for dock construction and harbour dredging.

The Division provided the Department of Northern Affairs and National Resources with technical advice on three requests for federal government financial participation in the construction of mining roads in Saskatchewan and Yukon, and it supplied the same department and Canadian National Railways and Canadian Pacific Railway with information on mineral developments relative to the possible construction of railway lines to the Great Slave Lake area, Northwest Territories. It assisted the Exhibition Branch, Department of Trade and Commerce, in the design, layout and preparation of a mining exhibit for the 1958 Brussels Exhibition, and the Commonwealth Geological Liaison Office in London, England, with the preparation of Commonwealth mineral resource studies; and it provided a private company with an extensive market survey on possible secondary products for its mining operation.

On a number of occasions, the Division provided information and advice (1) to foreign mining and metallurgical companies interested in investing capital in Canada, (2) to foreign smelting and refining companies on Canadian sources of ores and concentrates for their plants, and (3) to foreign metal-consuming industries on potential sources of Canadian refined metal products.

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The Division prepared numerous memoranda and reports, and provided continuous consulting services on mining and petroleum taxation and legislation to government departments, private organizations and individuals. At the request of the Department of National Revenue, it reviewed and reported on the applications of 18 companies for tax exemptions under Section 83 (5) of the Income Tax Act, and the applications for certification as to the mining of non-bedded deposits under Section 1201 of the Income Tax Regulations by three industrial-mineral mining companies. New and proposed foreign legislation, which might directly or indirectly affect the Canadian mineral industry, was closely studied and analyzed.

Briefs and Reports for Royal Commissions Although the work of the Royal Commission on Canada's Economic Prospects, otherwise known as the Gordon Commission, was drawing to a close in 1957, Division officers continued to spend much time assisting the Commission's research staff with the technical criticism and editing of the individual mineral studies for the volume on Mining and Mineral Processing in Canada and for that on Canadian Energy Prospects. Since the Commission's inception in 1955, the Division has assisted it considerably through the preparation of special mineral studies and of background studies on individual sectors of the mineral industry and through the compilation of abundant statistics on mineral production and consumption.

At the request of the Royal Commisison on Energy (the Borden Commission), Division officers prepared several briefs on the problems of the petroleum and natural gas industry. These were a valuable help to the Commission in its difficult task of selecting the topics to be studied during the course of its public hearings. In addition, arrangements were made to lend the Commission the full-time services of a senior officer of the Division.

Field Work To gain factual, first-hand knowledge of the mineral industry, Division officers annually carry out field investigations on all aspects of the industry from occurrence through to end use. In 1957, investigations were carried out in all provinces and territories, except Prince Edward Island. Because of important domestic and foreign economic problems involving specific minerals, principal emphasis was given to petroleum and natural gas, uranium, lead, zinc, copper, nickel and iron ore. Reports on developments in the petroleum, natural gas, and iron-ore industries will be published in 1958, and on lead, early in 1959.

NATO Petroleum Planning Committee A number of technical studies on the refining, transportation, and storage sectors of the petroleum industry were prepared on behalf of the NATO Petroleum Planning Committee. A senior officer of the Division attended the annual meeting of the committee in Paris, France, on behalf of the Emergency Measures Organization of the Department of Trade and Commerce.

Foreign Visitors' Tours of the Canadian Mineral Industry Division officers assisted the International Economics Technical Co-operation Division of the Department of Trade and Commerce, with the planning of study tours of the Canadian mineral industry for mining and geological experts from India and the British Solomon Islands Protectorate. Additional tours were arranged for mining and geological experts from France, United States, Japan, Italy and Sweden. In the main, these tours are arranged in fulfilment of Canadian obligations under the Colombo Plan and United Nations Technical Assistance Organization.

Mineral Industry Information Services The Division provided the delegates to the Sixth Commonwealth Mining and Metallurgical Congress, which was held in Canada in 1957, with published information on the Canadian mineral industry. This included a graphically illustrated volume, "Minerals—Canada and the World", which portrays the growth of the industry since the Congress was last held in Canada in 1927. The volume deals with 35 of the metals, non-metallics, and mineral fuels, and includes coloured maps of Canada and of the world, bar charts, and line graphs to illustrate mineral production and trade. Other publications were timed to be of use to Congress delegates. These included revised editions of the "Digest of Mining Laws of Canada" and of the "Summary Review of Federal Taxation and Certain Other Federal Legislation Affecting Mining, Oil, and Natural Gas Enterprises in Canada". A special edition of Map 900A, "Principal Mineral Areas", which receives wide distribution both inside and outside Canada, was prepared for the delegates as well as a summary, "The Canadian Mineral Industry", to accompany the 62 annual mineral reviews which form part of the regular Canadian Mineral Industry series.

Information Circulars on petroleum, natural gas, iron ore, titanium, gold, rare or less common metals, and a Memorandum, "Columbium (Niobium) and Tantalum", were prepared in response to public interest in these minerals. Revisions were made to seven lists of operators, and to

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the "Catalogue of Mines Branch Publications" for distribution to Congress delegates and the general public.

A small brochure was published to mark the twenty-fifth anniversary of the Prospectors and Developers Association, and work was started on a coloured brochure on the Canadian mineral industry for distribution to schools, Canadian missions abroad, foreign trade fairs, and at the Mining Exhibit of the Brussels Exhibition in Belgium. Work was also completed on a black and white filmstrip on nickel, one of the Canadian mining filmstrip series.

Administration of the Emergency Gold Mining Assistance Act

Assistance to the gold-mining industry was continued during 1957 under the terms of the Emergency Gold Mining Assistance Act, the operation of which was extended to December 31, 1958, by an amendment to the Act passed in 1956.

The Act is administered under the direction of the Deputy Minister by a senior officer of the Division. An inspection engineer makes an annual visit to each mine or operation receiving assistance, reviews the operations for the year, discusses problems arising therefrom and determines the exploration and development expenditures which are considered to be of a capital nature and therefore to be amortized under the Act. The Cost Inspection and Audit Division, Office of the Comptroller of the Treasury, conducts an annual audit at each mine to verify the data on the applications submitted.

The amount of assistance paid to an eligible operator is computed by multiplying the 'rate of assistance' by the number of 'assistance ounces'. The rate of assistance is two-thirds of the amount by which the average cost of producing an ounce of gold exceeds $26.50, with a maximum rate of $12.33 per ounce. The number of assistance ounces is two-thirds of the number of ounces of gold produced and sold in the calendar year in accordance with the terms of the Act.

During 1957, the industry continued to face rising costs. At the same time, the increase in the exchange rate differential between the United States and Canadian dollars resulted in a decline to $33.55 from $34.45 in 1956 in the average selling price in Canadian dollars per ounce of gold paid by the Royal Canadian Mint. During 1957, the average weekly Mint price per ounce of gold in Canadian dollars steadily declined from $33.61 in the first week of January to a low for the year of $33.06 during the week of August 19-23, when it began to rise again, reaching $34.42 in the last week of December. Despite this improvement in price, the gold-mining industry was adversely affected by the premium on the Canadian dollar throughout the year.

Beginning early in 1957, a comprehensive review of conditions in the gold-mining industry was made for departmental use. The review was based on data compiled during the year on the operation of gold mines which have received cost aid since the inception of the Act.

Representatives of the gold-mining industry submitted a formal brief to the federal government on August 21, 1957 reviewing conditions in the industry and requesting the government to extend the Emergency Gold Mining Assistance Act and to consider a revision to provide a more adequate scale of payments.

During the year, 225 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 of the Treasury, reviewed by the Department of Mines and Technical Surveys, and the required payments to the mines were made. Seventeen final audits remained to be completed at the end of 1957 in respect of the calendar year 1956.

No new gold mines came into production and none ceased operation in 1957. Nine lode gold mines were operating at costs below $26.50 per ounce and therefore were not eligible to receive cost aid.

The amount of assistance paid to the gold-mining industry to December 31, 1957 in respect of each of the calendar years since the Act became operative is shown below.

1948—$10,546,315.84	or	$3.33	per ounce produced
1949—$12,571,456.90	or	$3.48	" " "
1950—$ 8,993,490.51	or	$2.55	" " "
1951—$10,728,503.71	or	$3.30	" " "
1952—$10,845,978.62	or	$3.76	" " "
1953—$14,678,482.79	or	$4.62	" " "
1954—$16,251,042.70	or	$4.28	" " "
1955—$ 8,848,667.08	or	$2.96	" " "
1956[1]–$ 8,036,682.25	or	$3.21	" " "
1957[2]–$ 5,240,716.55			not available

[1] Final audits are not completed.
[2] Advance payments made during 1957.

Administration of the Explosives Act

The Explosives Division administers the Explosives Act (Chapter 102 of the Revised Statutes of Canada, 1952 as amended by Chapter 14 of the Statutes of Canada, 1953-54) which regulates the manufacture, testing, storage, sale and importation of explosives and also transportation of explosives by road.

In 1957, the Division issued 1,877 (1,843)* licences and permits, covering the manufacture, storage and transportation of explosives. These comprised 20 (19) covering factories, 1 (1) for a magazine depot, 458 (466) for permanent magazines, 939 (978) for temporary magazines, 122 (109) for registered premises, and 243 (270) transportation permits.

The location of factory buildings, magazines and registered premises, the quantity of explosives stored in each and the adherence to regulations to ensure the safety of personnel and the public are dealt with in the licences issued. Division inspectors check on compliance with the terms of licence and regulations under the Act by carrying out regular inspections of licenced premises and of unlicenced premises where limited quantities of explosives are kept for private use. In 1957 they inspected 37 (35) factories, 2,478 (1,932) magazines and registered premises, 166 (38) unlicenced premises, and 72 (85) transportation vehicles.

Members of the Royal Canadian Mounted Police act as deputy inspectors of explosives and give valuable assistance in the enforcement of the Act, particularly in remote areas.

There were no serious accidents in the manufacture of explosives. The Division collects and compiles data on all explosives accidents and endeavours to educate the public in good practice and the avoidance of hazards. Of the total of 111 accidents involving explosives reported to the Division, 64 occurred in circumstances not directly controlled by the Act.

A new explosives factory, probably the most modern on the continent, near North Bay in northern Ontario was licensed in May and commenced production in mid year. It incorporates design features new to Canada, which give prime attention to safety.

In 1957 a mining company requested permission to blend ammonium nitrate and fuel oil at open-pit drill holes for immediate use. This on-the-spot mixing of an explosive was legalized by the "Ammonium Nitrate and Fuel Oil Order", Order-in-Council P.C. 1957-335, 14 March 1957, under Section

* 1956 figures in brackets.

8 of the Act which allows blending of the inexplosive component parts of an authorized explosive at the place of use. This field-mixing of ammonium nitrate and fuel oil, which are used with fixed explosives as boosters, spread rapidly and 94 permits were granted during the year. The cost advantage is obvious but considerable difficulty has been experienced in adapting the explosive to operations in wet work. The explosive is a relatively insensitive one and no accidents have been reported.

During the latter part of the year, public interest in earth satellites, ballistic missiles and space rockets was reflected in a noticeable increase in accidents to teenagers experimenting with home-made explosives. A complicating factor has been the attitude expressed in letters, editorials and magazine articles against unduly restricting the attempts of amateur scientists to produce propellants and launch rockets. It was felt, however, in the interest of public safety and in the absence of any practical plan for adequate supervision of rocket experiments by amateurs, that there should be no relaxation in the enforcement of those sections of the Act dealing with the manufacture of explosives.

Import Permits The Division issued 1,175 (1,163) explosives import permits, covering fireworks and ammunition, distress signals, nitrocellulose for paint and lacquer manufacture, and seismic explosives for oil exploration.

Testing The Explosives Laboratory tests and analyzes explosives, and investigates the hazards attending the storage, shipment, and use of explosives. In 1957 it examined 97 samples of commercial high explosives; two detonating fuses; 16 samples of ammunition; and 24 varieties of fireworks, including toy pistol caps. The laboratory also tested and analyzed 22 samples of explosives for other government departments.

Prosecutions Prosecutions for infractions of the Explosives Act and Regulations were instituted in thirty-three cases. Convictions were obtained in thirty-one cases and penalties imposed, one case was dismissed, and one is pending. Nine were for infractions while transporting explosives by truck. Other offences included unlocked premises, improper storage of explosives, unlicenced premises, failure to keep magazine clean, unsuitable receptacle, selling explosives without a licence, failure to display 'Explosives' warning signs, and the manufacture of an aluminum-potassium chlorate-sulphur mixture by a youth.

APPENDICES

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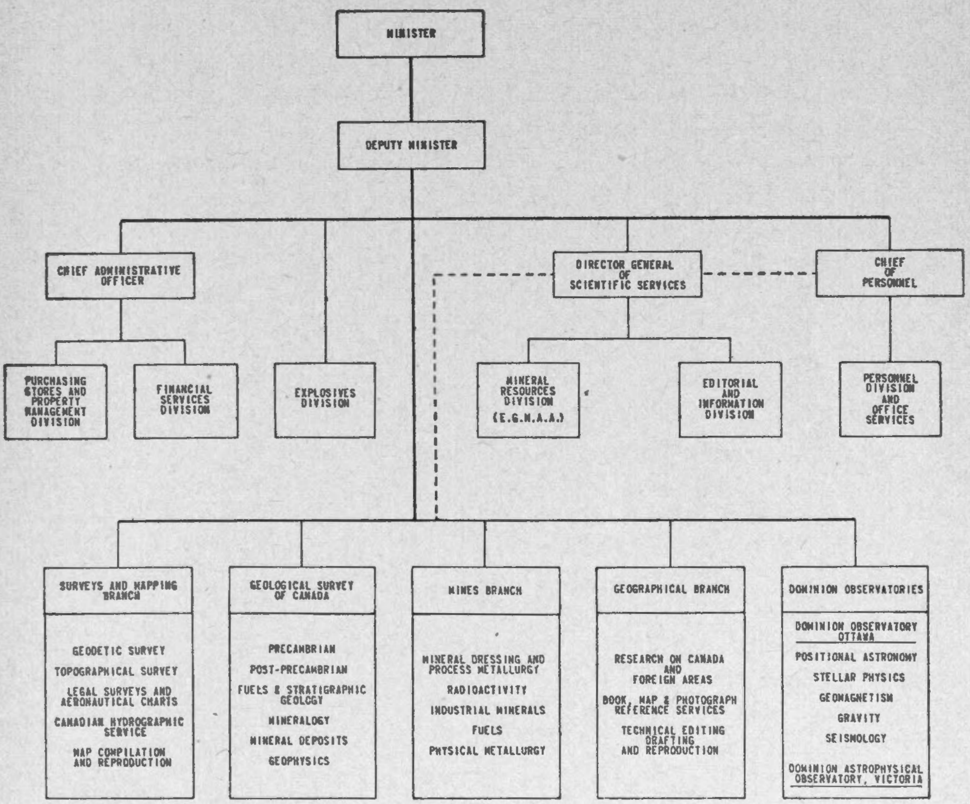
Appendix I

Department of Mines and Technical Surveys Organization as at December 31, 1957



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Appendix II

Senior Personnel of the Department as at December 31, 1957

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 .... W. H. Miller
Director, Geological Survey of Canada .... Dr. J. M. Harrison
Director, Mines Branch .... Dr. John Convey
Director, Dominion Observatories .... Dr. C. S. Beals
Director, Geographical Branch .... Dr. N. L. Nicholson

Appendix III

Revenue and Expenditures

A summary of revenue and expenditures for 1957 follows:

	Revenue	Ordinary Expenditures
Minister of Mines and Technical Surveys	$	$ 14,837
Miscellaneous Gratuities	....	870
Departmental Administration	....	538,596
Explosives Act	7,225	104,505
Mineral Resources Division	....	171,707
Surveys and Mapping Branch	157,494	8,407,447
Provincial and Territorial Boundary Surveys	....	51,379
Geological Survey of Canada	30,119	2,603,413
Mines Branch	28,724	3,318,704
Geographical Branch	134	297,402
Dominion Observatories	4,233	869,376
General		
To provide for payments under the Emergency Gold Mining Assistance Act (Chap. 95, R.S., as amended)	....	9,103,305
To provide for purchase of air photography and the expenses of the Interdepartmental Committee on Air Surveys, including purchases of equipment	....	2,020,707
	$227,929	$27,502,248

Appendix IV

Surveying, Mapping and Charting Activity

(*a*) Geodetic Survey of Canada

Province or Territory	Shoran			Triangulation						Astronomy		Base Lines		Levelling		
	Parties	Stations	Lines	Observing Parties	Stations	Mileage	Reconnaissance Parties	Stations	Mileage	Parties	Stations	Parties	Lines	Parties	Bench Marks	Mileage
Northwest Territories..	1	17	61	..	..	...	1(1)	12	100	..	..	..	..	..	...	...
Alberta.......	..	..	..	1	5	50	1(1)	6	25	..	..	..	..	..	...	...
Saskatchewan.	..	..	..	1	11	95	1(2)	29	200	1(3)	6	..	..	1	271	541
Manitoba.....	..	..	..	..	..	...	1(2)	2	25	1(3)	1	..	..	..	...	...
Ontario.......	..	..	..	1	24	160	..	..	...	1	2	1(4)	2	1(5)	50	86
Quebec........	..	..	..	1[a]	13	105	1[a]	12	105	..	..	1(4)	2	1(5)	37	83
Nova Scotia...	..	..	..	..	..	...	..	..	...	..	..	..	..	1	106	212
Newfoundland (Labrador) .	..	..	..	1[b]	9	30	1[b]	7	25	..	..	..	..	..	...	...
Total.........	1	17	61	5	62	440	4	68	480	2	9	1	4	3	464	922

1[a] and 1[b] indicate that a single party carried out both observing and reconnaissance operations in each province.
Similar numbers in parentheses in 'parties' columns indicate that the same party operated in different areas.

(*b*) Topographical Survey

Province or Territory	Field Work				Map Compilation							Map Sheets Forwarded for Reproduction					
					Planimetric			Contoured			Photo Mosaic	Scale 1:50,000		Scale 1:250,000		Total	
	No. of Parties	Type of Work	Publication Scale	Area Controlled Sq. Mi.	No. of Map Sheets	Publication Scale	Area Sq. Mi.	No. of Map Sheets	Publication Scale	Area Sq. Mi.	Area Sq. Mi.	Map Sheets	Area	Map Sheets	Area	Map Sheets	Area
Yukon	2	Photographic	1:50,000	6,000				2	1:50,000	559							
	1	Spirit Levelling	—	225 mi.				1	1:250,000	5,750		14	3,731			14	3,731
Yukon-Northwest Territories														3	14,013	3	14,013
Northwest Territories	1*	Topographic	1:50,000	16,300				30	1:50,000	6,267							
	1	Spirit Levelling	—	1,050 mi.	4	1:250,000	7,530	9	1:250,000	35,270		22	4,324	7	29,389	29	33,713
British Columbia	2	Photographic	1:50,000	4,800				40	1:50,000	13,683							
	1	Photographic	1:250,000	3,300				6	1:250,000	30,258		46	16,179	4	20,580	50	36,759
Alberta-British Columbia												6	2,107			6	2,107
Alberta	3	Vertical	1:50,000	13,300				49	1:50,000	17,570							
	1*	Vertical	1:250,000	4,605				1	1:12,000	14		45	15,444	1	5,296	46	20,740
Alberta-Saskatchewan	1	Traverse	—	980 mi.													
Saskatchewan	4	Vertical	1:50,000	12,400													
	1*	Vertical	1:50,000	3,300													
		Vertical	1:250,000	23,800	19	1:50,000	6,844	20	1:50,000	7,218	11,550	17	5,979			17	5,979
Manitoba-Saskatchewan								1	1:50,000	392		1	390			1	390
Manitoba	2	Vertical	1:50,000	4,200													
	1	Traverse	—	630 mi.	2	1:50,000	744	23	1:50,000	7,165	52,300	10	3,601			10	3,601
Ontario	3	Traverse	—	700 mi.													
	1	Tellurometer	—	200 mi.													
	1*	Vertical	1:50,000	15,500							57,200						
Ontario-Quebec	1	Winter Trav.	—	195 mi.				1	1:50,000	403		1	401			1	401
Quebec	1*	Vertical	1:50,000	24,500													
	2	Topographic	1:50,000	4,300													
	1*	Topographic	1:50,000	9,000													
	1*	Topographic	1:250,000	57,100				51	1:50,000	19,037	100,400	49	17,214			49	17,214
Quebec-Newfoundland								7	1:50,000	1,850		7	2,064			7	2,064
New Brunswick												3	1,211			3	1,211
Newfoundland								6	1:50,000	850							
								1	1:2,400	1		8	1,502			8	1,502
					Total planimetric mapping 15,118			Total contoured mapping 146,287			Total photo mosaic 221,450	229	74,147	15	69,278	244	143,425

*Helicopter Party.

(c) Canadian Hydrographic Service

Provinces	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	KAPUSKASING*	17,126	25,000	7		5		75	18	8
	ACADIA.*	2,988	64	77	64					
	DAWSON	1,641	120	181	95					
Newfoundland, Quebec and New Brunswick	CARTIER*	1,467	103	71	122					
Nova Scotia	BAFFIN*	1,504	315	4		10		74	1	17
	HENRY HUDSON	1,425	71	185	35					
	ANDERSON	2,237	90	289	44					
New Brunswick						2	1	25	1	4
Prince Edward Island	KAPUSKASING Shore Party	1,744	112	52	98	3		12		2
Quebec	ALGERINE	50	100			31	1	102	3	26
Ontario	BAYFIELD	1,755	300	173	149	27		95	3	32
	BOULTON	1,500	100	123	130					
Manitoba	COOT	1,359	165	14	152	2		18		2
Saskatchewan								1	1	
Alberta								2	2	
British Columbia	WM. J. STEWART*	4,467	1,495	2		21	2	147	8	35
	PARRY*	599	58	195	71					
	MARABELL*	1,618	170	33	154					
Northwest Territories	THERON	3,714	566	179	59	9		113	6	23
	RAE	1,284	85							
	LABRADOR	10,770	50	5	65					
	C. D. HOWE	3,538								
	d'IBERVILLE	750		3						
TOTAL	20	61,536	28,964	1,593	1,238	110	4			

*Major survey ships.

DISTRIBUTION

Standard Navigation Charts	95,959
Special Charts	49,266
Tide and Current Tables—	
Pacific Coast	49,806
Atlantic Coast	22,423
Inland Waterlevel bulletins	28,800
Other Publications	4,915

(*d*) Legal Surveys and Aeronautical Charts

Type of Chart	Scale	New Editions	Revisions	Total
1. *Air Overprint Compilations and Revisions*				
Aeronautical	1:506,880	42	67	109
World Aeronautical	1:1,000,000	23	27	50
Special-composite	1:1,000,000	2	....	2
Aeronautical Route	1:1,000,000	1	14	15
Navigation Route	1:3,000,000	....	2	2
Navigation Plotting	1:3,000,000	3	....	3
Polar Plotting	1:3,000,000	1	....	1
2. *Canada Air Pilot*				
Instrument Landing		15	30	45
Radio Range		....	118	118
Radio Beacon		13	4	17
Radio Facility		....	104	104
Miscellaneous		....	105	105
3. *Contour and Spot Height Compilations from Radar Altimetry*				
		New Compilations		
Aeronautical	1:506,880	14		14

(*e*) Map Compilation and Reproduction

Type of Map	Scale	New Edition
1. *Summary of Compilation*		
National Topographic Series	1:50,000	6
National Topographic Series	1:250,000	16
National Topographic Series	1:500,000	4
Aeronautical Chart Bases	1:506,880	12
Aeronautical Route Charts	1:1,000,000	1
Atlas of Canada		1
Miscellaneous		40
2. *Summary of Drafting*		
National Topographic Series	1:50,000	129
National Topographic Series	1:126,720	1
National Topographic Series	1:250,000	16
National Topographic Series	1:506,880	20
National Topographic Series	1:500,000	1
Aeronautical Chart Bases	1:1,000,000	2
Navigation Route Charts		1
Air Overprints	Various	148
Atlas of Canada	Various	36
Miscellaneous Maps		57

(e) MAP COMPILATION AND REPRODUCTION—(*Cont.*)

3. *Summary of Editing*

	Scale	*Checked*	*Nomenclature Prepared*
National Topographic Series	1:50,000	132	103
National Topographic Series	1:126,720	8	3
National Topographic Series	1:250,000	31	18
National Topographic Series	1:253,440	2	....
National Topographic Series	1:500,000	....	4
National Topographic Series	1:506,880	66	16
Aeronautical Charts (base)	1:1,000,000	12	2
Atlas of Canada	Various	....	5
Columbia River		13	....
Miscellaneous		50	14
Hydrographic		....	27

4. *Summary of Photo-Mechanical*

	Scale	*Quantity*
National Topographic Series	1:50,000	185
National Topographic Series	1:63,360	5
National Topographic Series	1:126,720	13
National Topographic Series	1:250,000	41
National Topographic Series	1:500,000	3
National Topographic Series	1:506,880	83
World Aeronautical Chart Bases	1:1,000,000	17
Aeronautical Route Charts	1:1,000,000	2
Air Overprints	Various	173
Atlas of Canada	Various	32
Hydrographic Charts	Various	203
Geological	Various	74
Miscellaneous	Various	266
Columbia River		20

Photographic Processing

Film and plastic	94,723 sq. ft.
Contact prints	3,201 sq. ft.
Enlargements	6,940 sq. ft.
Vandyke	25,379 sq. ft.
Diazo	285,419 sq. ft.
Photostat	7,230 sheets
Litho plates	3,380 plates
Multilith	1,764 plates
Ozalid proofs	1,646 sheets
Sensitized linen	5,361 sq. ft.

(*e*) MAP COMPILATION AND REPRODUCTION—(*Conc.*)

5. *Summary of Printing*

	Scale	*Quantity*
National Topographic Series	1:50,000	188
National Topographic Series	1:63,360	2
National Topographic Series	1:126,720	12
National Topographic Series	1:250,000	29
National Topographic Series	1:253,440	13
National Topographic Series	1:506,880	102
Sectional Maps	1:190,080	10
World Aeronautical Chart Bases	1:1,000,000	32
Aeronautical Route Charts	1:1,000,000	7
Navigation Route Charts	1:3,000,000	1
Air Overprints	Various	229
Atlas of Canada	Various	22
Hydrographic Charts	Various	249
Geological	Various	76
Miscellaneous		213
Canada Air Pilot		249

Appendix V

Topographical Maps, and Charts

In the following tabulation, the column headed 'Year and Edition' refers to the year of publication and the edition number: 54–1 means it was published in 1954 is the first edition; 54–P–1 means it was published in 1954, is a preliminary map and is the first edition; 55–PR–1 means it was published in 1955, is a provisional map and is the first edition.

Number	Name	Location	Latitude	Longitude	Year and Edition
	(1) AERONAUTICAL CHARTS—NATIONAL TOPOGRAPHIC SERIES (*Scale, 1 inch to 8 miles*)				
14 SW	Nain-Nutak	Que. Nfld.	56°00′– 58°00′	60°00′– 64°00′	57–3
22 SW	Chicoutimi-Rimouski	Que.	48 00 – 50 00	68 00 – 72 00	57–4
24 SE	Indian House	Que. Nfld.	56 00 – 58 00	64 00 – 66 00	57–5
24 SW	Fort McKenzie	Que.	56 00 – 58 00	68 00 – 72 00	57–P–4
64 SE	Southern Indian	Man.	56 00 – 58 00	96 00 –100 00	57–P–6
64 SW	Reindeer Lake	Sask. Man.	56 00 – 58 00	100 00 –104 00	57–3
94 SW	Finlay River	B.C.	56 00 – 58 00	124 00 –128 00	56–3
116 SW and SE	Klondike	Yukon Alaska	64 00 – 66 00	136 00 –144 00	57–3
26 SW and SE	Cumberland Sound	NWT.	64 00 – 66 00	64 00 – 72 00	56–P–3
29 N ½ 19 N ½	Kane Basin	NWT. Greenland	78 00 – 80 00	58 00 – 72 00	55–P–2
35 NW and NE	Hudson Strait West	NWT. Que.	62 00 – 64 00	72 00 – 80 00	56–P–5
39 S ½ 29 S ½	Melville North	NWT.	68 00 – 70 00	80 00 – 88 00	56–P–3
49 N ½ 39 N ½	Bache Peninsula	NWT. Greenland	78 00 – 80 00	72 00 – 88 00	57–P–2
49 AS ½ 39 AS ½	Greely Fiord	NWT.	80 00 – 82 00	72 00 – 88 00	57–P–3
49 AN ½ 39 AN ½	Challenger Mountains	NWT.	82 00 – 84 00	72 00 – 90 00	55–P–2
57 SW-SE	Rae Strait	NWT.	68 00 – 70 00	88 00 – 96 00	57–P–4
57 NW-NE	Boothia	NWT.	70 00 – 72 00	88 00 – 96 00	57–P–3
67 SE-SW	King William Island	NWT.	68 00 – 70 00	96 00 –104 00	57–P–4
68 SW-SE	Prince of Wales Island	NWT.	72 00 – 74 00	96 00 –104 00	56–P–2
69 N ½ 59 N ½	Sverdrup Islands	NWT.	78 00 – 80 00	88 00 –104 00	55–P–2
75 SW	Fort Smith-Nonacho	NWT.	60 00 – 62 00	108 00 –112 00	56–P–4
78 SW-SE	Hadley Bay	NWT.	72 00 – 74 00	104 00 –112 00	57–P–4
88 SW-SE	Banks-Victoria	NWT.	72 00 – 74 00	112 00 –120 00	57–P–3
97 SW-SE	Colville Lake	NWT.	66 00 – 68 00	120 00 –128 00	56–P–3
98 NW-NE	Anderson River	NWT.	68 00 – 70 00	120 00 –128 00	57–P–3
98 SW-SE	Banks Island	NWT.	72 00 – 74 00	120 00 –128 00	57–P–3
98 NE 88 NW-NE	M'Clure Strait	NWT.	74 00 – 76 00	112 00 –125 00	56–P–3

Number	Name	Location	Latitude	Longitude	Year and Edition
		(2) NATIONAL TOPOGRAPHIC SERIES MAPS (*Scale, 1:250,000*)			
42 L	Nakina	Ont.	50°00′– 51°00′	86°00′– 88°00′	57–P–3
52 B	Quetico	Ont. USA.	48 00 – 49 00	90 00 – 92 00	57–P–5
53 K	Stull Lake	Man. Ont.	54 00 – 55 00	92 00 – 94 00	56–P–2
62 F	Virden	Man. Sask.	49 00 – 50 00	100 00 –102 00	55–1
73 Mq	Winefred Lake	Alta.	55 00 – 56 00	110 00 –112 00	56–P–1
82 P	Drumheller	Alta.	51 00 – 52 00	112 00 –114 00	55–1
84 A	Algar Lake	Alta.	56 00 – 57 00	112 00 –114 00	56–P–1
84 B	Peerless Lake	Alta.	56 00 – 57 00	114 00 –116 00	56–P–1
84 C	Peace River	Alta.	56 00 – 57 00	116 00 –118 00	57–P–1
84 F	Bison Lake	Alta.	57 00 – 58 00	116 00 –118 00	57–P–1
84 I	Lake Claire	Alta.	58 00 – 59 00	112 00 –114 00	57–P–2
64 M	Bistcho Lake	Alta.	59 00 – 60 00	118 00 –120 00	57–P–1
84 O	Whitesand River	Alta.	59 00 – 60 00	114 00 –116 00	56–P–1
82 E	Penticton	B.C.	49 00 – 50 00	118 00 –120 00	57–1
92 H	Hope	B.C.	49 00 – 50 00	120 00 –122 00	57–1
93 L	Smithers	B.C.	54 00 – 55 00	126 00 –128 00	57–2
106 D	Nash Creek	Yukon	64 00 – 64 00	134 00 –136 90	57–1
116 G and 116 F-E	Ogilvie River	Yukon	65 00 – 66 00	138 00 –141 00	57–1
75 D	Fort Smith	NWT.	60 00 – 61 00	110 00 –112 00	38–PR
85 P	Carp Lakes	NWT.	63 00 – 64 00	112 00 –114 00	43–PR
95 H	Fort Simpson	NWT.	61 00 – 62 00	120 00 –122 00	57–1
95 J	Camsell Bend	NWT.	62 00 – 63 00	122 00 –124 00	45–PR
		(3) WORLD AERONAUTICAL CHARTS (*Scale, 1:1,000,000*)			
Special	Bagotville	Que.	46°00′– 50°00′	68°00′– 76°00′	57
2179	Kaniapiskau River	Ont. Nfld.	52 00 – 56 00	64 00 – 72 00	56
2021	Belcher Channel	NWT.	76 00 – 80 00	88 00 –112 00	56–1
2036	Lancaster Sound	NWT.	72 00 – 76 00	79 00 – 96 00	56–1
2061	Horton River	NWT.	68 00 – 72 00	112 00 –128 00	56–1
		(4) AERONAUTICAL ROUTE CHARTS (*Scale, 1:1,000,000*)			
4	Kapuskasing-Ottawa	Ont.			New
		(5) NAVIGATION ROUTE CHARTS (*Scale 1:3,000,000*)			
1	Windsor-Gander	Que.-Ont.			

Number	Name	Location	Latitude	Longitude	Year and Edition
		(6) MAPS OF 1:50,000 SERIES			
1 L/14	St. Lawrence	Nfld.	46°45′– 47°00′	55°00′– 55°30′	57–1
1 M/5	Harbour Breton	Nfld.	47 15 – 47 30	55 30 – 56 00	56–1
1 M/6	Point Enragee	Nfld.	47 15 – 47 30	55 00 – 55 30	57–1
1 M/8	Nerasheen	Nfld.	47 15 – 47 30	54 00 – 54 30	57–1
1 M/11	Belleoram	Nfld.	47 30 – 47 45	55 00 – 55 30	56–1
1 M/13	St. Albans	Nfld.	47 45 – 48 00	55 30 – 56 00	57–1
2 E/6	Point Leamington	Nfld.	49 15 – 49 30	55 00 – 55 30	57–1
11 P/8-E	Pass Island	Nfld.	47 15 – 47 30	56 00 – 56 15	56–1
12 A/5	Puddle Pond	Nfld.	48 15 – 48 30	57 30 – 58 00	57–1
12 A/14	Rainy Lake	Nfld.	48 45 – 49 00	57 00 – 57 30	56–1
12 B/2	St. Fintan's	Nfld.	48 00 – 48 15	58 30 – 59 00	57–1
12 B/3	Little Friars Cove	Nfld.	48 00 – 48 15	59 00 – 59 15	56–1
12 H/3	Deer Lake	Nfld.	49 00 – 49 15	57 00 – 57 30	56–1
12 H/6	Cormack	Nfld.	49 15 – 49 30	57 00 – 47 30	57–1
12 H/12	Gros Morne	Nfld.	49 30 – 49 45	57 30 – 58 00	57–1
12 H/15	Jackson's Arm	Nfld.	49 45 – 50 00	56 30 – 57 00	57–1
12 I/9	Englee	Nfld.	50 30 – 50 45	56 00 – 56 30	56–1
12 I/15	Castors River	Nfld.	50 45 – 51 00	56 30 – 57 00	56–1
12 I/16	Roddickton	Nfld.	50 45 – 51 00	56 00 – 56 30	56–1
12 P/1	Salmon River	Nfld.	51 00 – 51 15	56 00 – 56 30	56–1
12 P/2	Brig Bay	Nfld.	51 00 – 51 15	56 30 – 57 00	57–1
12 P/8	Eddies Cove	Nfld.	51 15 – 51 30	56 00 – 56 30	56–1
11 E/12-E	Wentworth	N.S.	45 30 – 45 45	63 30 – 63 45	44–PR
11 E/12-W	Oxford	N.S.	45 30 – 45 45	63 45 – 64 00	44–PR
11 E/13-E	Pugwash	N.S.	45 45 – 46 00	63 30 – 63 45	44–PR
11 E/13-W	Shinimikas	N.S.	45 45 – 46 00	63 45 – 64 00	44–PR
20 O/16-E	Yarmouth	N.S.	43 45 – 44 00	66 00 – 66 15	56–4
21 H/7-E	Port Greville	N.S.	45 15 – 45 30	64 30 – 64 45	45–PR
21 H/7-W	Cape Chignecto	N.S.	45 15 – 45 30	64 30 – 65 00	45–PR
21 H/4-W	Cape Spencer	N.B.	45 00 – 45 15	65 45 – 66 00	56–1
21 I/7	Buctouche	N.B.	46 15 – 46 30	64 30 – 65 00	57–1
21 I/10	Richibucto	N.B.	46 30 – 46 45	64 30 – 65 00	56–1
21 J/9	Doaktown	N.B.	46 30 – 46 45	66 00 – 66 30	55–1
21 J/11	Juniper	N.B.	46 30 – 46 45	67 00 – 67 30	57–2
21 J/14	Plaster Rock	N.B.	46 45 – 47 00	67 00 – 67 30	57–2
21 J/15	Tuadook Lake	N.B.	46 45 – 47 00	66 30 – 67 00	57–2
21 O/1	Big Bald Mountain	N.B.	47 00 – 47 15	66 00 – 66 30	57–2
21 O/9	Tetagouche Lakes	N.B.	47 30 – 47 45	66 00 – 66 30	56–2
21 O/10	Upsalquitch Forks	N.B.	47 30 – 47 45	66 30 – 67 00	57–1
21 P/4	Sevogle	N.B.	47 00 – 47 15	65 30 – 66 00	56–2
21 P/5	Nipisiguit Falls	N.B.	47 15 – 47 30	65 30 – 66 00	57–2
12 F/4	Heath Point	Que.	49 00 – 49 15	61 30 – 62 00	57–1
12 F/5-W	Table Head	Que.	49 15 – 49 30	61 45 – 62 00	57–1
22 A/12	Deville	Que.	48 30 – 48 45	65 30 – 66 00	56–1
22 A/15	Bunny Bank	Que.	48 45 – 49 00	64 30 – 65 00	57–1

Number	Name	Location	Latitude	Longitude	Year and Edition
22 B/1	Escuminac	Que.	48 00 – 48 15	66 00 – 66 30	27–PR
22 B/11-E	Cuoq	Que.	48 30 – 48 45	67 00 – 67 15	44–PR
22 B/11-W	St. Vianney	Que.	48 30 – 48 45	67 15 – 67 30	44–PR
22 B/14-E	Grosses Roches	Que.	48 45 – 49 00	67 00 – 67 15	43–PR
22 B/16-E	Mount Albert	Que.	48 45 – 49 00	66 00 – 66 15	25–PR
22 C/9	Mont Joli	Que.	48 30 – 48 45	68 00 – 68 30	56–1
22 D/11	St. Ambroise	Que.	48 30 – 48 45	71 00 – 71 30	56–1
24 C/1	Otelnuk Lake	Que.	46 00 – 56 15	68 00 – 68 30	56–1
24 C/2	Lace Lake	Que.	56 00 – 56 15	68 30 – 69 00	56–1
24 C/15	Fort McKenzie	Que.	56 45 – 57 00	68 30 – 69 00	56–1
24 F/11	Manitou Gorge	Que.	57 30 – 57 45	69 00 – 69 30	56–1
24 F/15	Scattered Lake	Que.	57 45 – 58 00	68 30 – 69 00	57–1
24 K/1	Fort Chimo	Que.	58 00 – 58 15	68 00 – 68 30	56–1
24 K/12	Deep Harbour	Que.	58 30 – 58 45	69 30 – 70 00	57–1
24 K/16-W	Ragged Point	Que.	58 45 – 59 00	68 15 – 68 30	57–1
31 I/4	Rawdon	Que.	46 00 – 46 15	73 30 – 74 00	57–1
31 J/1	Ste-Agathe-des-Monts	Que.	46 00 – 46 15	74 00 – 74 30	57–1
31 J/15-E	Lac-Maison-de-Pierre	Que.	46 45 – 47 00	74 30 – 74 45	44–PR
31 J/16-E	Lac Charland	Que.	46 45 – 47 00	74 00 – 74 15	44–PR
31 K/3	Chalk River	Que.-Ont.	46 00 – 46 15	77 00 – 77 30	57–3
31 K/6	St. Patrick Lake	Que.	46 15 – 46 30	77 00 – 77 30	47–PR
31 N/7-E	Cabonga	Que.	47 15 – 47 30	76 30 – 76 45	43–PR
31 N/7 W	Camatose Lake	Que.	47 15 – 47 30	76 45 – 77 00	43–PR
31 N/12-E	Gaotanaga Lake	Que.	47 30 – 47 45	77 30 – 77 45	44–PR
31 N/12-W	Otanabi Lake	Que.	47 30 – 47 45	77 45 – 78 00	44–PR
31 N/13-W	Lac Marmette	Que.	47 45 – 48 00	77 45 – 78 00	43–PR
31 N/14-W	Lac Marrias	Que.	47 45 – 48 00	77 15 – 77 30	44–PR
31 P/5-E	Widkenden Lake	Que.	47 15 – 47 30	73 30 – 73 45	42–PR
31 P/6-E	Harper Lake	Que.	47 15 – 47 30	73 00 – 75 15	44–PR
31 P/6-W	Lac Boucher	Que.	47 15 – 47 30	73 15 – 73 30	42–PR
32 C/11-W	Rochebaucourt	Que.	48 30 – 48 45	77 15 – 77 30	39–PR
32 D/3	Rouyn	Que.	48 00 – 48 15	79 00 – 79 30	57–1
32 D/1	Clericy	Que.	48 15 – 48 30	78 30 – 79 00	56–1
32 E/3	Perron-Rousseau	Que.	49 00 – 49 15	79 00 – 79 30	38–PR
31 D/10-W	Kirkfield	Ont.	44 30 – 44 45	78 45 – 79 00	16–PR
31 D/13	Penetanguishene	Ont.	44 45 – 45 00	79 30 – 80 00	57–1
31 D/14	Gravenhurst	Ont.	44 45 – 45 00	79 00 – 79 30	56–1
31 F/12	Round Lake	Ont.	45 30 – 45 45	77 30 – 78 00	57–3
31 K/4	Des Joachims	Ont.-Que.	46 00 – 46 15	77 30 – 78 00	56–3
62 K/2-E	Hamiota	Man.	50 00 – 59 15	100 30 –100 45	57–1
62 K/8	Newdale	Man.	50 15 – 50 30	100 00 –100 30	57–1
62 N/1	Dauphin	Man.	51 00 – 51 15	100 00 –100 30	57–1
62 O/2-W	Ebb and Flow	Man.	51 00 – 51 15	98 45 – 99 00	57–1
62 O/3	Valpoy	Man.	51 00 – 51 15	99 00 – 99 30	57–1
62 O/4	Ochre River	Man.	51 00 – 51 15	99 30 –100 00	57–1
63 J/13	Herb Lake	Man.	54 45 – 55 00	99 30 –100 00	47–PR

Number	Name	Location	Latitude	Longitude	Year and Edition
63 K/10	Iskwasum Lake	Man.	54 30 – 54 45	100 30 – 101 00	46–PR
63 K/16	File Lake	Man.	54 45 – 55 00	100 00 – 100 30	45–PR
62 E/6	Midale	Sask.	49 45 – 49 30	103 00 – 103 30	57–1
62 E/8	Alameda	Sask.	49 15 – 49 30	102 00 – 102 30	57–1
62 F/12	Redvers	Sask.	49 30 – 49 45	101 30 – 102 00	57–1
62 F/13	Maryfield	Sask.	49 45 – 50 00	101 30 – 102 00	57–1
62 F/14	Elkhorn	Sask.-Man.	49 45 – 50 00	101 00 – 101 30	57–1
72 F/9	Shaunavon	Sask.	49 30 – 49 45	108 00 – 108 30	57–1
72 G/9	Limerick	Sask.	49 30 – 49 45	106 00 – 106 30	56–1
72 G/16	Mazenod	Sask.	49 45 – 50 00	106 00 – 106 30	57–1
72 H/12	Assiniboia	Sask.	49 30 – 49 45	105 30 – 106 00	57–1
72 H/13	Mossbank	Sask.	49 45 – 50 00	105 30 – 106 00	57–1
72 H/14	Spring Valley	Sask.	49 45 – 50 00	105 00 – 105 30	57–1
72 I/3	Briercrest	Sask.	50 00 – 50 15	105 00 – 105 30	57–1
72 J/4	Wymark	Sask.	50 00 – 50 15	107 30 – 108 00	56–1
72 J/5	Swift Current	Sask.	50 15 – 50 30	107 30 – 108 00	56–1
73 A/12	Wakaw	Sask.	52 30 – 52 45	105 30 – 106 00	57–1
73 A/13	Domremy	Sask.	52 45 – 53 00	105 30 – 106 00	57–1
74 N/9-E	Forget Lake	Sask.	59 30 – 59 45	108 00 – 108 15	41–PR
74 O/7	Lowe Lake	Sask.	59 15 – 59 30	106 30 – 107 00	46–PR
74 O/8	Wiley Lake	Sask.	59 15 – 59 30	106 00 – 106 30	46–PR
82 G/8-E	Beaver Mines	Alta.	49 15 – 49 30	114 90 – 114 15	43–PR
82 G/16-W	Gap	Alta.	49 45 – 50 00	114 15 – 114 30	44–PR
82 H/4-E	Mountain View	Alta.	49 00 – 49 15	113 30 – 113 45	44–PR
82 H/5-E	Glenwoodville	Alta.	49 15 – 49 30	113 30 – 113 45	44–PR
82 H/5-W	Pincher Creek	Alta.	49 15 – 49 30	113 45 – 114 00	44–PR
82 J/15-E	Bragg Creek	Alta.	50 45 – 51 00	114 30 – 114 45	40–PR
82 J/10-E	Dyson Creek	Alta.	50 30 – 50 45	114 30 – 114 45	43–PR
82 J/15-W	Moose Mountain	Alta.	50 45 – 51 00	114 45 – 115 00	41–PR
82 O/2-E	Jumping Pound	Alta.	51 00 – 51 15	114 30 – 114 45	31–PR
82 O/3-E O/2-W	Morley	Alta.	51 00 – 51 15	114 45 – 115 00	39–PR
82 O/9	Didsbury	Alta.	51 30 – 51 45	114 00 – 114 30	56–1
82 O/14-E	Marble Mountain	Alta.	51 45 – 52 00	115 00 – 115 15	43–PR
82 O/10	Fallentimber	Alta.	51 30 – 51 45	114 30 – 115 00	37–PR
82 P/12	Lonepine Creek	Alta.	51 30 – 51 45	113 30 – 114 00	56–1
82 P/13	Torrington	Alta.	51 45 – 52 00	113 30 – 114 00	57–1
83 B/12	Harlech	Alta.	52 30 – 52 45	115 30 – 116 00	57–1
83 B/13	Nordegg River	Alta.	52 45 – 53 00	115 30 – 116 00	57–1
83 C/8	Nordegg	Alta.	52 15 – 52 30	116 00 – 116 30	34–PR
83 C/9-E	Wawa	Alta.	52 30 – 52 45	116 00 – 116 15	42–PR
83 C/10-E	George Creek	Alta.	52 30 – 52 45	116 30 – 116 45	42–PR
83 C/15-E	Pembina Forks	Alta.	52 45 – 53 00	116 30 – 116 45	40–PR
83 C/9	Moberly Creek	Alta.	53 30 – 53 45	118 00 – 118 30	46–PR
83 E/16	Donald Flats	Alta.	53 45 – 54 00	118 00 – 118 30	57–2
83 F/2-E	Foothills	Alta.	53 00 – 53 15	116 30 – 116 45	57–1

Number	Name	Location	Latitude	Longitude	Year and Edition
83 F/3-E	Coalspur	Alta.	53 00 – 53 15	117 00 –117 15	45–PR
83 F/3-W	Alberta	Alta.	53 00 – 53 15	117 15 –117 30	26–PR
83 F/G-E	White Creek	Alta.	53 15 – 53 30	117 00 –117 15	45–PR
83 F/6-W	Pedley	Alta.	53 15 – 53 30	117 15 –117 30	45–PR
83 F/12-E	Barbara Creek	Alta.	53 30 – 53 45	117 30 –117 45	45–PR
83 F/12-W	Gregg Lake	Alta.	53 30 – 53 45	117 45 –118 00	46–PR
83 G/4	Zeta Lake	Alta.	53 00 – 53 15	115 30 –116 00	57–1
83 G/7	Tomahawk	Alta.	53 15 – 53 30	114 30 –115 00	57–1
83 G/8	Genesee	Alta.	53 15 – 53 30	114 00 –114 30	57–1
83 G/10	Isle Lake	Alta.	53 30 – 53 45	114 30 –115 00	57–1
83 G/15	Sangudo	Alta.	53 45 – 54 00	114 30 –115 00	57–1
83 G/16	Lac la Nonne	Alta.	53 45 – 54 00	114 00 –114 30	57–1
83 H/6	Cooking Lake	Alta.	53 15 – 53 30	113 00 –113 30	57–1
83 H/10	Elk Island Park	Alta.	53 30 – 53 45	112 30 –113 00	57–1
83 J/1	Barrhead	Alta.	54 00 – 54 15	114 00 –114 30	57–1
83 O/1	Smith	Alta.	55 00 – 55 15	114 00 –114 30	57–1
83 O/2	Florida Lake	Alta.	55 00 – 55 15	114 30 –115 00	57–1
83 O/3	Adams Creek	Alta.	55 00 – 55 15	115 00 –115 30	56–1
83 O/7	Slave Lake	Alta.	55 15 – 55 30	114 30 –115 00	56–1
82 E/6, 7 10, 11 (Parts)	Beaverdell	B.C.	49 25 – 49 37	118 55 –119 10	11–PR
82 F/2-E	Creston	B.C.	49 00 – 49 15	116 30 –116 45	26–PR
82 F/3	Salmo	B.C.	49 00 – 49 15	117 00 –117 30	34–PR
92 H/11-W	Spuzzum	B.C.	49 30 – 49 45	121 15 –121 30	57–1
92 I/16	Heffley	B.C.	50 45 – 51 00	120 00 –120 30	57–1
92 J/14, 15 O/2, 3 (Parts)	Tyaughton Lake	B.C.	50 50 – 51 05	122 45 –123 05	40–PR
92 P/1-E	Louis Creek	B.C.	51 00 – 51 15	120 00 –120 15	24–PR
92 P/8-E	Chu Chua Creek	B.C.	51 15 – 51 30	120 00 –120 15	23–PR
93 O/9-E	Mount Hulcross	B.C.	55 30 – 55 45	122 00 –122 15	44–PR
94 B/1-E	Chinaman Lake	B.C.	56 00 – 56 15	122 00 –122 15	44–PR
94 B/1-W	Dunlevy	B.C.	56 00 – 56 15	122 15 –122 30	44–PR
103 P/13-W	Stewart	B.C.	55 45 – 56 00	129 45 –130 00	29–PR
104 A/4-W	Bear River	B.C.	56 00 – 56 15	129 45 –130 00	29–PR
105 M/12	Mayo	Yukon	63 30 – 63 45	135 30 –136 00	56–1
105 M/13	Mount Haldane	Yukon	63 45 – 64 00	135 30 –136 00	56–1
75 M/2	Benjamin Lake	NWT.	63 00 – 63 15	110 30 –111 00	57–1
85 H/14	Caribou Islands	NWT.	61 45 – 62 00	113 00 –113 30	56–1
85 H/16	Hornby Channel	NWT.	61 45 – 62 00	112 00 –112 30	56–1
85 I/1	Blanchet Island	NWT.	62 00 – 62 15	112 00 –112 30	56–1
85 I/11	Ross Lake	NWT.	62 30 – 62 45	113 00 –113 30	56–PR
85 I/12	Prelude Lake	NWT.	62 30 – 62 45	113 30 –114 00	47–PR
85 I/14	Gordon Lake South	NWT.	62 45 – 63 00	113 00 –113 30	41–PR
85 P/3	Gordon Lake	NWT.	63 00 – 63 15	113 00 –113 30	41–PR
85 P/6	Muir Lake	NWT.	63 15 – 63 30	113 00 –113 30	40–PR
86 B/3	Ranji Lake	NWT.	64 00 – 64 15	115 00 –115 30	47–PR
86 B/6	Chalco Lake	NWT.	64 15 – 64 30	115 00 –115 30	47–PR

Appendix VI

Geological Maps

A—Geological Series (Multicolour)
P.S.—Preliminary Geological Series
G—Aeromagnetic Series, Scale, 1 inch to 1 mile

CANADA

900A	Canada, Principal Mineral Areas (seventh edition); in cooperation with the Mines Branch; scale, 1 inch to 120 miles.	

NORTHWEST TERRITORIES—DISTRICT OF FRANKLIN

15–1956 (P.S.)	Isachsen Area (parts of 69 NW and 79 NE); scale, 1 inch to 3 miles	Paper 56–8
16–1956 (P.S.)	North Coast of Ellesmere Island; scale, 1 inch to 8 miles	Paper 56–9

NORTHWEST TERRITORIES—DISTRICT OF MACKENZIE

7–1956 (P.S.)	Snowbird Lake (65D); scale, 1 inch to 4 miles	
9–1956 (P.S.)	Tumi Lake (85 N/7); scale, 1 inch to 1 mile	Paper 56–4
17–1956 (P.S.)	Eastern District of Mackenzie; scale, 1 inch to 8 miles	Paper 56–10
402G	Stephenson Lake (75 H/12)	
403G	Rauta Lake (75 H/13)	

NORTHWEST TERRITORIES AND YUKON

12–1956 (P.S.)	Northern Richardson Mountains (parts of 116NE and 106NW); scale, 1 inch to 6 miles	Paper 56–6

YUKON

1048A	Geological Map of Yukon Territory; scale, 1 inch to 20 miles	Geology. For Memoir 284 and separate distribution
5–1956 (P.S.)	Mayo Lake (105 M/15); scale, 1 inch to 1 mile	
4–1957 (P.S.)	Galena Hill Area (parts of 105 M/13 and 105 M/14); scale 1 inch to 2,000 feet	Paper 57–1

BRITISH COLUMBIA

55–40 (P.S.)	Vancouver Area (parts of 92G/3 and 6); New Westminster District, (Surficial Geology); scale, 1 inch to 1 mile	
3–1956 (P.S.)	Nelson, West Half (82 F, W. 1/2); Kootenay, and Similkameen Districts; scale, 1 inch to 4 miles	
4–1956 (P.S.)	Coal Mountain (parts of 82G/7 and 10); Kootenay District; scale, 1 inch to 800 feet	
8–1956 (P.S.)	Pitt Lake (92G, W. 1/2); New Westminster District; scale, 1 inch to 4 miles	

11–1956 (P.S.)	Terrace (103 I, E. 1/2); Coast District; scale, 1 inch to 4 miles	
6–1957 (P.S.)	Kettle River, East Half (82E, E. 1/2); Similkameen, Kootenay, and Osoyoos Districts; scale, 1 inch to 4 miles	
9–1957 (P.S.)	Stikine River Area (parts of 104 NE and SE); Cassiar District; scale, 1 inch to 8 miles	
10–1957 (P.S.)	Anahim Lake (93C); Coast District; scale, 1 inch to 4 miles	
12–1957 (P.S.)	Lardeau, East Half (82K, E. 1/2); Kootenay District; scale, 1 inch to 4 miles	
15–1957 (P.S.)	St. Mary Lake (82 F/9); Kootenay District; scale, 1 inch to 1 mile	
19–1957 (P.S.)	Bennett (104M); Cassiar District; scale, 1 inch to 4 miles	

ALBERTA AND BRITISH COLUMBIA

1039A	Alberta and Northeastern British Columbia; Oil and Gas Fields (fourth edition); scale, 1 inch to 20 miles	For separate distribution

ALBERTA

1049A	Grande Cache (83 E/14); West of Sixth Meridian; scale, 1 inch to 1 mile	Geology. For separate distribution
5–1957 (P.S.)	Adams Lookout, East Half (85 E/10, E.1/2); West of Sixth Meridian; scale, 1 inch to 1 mile	
11–1957 (P.S.)	Canmore Area (part of 820/3); West of Fifth Meridian; scale, 1 inch to 1,200 feet	Paper 57–4
13–1957 (P.S.)	Drumheller, East Half (82 P, E.1/2); West of Fourth Meridian, (Surficial Geology); scale, 1 inch to 4 miles	
14–1957 (P.S.)	High River (82 I, W.1/2); West of Fourth Meridian, (Surficial Geology); scale, 1 inch to 4 miles	

West of Fifth Meridian

333G Willow River (83 O/9)
338G Mistehae Lake (83 O/16)
351G Godin Lake (84 B/1)

West of Fourth Meridian

409G Kerchief Lake (84 A/11)
410G Woodenhouse River (84 A/12)
415G Seaforth Creek (84 A/13)
416G Chipewyan Lake (84 A/14)
417G Dunkirk River (84 A/15)
418G MacKay River (84 A/16)
419G Ruth Lake (74 D/13)
420G Clarke Creek (74 D/14)
421G Steepbank River (74 D/15)
422G Sutton Creek (74 D/16)
437G High Hill River (74 E/1)
438G Shillelagh Lake (74 E/2)
439G Muskeg River (74 E/3)
440G Fort MacKay (74 E/4)

West of Fourth Meridian—conc.

441G Upper Dover River (84 H/1)
442G Snipe Creek (84 H/2)
443G Osi Creek (84 H/3)
444G Osi Lake (84 H/4)
445G Bitumount (74 E/5)
446G McClelland Lake (74 E/6)
447G Firebag River (74 E/7)
448G Trout Creek (74 E/8)
449G Burnt Lakes (84 H/5)
450G Mikkwa River (84 H/6)
451G Namur Lake (84 H/7)
452G Joslyn Creek (84 H/8)
453G Tar River (84 H/9)
454G Gardiner Lake (84 H/10)
455G Bergeron Creek (84 H/11)
456G Upper Mikkwa River (84 H/12)
457G Raymond Creek (84 H/13)
458G Bolton Creek (84 H/14)
459G Louise River (73 H/15)
460G Eaglenest Lake (84 H/16)
462G Marguerite River (74 E/9)
463G Reid Creek (74 E/10)
464G Coffey Lake (74 E/11)
465G Eymundson Creek (74 E/12)
466G Ronald Lake (74 E/13)
467G Pearson Lake (74 E/14)
468G Richardson River (74 E/15)
469G Robert Creek (74 E/16)
470G Warspite (83 I/2)
471G Thorhild (83 I/3)
472G Westlock (83 I/4)
473G Dapp (83 I/5)
474G Perryvale (83 I/6)
475G Newbrook (83 I/7)
476G Bondiss (83 I/10)
477G Athabasca (83 I/11)
478G Coolidge (83 I/12)
479G Grosmont (83 I/13)
480G Sawdy (83 I/14)
481G Vincent Lake (73 L/3)
482G Cache Lake (73 L/4)
483G Goodfish Lake (73 L/5)
484G Maloy (73 L/6)
485G Pinehurst Lake (73 L/11)
486G Beaver Lake (73 L/12)
487G Lac la Biche (73 L/13)
488G Touchwood Lake (73 L/14)
489G Smoky Lake (83 I/1)
490G Victor Lake (83 I/8)
491G Hylo (83 I/9)
492G Horse Lake (83 I/16)
493G Pine Creek (83 I/15)
500G Cold Lake (73 L/8)
501G Marie Lake (73 L/9)
502G Medley River (73 L/16)
588G Muriel Lake (73 L/2)
589G Bonnyville (73 L/7)
590G Marguerite Lake (73 L/10)
591G Wolf River (73 L/15)

SASKATCHEWAN

55–28 (P.S.)	Uranium City, Sheets 3 and 4 (parts of 74 N/9 and 10); scale, 1 inch to 800 feet	Paper 55–28
18–1956 (P.S.)	Uranium City, Sheet 5, (part of 74 N/9); scale, 1 inch to 800 feet	
543G	Deep Bay (parts of 64 D/6 and 7)	

West of Third Meridian

305G Watapi Lake (73 N/5)
306G Nipin Lake (73 N/6)
307G McCusker Lake (73 N/7)
319G Niska Lake (73 N/10)
320G Vermette Lake (73 N/11)
321G McAlister Lake (73 N/12)
322G Graham Lake (73 N/13)
323G Michel (73 N/14)
324G Dillon (73 N/15)
494G Apps Lake (73 N/8)
495G Kazan Lake (73 N/9)
496G Buffalo Narrows (73 N/16)
552G Canoe Lake (73 N/1)
553G Juggins Creek (73 N/2)
554G Carlton Lake (73 N/3)
555G Calder River (73 N/4)
556G Primrose Lake (73 K/13)
557G Kesatasew Lake (73 K/14)
558G Lost Lake (73 K/15)
559G Keeley Lake (73 K/16)
560G Lac la Plonge (73 O/3)
561G La Plonge (73 O/4)
562G Ile-à-la-Crosse (73 O/5)
563G Cinder Lake (73 O/6)
564G Alstead Lake (73 O/11)
565G Abitau Bay (73 O/12)

West of Third Meridian—conc.

566G Shagwenaw Lake (73 O/13)
567G Dipper Lake (73 O/14)
568G Dore Lake South (73 J/11)
569G Aubichon Lake (73 J/12)
570G Durocher Lake (73 J/13)
571G Dore Lake North (73 J/14)
572G Waterhen Lake (73 K/9)
573G Flotten Lake (73 K/10)
574G Muskeg Lake (73 K/11)
575G Cold River (73 K/12)
576G Taggart Lake (73 J/3)
577G Green Lake South (73 J/4)
578G Green Lake North (73 J/5)
579G Sled Lake (73 J/6)
580G Meadow Lake (73 K/1)
581G Rapid View (73 K/2)
582G Makwa Lake (73 K/3)
583G Ministikwan Lake (73 K/4)
584G Pierceland (73 K/5)
585G Goodsoil (73 K/6)
586G Dorintosh (73 K/7)
587G Island Hill (73 K/8)

SASKATCHEWAN AND MANITOBA

1044A Saskatchewan and Western Manitoba, Oil and Gas Fields (third edition); scale, 1 inch to 20 miles .... For separate distribution

MANITOBA

10–1956 (P.S.) Split Lake (64A); scale, 1 inch to 4 miles
550G Anomaly North of Seal River, (part of 64 P/1)

628G Nichol Lake (64 I/9)
629G Lovat Lake (64 I/10)
630G Wither Lake (64 I/15)
631G Meades Lake (64 I/16)
632G Quinn Lake (64 I/11)
633G Steel River (64 I/14)
634G Knights Hill (54 K/13)
635G Cape Churchill (54 K/14)
636G Eppler Lake (54 L/13)
637G Howard Lake (54 L/14)
638G Knife Delta (54 L/15)
639G Churchill (54 L/16)
640G Button Bay (54 L/9)
641G Nowell Lake (54 L/10)
642G Langille Creek (54 L/11)
643G Duddles Lake (54 L/12)
644G White Whale River (43 K/11)
645G Norton Lake (54 K/12)

ONTARIO

1970 Blind River (part of 41J); Algoma District, (reprint); scale, 1 inch to 2 miles .... Geology. For separate distribution

20–1957 (P.S.) Manitoulin Island (parts of 41G and 41H); Manitoulin District; scale, 1 inch to 4 miles

55–41 (P.S.) Smooth Rock (42 H/SW); Cochrane District, (Surficial Geology); scale, 1 inch to 2 miles

14G Bannockburn (31 C/12); Hastings, and Peterborough Counties (revision)

15G Bancroft (31 F/4); Hastings, Renfrew, Lennox, and Addington Counties (revision)

16G Coe Hill (31 C/13); Hastings, Peterborough, and Haliburton Counties (revision)

279G Thorlake (41 P/3); Sudbury District

280G Opikinimika Lake (41 P/6); Sudbury, and Timiskaming Districts

ONTARIO—*conc:*

285G	Shining Tree (41 P/11); Sudbury, and Timiskaming Districts	
286G	Sinclair Lake (41 P/14); Sudbury, and Timiskaming Districts	
504G	Milnet (41 I/15); Sudbury District	
505G	Lake Timagami (41 I/16); Nipissing, and Sudbury Districts	
506G	Marten Lake (31 L/12); Nipissing District	
507G	Ingall Lake (31 L/13); Nipissing District	
508G	Ottertail Creek (31 L/14); Nipissing District	
510G	Timagami (31 M/4); Nipissing, and Timiskaming Districts	
551G	Venetian Lake (41 I/14); Sudbury District	

ONTARIO AND QUEBEC

509G	Fabre (31 M/3); Timiskaming, and Nipissing Districts, and Témiscamingue County	
511G	Cobalt (31 M/5); Timiskaming District and Témiscamingue County	
512G	Ville Marie (31 M/6); Timiskaming District and Témiscamingue County	
514G	Earlton (31 M/12); Timiskaming District and Témiscamingue County	
515G	Englehart (31 M/13); Timiskaming District and Témiscamingue County	

QUEBEC

570A	Puskitamika Lake (32F, E.1/2); Abitibi Territory; scale, 1 inch to 4 miles (reprint)	Geology. For separate distribution
703A	Southern Quebec, West Sheet; scale, 1 inch to 12 miles (reprint)	Geology. For separate distribution
55–42 (P.S.)	Cambrian Lake, West Half (24C, W.1/2); New Quebec; scale, 1 inch to 4 miles	Paper 55–42
513G	Angliers (31 M/11); Témiscamingue County	
516G	Lac Barrière (31 M/14); Témiscamingue County	
Abitibi County		
517G	Opawica Lake-Lewis Lake (32 G/12)	
518G	Michwacho Lake (32 G/14)	
519G	Opémisca Lake (32 G/15)	
520G	Miller Creek (32 E/1)	
521G	Kistabiche Creek (32 E/8)	
522G	Adam River (32 E/9)	
523G	Rivière Subercase (32 E/16)	

Abitibi County—conc.

QUEBEC—*conc.*

524G	Lac Quévillon (32 F/2)	
525G	Rivière Coigny (32 F/4)	
526G	Indian River (32 F/5)	
527G	Canica Island (32 F/6)	
528G	Lac Madeleine (32 F/7)	
529G	Puskitamika Lake (32 F/8)	
530G	Waswanipi (32 F/9)	
531G	Ramsay Bay (32 F/10)	
532G	Opaoca River (32 F/11)	
533G	Rivière Allard (32 F/12)	
534G	MacIvor River (32 F/13)	
535G	Olga Lake (32 F/14)	
536G	Maicasagi Lake (32 F/15)	
537G	McDonald Lake (32 F/16)	
539G	Lac à l'Eau-Jaune (32 G/10)	
540G	Dickson Lake (32 G/11)	
541G	Lac Inconnu (32 G/13)	
538G	Lac Boisvert (32 G/9); Abitibi and Lac St. Jean West Counties	
542G	Chibougamau (32 G/16); Abitibi and Lac St. Jean West Counties	
544G	Rivière de l'Epervier (32 H/13); Lac St. Jean West and Abitibi Counties	
545G	Canoe Lake (32 I/4); Mistassini and Abitibi Territories, Lac St. Jean West and Abitibi Counties	
546G	Mistassini Post (32 I/5); Mistassini Territory and Lac St. Jean West County	
547G	Waconichi Lake (32 J/1); Abitibi and Mistassini Territories and Abitibi County	
548G	Crinkle Creek (32 J/2); Abitibi Territory and Abitibi County	
549G	Lac Dumas (32 J/3); Abitibi Territory and Abitibi County	

NEW BRUNSWICK

2–1956 (P.S.)	Fredericton (21 G/15); York and Sunbury Counties, (Surficial Geology); scale, 1 inch to 1 mile	Paper 56-2
1–1957 (P.S.)	Bathurst Area (parts of 21O and 21P); Northumberland, Restigouche, and Gloucester Counties; scale, 1 inch to 2 miles	
7–1957 (P.S.)	Burtts Corner, West Half, (21 J/2, W.1/2); York County; scale, 1 inch to 1 mile	
136G	McAdam (21 G/11); York, and Charlotte Counties (revision)	
592G	Musquash (21 G/1); Saint John, Charlotte, and Kings Counties	
593G	McDougall Lake (21 G/7); Charlotte, Queens, and Sunbury Counties	
594G	Rolling Dam (21 G/6); Charlotte County	
595G	St. Stephen (21 G/3); Charlotte County	

NEW BRUNSWICK—*conc.*

596G	St. George (21 G/2); Charlotte County	
597G	Codys (21 H/13); Queens, and Kings Counties	
598G	Sussex (21 H/12); Kings, and Queens Counties	
599G	Hampstead (21 G/9); Queens, Kings, and Sunbury Counties	
600G	Saint John (21 G/8); Charlotte, Queens, Kings, and Saint John Counties	

NOVA SCOTIA

55–36 (P.S.)	Chéticamp River (11 K/10); Inverness, and Victoria Counties; scale, 1 inch to 1 mile........	Paper 55–36
1–1956 (P.S.)	Kennetcook (11 E/4); Hants County; scale, 1 inch to 1 mile	
6–1956 (P.S.)	Shubenacadie (11 E/3); Colchester, Halifax, and Hants Counties (Surficial Geology); scale, 1 inch to 1 mile	Paper 56–3
14–1956 (P.S.)	Baddeck (11 K/2); Victoria, Cape Breton, and Inverness Counties; scale, 1 inch to 1 mile	
17–1957 (P.S.)	Whycocomagh (11 F/14); Inverness County; scale, 1 inch to 1 mile	
601G	Yarmouth (20 O/16); Yarmouth County	
602G	Comeau Hill (20 O/9); Yarmouth County	
603G	Lockeport (20 P/11); Shelburne County	
604G	Cape Sable Island (20 P/5); Shelburne County	
605G	Pubnico (20 P/12); Yarmouth, and Shelburne Counties	
606G	Tusket (20 P/13); Yarmouth, and Shelburne Counties	
607G	Baccaro (20 P/6); Shelburne County	
608G	Shelburne (20 P/14); Shelburne, and Queens Counties	
609G	Port Mouton (20 P/15); Queens, and Shelburne Counties	
610G	Meteghan (21 B/1); Digby, and Yarmouth Counties	
611G	Church Point (21 B/8); Digby County	
612G	La Have Islands (21 A/1); Lunenburg County	
613G	Liverpool (21 A/2); Queens, and Lunenburg Counties	
614G	Lake Rossignol (21 A/3); Queens, Shelburne, Yarmouth, and Digby Counties	
615G	Wentworth Lake (21 A/4); Digby, Yarmouth, and Shelburne Counties	
616G	Weymouth (21 A/5); Digby, and Annapolis Counties	

NOVA SCOTIA—*conc.*

617G	Kejimkujik Lake (21 A/6); Annapolis, Queens and Digby Counties	
618G	Bridgewater (21 A/7); Lunenburg, and Queens Counties	
619G	Lunenburg (21 A/8); Lunenburg County	

NEWFOUNDLAND

55–31 (P.S.)	Comfort Cove (2 E/7); scale, 1 inch to 1 mile	Paper 55–31
13–1956 (P.S.)	Dildo (1 N/12); scale, 1 inch to 1 mile	
2–1957 (P.S.)	Stephenville (12B); scale, 1 inch to 4 miles	
3–1957 (P.S.)	Gander Lake, East Half (2D, E.1/2); scale, 1 inch to 4 miles	
8–1957 (P.S.)	Red Indian Lake, West Half (12A, W.1/2); scale, 1 inch to 4 miles	
206G	Dashwoods Pond (12 B/1), (revision)	

Appendix VII

Geographical Maps

Agricultural Regions of Canada; scale, 1 inch to 53 miles (black and white).
Canada; Points Served by Civil Air Lines; scale, 1 inch to 106 miles (black and white).

Atlas of Canada Sheets Printed in 1957

1 Routes of Explorers, 1534-1870
2 Extent of Topographical Mapping—1955
6 Comparison of Scales
7 Aeronautical Charts
15 Glacial Geology
22 Temperature Ranges
23 Frost
24 Growing Seasons
25 Annual Precipitation
26 Precipitation Days and Precipitation Variability
27 Seasonal Precipitation
29 Humidity and Fog
30 Climatic Regions
32 Weather Stations and Forecast Regions
34 Profiles of Major Rivers
36 Soil Survey Maps
39 Forest Regions
46 Distribution of Population, 1851-1941
53 French and British Origins
55 Principal Religions
66 Other Grain and Oil Seeds
67 Fodder Crops and Intensive Crops
68 Farms
90 Shipping

64129-0—9

Appendix VIII

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

Table 1—Ore or Product*

Nature of Sample	Yukon	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	Nfld.	Total
Aluminum	....	....	....	....	....	....	....	....	1	....	1
Chromium	....	....	....	....	1	....	....	....	....	....	1
Cobalt-Silver	....	....	....	....	....	1	....	....	....	....	1
Copper	....	1	....	....	....	2	2	....	....	....	5
Copper-Nickel	....	....	....	....	1	4	3	....	....	....	8
Gold	1	....	....	....	....	2	....	....	1	....	4
Gold-Iron-Titanium-Zirconium	....	1	....	....	....	....	....	....	....	....	1
Iron	....	....	2	1	....	9	3	....	....	2	17
Iron-Manganese	....	....	....	....	....	1	....	....	....	....	1
Iron-Titanium	....	....	....	....	....	....	8	....	....	1	9
Lead-Zinc	....	1	....	....	....	1	....	....	....	....	2
Lead-Zinc-Copper	....	1	....	....	....	....	....	....	....	....	1
Lithium	....	....	....	....	1	....	....	....	....	....	1
Manganese	....	....	....	....	....	1	....	4	....	....	5
Manganese-Tungsten	....	....	....	....	....	....	....	....	1	....	1
Molybdenum	....	....	....	....	....	1	....	....	....	....	1
Nickel	....	1	....	....	....	....	....	....	....	....	1
Niobium	....	....	....	....	....	1	4	....	....	....	5
Rare Earths	....	1	....	....	....	....	....	....	....	....	1
Silver-Lead-Tungsten	....	....	....	....	....	....	1	....	....	....	1
Silver-Lead-Zinc	....	1	....	....	....	....	....	....	....	....	1
Speiss	....	....	....	....	....	1	....	....	....	....	1
Tin	....	1	....	....	....	....	....	....	....	....	1
Titanium	....	....	....	....	....	....	1	....	....	....	1
Total	1	8	2	1	3	24	22	4	3	3	71

* Table 1 includes only those samples received for major ore-dressing or metal-recovery investigation.

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

Table 2—Industrial Minerals

	Yukon N.W.T.	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.	Total
Andalusite	....	....	....	....	....	....	....	....	2	....	....	2
Apatite	....	1	....	....	....	....	....	....	....	....	....	1
Asbestos	1	1	....	....	....	2	15	....	....	....	....	19
Barite	....	1	....	....	....	....	....	2	....	....	....	3
Bentonite	....	....	....	....	8	....	....	....	....	....	....	8
Beryl	....	....	....	....	1	....	....	....	....	....	....	1
Celestite	....	1	....	....	....	....	....	....	....	....	....	1
Diatomite	....	1	2	....	....	....	....	....	....	....	....	3
Dolomite	....	....	....	....	....	8	7	....	1	....	....	16
Feldspar	....	2	....	....	....	....	1	....	2	....	....	5
Garnet	....	1	....	....	....	3	2	....	2	....	....	8
Graphite	....	....	....	....	....	3	3	....	....	....	1	7
Gypsum	....	....	....	....	....	1	....	....	1	....	....	2
Iron Oxide	....	....	....	....	....	....	3	....	....	....	....	3
Kyanite	....	1	....	....	....	1	....	....	....	....	....	2
Limestone	1	1	2	....	2	25	22	....	2	....	....	55
Magnesia	....	....	....	....	....	....	14	....	....	....	....	14
Magnesite	....	1	....	....	....	....	....	....	....	....	....	1
Marl	....	....	....	2	....	12	4	....	....	....	....	18
Mica	....	2	....	....	....	3	7	....	1	....	....	13
Nepheline syenite	....	....	....	....	....	1	....	....	....	....	....	1
Potash	....	....	....	8	....	....	....	....	....	....	....	8
Pyrophyllite	....	....	....	....	....	....	....	....	....	....	2	2
Rutile	....	....	....	....	....	....	1	....	....	....	....	1
Salt	....	....	....	....	....	3	....	....	....	....	....	3
Silica	....	1	....	1	....	40	13	....	2	1	....	58
Spodumene	....	....	....	....	1	1	....	....	....	....	....	2
Talc	....	1	....	....	1	1	....	....	....	....	....	3
Witherite	....	1	....	....	....	....	....	....	....	....	....	1
Zeolites	....	....	....	....	....	....	....	....	12	....	....	12
Aggregate: i.e. Crushed stone and gravel	....	....	1	....	....	40	10	....	1	....	....	52
Light-weight aggregate:												
(*a*) Clays and shales	....	2	....	....	....	18	48	3	1	....	4	76
(*b*) Vermiculite	....	....	....	....	....	2	....	....	....	....	....	2
(*c*) Others	....	....	....	....	....	1	....	....	....	....	....	1
Building stones:												
(*a*) Granite	....	....	....	....	....	....	2	....	3	....	....	5
(*b*) Limestone	....	....	....	....	....	2	1	....	....	....	....	3
(*c*) Marble	....	....	....	....	....	2	4	....	....	....	....	6
(*d*) Sandstone	....	....	....	....	....	....	3	....	....	....	....	3
Roofing granules	....	....	....	....	....	3	....	....	....	....	....	3
Ceramic clays and shales	....	26	10	8	12	16	25	6	4	3	4	114
Refractory materials and products	....	8	....	....	3	9	10	....	....	....	....	30
Structural and other ceramic materials	....	....	....	....	....	17	14	1	1	....	....	33
Other materials	....	1	1	....	....	3	2	....	....	....	....	7
Total	21	53	16	19	28	217	211	12	35	4	11	608

Appendix IX

Geological Survey of Canada Research Grants to Canadian Universities—1957-58

Twenty applications for grants-in-aid for the support and stimulation of geological research in Canadian universities were received, amounting to $61,101. Grants totalling $40,000 were awarded in support of 16 new research projects in nine universities.

Applications for grants are submitted by members of university staffs to the Director of the Geological Survey of Canada. They are reviewed by the National Advisory Committee on Research in the Geological Sciences, and are awarded by the Geological Survey on the basis of the resulting recommendations.

Thirty-one projects in eleven universities are being supported; twenty-seven other projects have been completed. The grants are achieving their purpose and, in addition, are supplying valuable research information which could not be provided by the staffs and facilities available. They are producing results of real value to the scientist and the public. Since 1951, when the grants were initiated, more than fifty-five papers, recording the results of research supported by the grants, have been published in scientific periodicals.

Emphasis in the projects supported is in the newer and more experimental fields that will extend knowledge of general principles rather than answer specific practical problems. Real advances in the science must come from increased knowledge of this kind. Thus, experimental studies at McGill University of the behaviour of silicates and sulphides at high temperatures and pressures may provide more information on the changes rocks undergo when deeply buried in the earth's crust, and on how and why the ore deposits associated with them are formed. Research on the determination of the ages of rocks and minerals at University of Toronto and University of Alberta will add to existing knowledge of the structure and history of the rocks of the earth's crust. Detailed studies in granitic rocks at Queen's University may tell more about their origin and the origin of important ore deposits associated with them.

Amounts of the individual grants made to the universities in 1957 and descriptions of the projects follow. Summaries of the projects, supported by grants, that were completed in 1956-57 and of others that are under way, may be found in the Seventh Annual Report of the National Advisory Committee, 1956-57, Appendices I and II.

University of Alberta

Heat-flow Measurements in Western Canada

Applicant—G. D. Garland .... Amount $1,000.00

The aim of this project is to measure the outflow of heat from the earth's interior in that part of Western Canada where deep bore holes are available. It is hoped to determine whether there are regional variations in heat flow in the areas studied, especially from the vicinity of the Precambrian Shield toward the Cordilleran Mountains.

The rate of outflow of heat from the earth's interior is important because present theories of mountain building and orogenesis are based on assumptions regarding the thermal state of the earth's interior which, in turn, is based on heat-flow measurements.

Problems in Nuclear Geochronology

Applicant—R. E. Folinsbee .... Amount $4,200.00

Dr. Folinsbee is 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 is attempting to date and relate significant events in the orogenic and sedimentary history of the rocks of Western Canada. The project was initiated in 1955.

University of British Columbia

Trace-element Study of Some Rocks in Western Canada

Applicant—H. V. Warren .... Amount $3,800.00

This project concerns the study of trace-element relations between soils and rocks. The investigation involves the development of special chemical techniques, supplemented by spectroscopy.

École Polytechnique

Mineralogy and Petrography of the Oka Alkaline Intrusions

Applicant—Guy Perrault .... Amount $1,000.00

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

This project includes a detailed study of the mineralogy and petrography of the intrusions, including a study of the common rock-forming minerals and the columbian minerals of the ore deposits. It is hoped the study may give some insight into the genesis of the alkaline rocks and of the associated columbium deposits.

University of Manitoba

Basic Intrusions in the Kenora–Fort William Area

Applicant—H. D. B. Wilson..Amount $2,500.00

This project involves fundamental petrographic and geochemical studies of the basic intrusions of this area. These rocks are of particular interest because of the nickel deposits associated with them at Gordon Lake, north of Kenora.

McGill University

Silicate and Sulphide Phase Relationships

Applicants—J. E. Gill, E. H. Kranck, V. A. Saull...........Amount $3,600.00

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

Current work consists of the study of (1) deposition of sulphides from solution or suspension by changing P-T conditions, (2) rheomorphism of sulphide-bearing rocks, (3) stability relations of pyrrhotite, and (4) sphalerite and pyrrhotite as temperature indicators.

McMaster University

Greywackes of the Northern Appalachians

Applicant—G. V. Middleton..Amount $1,200.00

The purpose of this project is to learn more about the petrography and geochemistry of this type of sedimentary rock of which relatively few petrographic, and still fewer geochemical studies have been made. The geochemical work will include a study of the trace elements and selected major elements using spectrographic techniques. The ratio of Na to K is high in most greywackes. It is hoped the combined petrographic and chemical studies may indicate the reason for this and to what extent it is caused by the presence of fragments of Na-rich volcanic rocks.

Geochemical Studies

Applicant—Denis M. Shaw...Amount $3,800.00

A program of spectrochemical research on the distribution of minor elements in metamorphic rocks and minerals has been supported at McMaster University since 1951. Investigations under way include (1) major and minor elements in the skarn minerals of the Quebec-Grenville region, (2) the relation of alkali contents to refractive index in scapolites, (3) minor elements in pyroxenes, (4) distribution of lithium in minerals of the LaCorne region, Quebec, and (5) minor elements in the White Mountain (New Hampshire) magma series.

Queen's University

Publication of "Canadian Mineralogist"

Applicant—L. G. Berry, *Editor*...Amount $2,400.00

The Mineralogical Association of Canada was organized in 1954 to publish the "Canadian Mineralogist" annually (the first number was issued in September, 1957). Mineralogical studies are of interest to a relatively small group of readers in Canada. This makes it difficult to publish such a periodical without financial support for the first few years. Support will be on a diminishing scale as circulation, particularly outside Canada, is built up.

X-ray Spectrographic Analysis of Minerals and Rocks

Applicant—L. G. Berry...Amount $2,200.00

The basic equipment for this research which was initiated in 1955 has been provided by a grant of $20,000 from the Atkinson Charitable Foundation. The Geological Survey of Canada grant provides operating costs, including the services of a technician.

The research includes exploration of the application of the equipment to the determination of Ti, Ca, K, Cl, P, Si and Al in rocks and minerals, the determination of sulphur in minerals, and the development of methods of sample preparation that will be applicable to qualitative and quantitative analysis of small samples of minerals. Some success has been attained in the determination of Cl, Ti, Ca, and K in minerals and rocks, using the helium path attachment with the X-ray spectrograph.

Annual Report—Mines and Technical Surveys

Spectrographic and Geochemical Research on Rocks, Minerals, and Ores

Applicant—J. E. Hawley .... Amount $4,600.00

Since the initiation of this project in 1952, a scheme has been developed for the accurate analysis of siliceous rocks. Present emphasis is on the analysis of granites of the Grenville provinces of southeastern Ontario, including major constituents and trace elements. It is hoped the results of this study will assist in distinguishing granitic rocks formed from magmas from those produced by metamorphic processes. Similar geochemical studies are being made of the granitic basement rocks in the Algoma uranium area and of several granitic bodies in the Sudbury area. A geochemical study of the Grenville paragneisses, limestones, and basic intrusions is planned.

University of Toronto

Formation of Clay Minerals in Weathering

Applicants—A. Gorman and R. E. Deane .... Amount $2,400.00

Although much is known about the properties and composition of the clay minerals, nothing is known of the time required for the formation of clays from minerals and rocks, and little about the genetic relationships between parent minerals and clays.

In this project, which was initiated in 1956, weathering effects on twenty-five minerals and six rock types are being investigated. Samples are crushed and ground, separated into sized fractions, placed in natural environments above and below ground surface, and examined at intervals to ascertain the mineralogical changes taking place. The project, although primarily of interest to the clay mineralogist, will also prove interesting to those concerned with the various fields of geology, pedology, and soil mechanics.

Annotated Bibliography and Index of Pleistocene Geology of Canada

Applicant—R. E. Deane .... Amount $1,050.00

No comprehensive bibliography of Pleistocene geology exists and a sound program of research cannot be undertaken without knowledge of what has been done. The bibliography will supplement the Pleistocene map of Canada now being compiled. The two will summarize present knowledge of Canadian Pleistocene geology, and provide a framework for the detailed information being accumulated.

Geological Age Determination

Applicant—J. T. Wilson..Amount $5,000.00

This project has been supported by Geological Survey of Canada grants since 1951. The results of the work on potassium-argon age determinations carried on in 1955 and 1956 have been published. An argon line of improved design has been completed and preliminary experiments have been successful. Ion-exchange columns were set up to separate rubidium and strontium-bearing solutions. It is hoped rubidium-strontium ages can be determined by the summer of 1957.

University of Western Ontario

Scale-model Experiments of Electro-magnetic Prospecting

Applicant—Robert J. Uffen..Amount $1,000.00

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.

Work on this project, which was initiated in 1954, involves scale-model experiments of the electromagnetic response of typical geological structures, as an aid in the interpretation of field surveys. Measurements of amplitude and phase using good conducting sheets of various sizes and attitudes will be continued. The theoretical treatment of the response of disseminated metallic minerals will also be tested by using assemblies of closely packed metal spheres of various sizes.

Microfauna of the Kettle Point, Port Lambton, and Other Devonian Black Shales in Southern Ontario

Applicant—G. Gordon Winder...Amount $250.00

The age of these shales is in doubt—they may be Devonian or Mississippian. It is hoped that the differentiation, description, and correlation of the microfauna, particularly the conodonts, will aid in determining their correct stratigraphic position.

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Appendix X

PUBLICATIONS AND ARTICLES PUBLISHED

1. Publications

Administrative

Summary of Activities 1956. (Offset.)
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, 1957.
Annual Report for the fiscal year ended March 31, 1956.

French Versions

Report of the Explosives Division (Calendar Year 1955).
The Storage of Explosives.
Summary of Activities 1956. (Offset.)
Report on the Administration of the Emergency Gold Mining Assistance Act for the fiscal year ended March 31, 1957.
Annual Report for the fiscal year ended March 31, 1956.

Mineral Resources Division

63 Preliminary mineral reviews. (Offset.)
List 1-1, *Metallurgical Works in Canada, Part I, Primary Iron and Steel, January 1957.* (Offset.)
List 1-1, *Metallurgical Works in Canada, Part II, Non-Ferrous and Precious Metals, January 1957.* (Offset.)
List 1-2, *Milling Plants in Canada, Part I, Metallic Ores, January 1957.* (Offset.)
List 1-2, *Milling Plants in Canada, Part II, Industrial Minerals, January 1957.* (Offset.)
List 2-1, *Metal and Industrial Mineral Mines in Canada, January 1957.* (Offset.)
List 4-1, *Coal Mines in Canada, January 1957.* (Offset.)
List 5-2, *Petroleum Refineries in Canada, January 1957.* (Offset.)

Inf. Circ.:

M.R. 21: *Rare or Less Common Metals in Canada,* by T. H. Janes.
M.R. 22: *A Survey of the Iron Ore Industry in Canada during 1956,* by T. H. Janes.
M.R. 23: *A Survey of the Petroleum Industry in Canada during 1956,* by R. B. Toombs and R. A. Simpson.
M.R. 24: *A Survey of the Natural Gas Industry in Canada during 1956,* by R. B. Toombs and R. A. Simpson.
M.R. 25: *A Survey of the Gold Mining Industry in Canada during 1956,* by T. W. Verity.
M.R. 26: *A Survey of Developments in the Titanium Industry during 1956,* by T. H. Janes.

French Versions

63 Preliminary mineral reviews. (Offset.)

Surveys and Mapping Branch

Geodetic Survey of Canada

Geodetic Operations in Canada, January 1, 1954 to December 31, 1956, by J. E. R. Ross.

Publ. 19. *Precise Levelling in Ontario, South of Parry Sound,* by R. H. Montgomery. (Reprint.)

Canadian Hydrographic Service

Construction of Tide Stations at Brevoort Harbour and Resolute, N.W.T., by G. C. Dohler. (Offset.)

Suppl. No. 1, British Columbia Pilot, Vol. I, (1951 Edn.)

Suppl. No. 1, Labrador and Hudson Bay Pilot, (1954 Edn.)

Suppl. No. 1, Great Lakes Pilot, Vol. II, (1955 Edn.)

Foxe Basin Pilot. (Revised Prelim. Edn. 1957.)

St. Lawrence Pilot. First Edition (combines Gulf of St. Lawrence Pilot and the St. Lawrence Pilot below Quebec).

Tide Tables, 1958:

1. *Atlantice Coast.*
2. *St. Lawrence and Saguenay Rivers.*
3. *Prince Edward Island and Adjacent Waters.*
4. *Nova Scotia, Atlantic Coast.*
5. *Bay of Fundy.*
6. *Newfoundland, South and East Coasts.*
10. *Pacific Coast.*
11. *Strait of Georgia.*
12. *British Columbia, Northern Waters.*
13. *Vancouver Island, Southwest Coast.*

Geological Survey of Canada

Memoirs:

282: *Subsurface Stratigraphy of the Mississippian Rocks of Saskatchewan,* by G. H. MacDonald.

284: *Yukon Territory—Selected Field Reports of the Geological Survey of Canada 1898 to 1933,* by H. S. Bostock.

285: *Lower Cretaceous Floras of Western Canada,* by W. A. Bell.

286: *The Arthropod Fauna of the Upper Carboniferous Rocks of the Maritime Provinces,* by M. J. Copeland.

287: *The Jurassic Fernie Group in the Canadian Rocky Mountains and Foothills,* by H. Frebold.

Bulletins:

34: *Regional Zonation of Pegmatites near Ross Lake, District of Mackenzie, Northwest Territories,* by R. W. Hutchinson.

36: *Geochemical Investigation of Heavy Metal Content of Streams and Springs in the Galena Hill-Mount Haldane Area, Yukon Territory,* by R. W. Boyle, E. L. Pekar and P. R. Patterson.

37: *The Erratics Train, Foothills of Alberta,* by A. MacS. Stalker.

Papers:

55–28: *Uranium City, Saskatchewan.* (Map with marginal notes, Sheets 3 and 4), by L. P. Tremblay.

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55–31: *Comfort Cove, Newfoundland.* (Map with marginal notes), by T. O. H. Patrick.

55–36: *Cheticamp River, Inverness and Victoria Counties, Nova Scotia.* (Map with marginal notes), by A. S. MacLaren.

55–38: *Correlation of Devonian Subsurface Formations, Southern Alberta,* by Helen R. Belyea.

55–40: *Surficial Geology of Vancouver Area, British Columbia.* (Map and report), by J. E. Armstrong.

55–41: *Surficial Geology of Smooth Rock, Cochrane District, Ontario.* (Preliminary report), by O. L. Hughes.

55–42: *Cambrian Lake (West Half), New Quebec,* by W. F. Fahrig.

56– 2: *Surficial Geology of Fredericton, York and Sunbury Counties, New Brunswick.* (Preliminary report and Map 2-1956), by H. A. Lee.

56– 3: *Surficial Geology of Shubenacadie Map-area, Nova Scotia.* (Report and Map 6-1956), by O. L. Hughes.

56– 4: *Tumi Lake Map-area, District of Mackenzie, Northwest Territories.* (Report and Map 9-1956), by J. C. McGlynn.

56– 6: *Geological Reconnaissance in the Northern Richardson Mountains, Yukon and Northwest Territories.* (Report and Map 12-1956), by H. Gabrielse.

56– 7: *Geology and Uranium Deposits, Quirke Lake-Elliot Lake, Blind River Area, Ontario.* (Preliminary report), by S. M. Roscoe.

56– 8: *Isachsen Area, Ellef Ringnes Island, District of Franklin, Northwest Territories.* (Report and Map 15-1956), by W. W. Heywood.

56– 9: *Geological Reconnaissance of the North Coast of Ellesmere Island, District of Franklin, Northwest Territories (1954).* (Report and Map 16-1956), by R. L. Christie.

56–10: *Geological Notes on Eastern District of Mackenzie, Northwest Territories.* (Report and Map 17-1956), by G. M. Wright.

57– 1: *The Geology and Geochemistry of the Silver-Lead-Zinc Deposits of Galena Hill, Yukon Territory.* (Preliminary report, Map 4-1957, and 6 figures), by R. W. Boyle.

57– 2: *Uranium Deposits in Gaspé, New Brunswick, and Nova Scotia,* by G. A. Gross.

57– 3: *Lithium Deposits of Manitoba, Ontario, and Quebec (1956),* by R. Mulligan.

57– 4: *Canmore, Alberta (82 O/3 in part).* (Report and Map 11-1957), by D. K. Norris.

Miscellaneous:

Economic Geology Series No. 1: Geology and Economic Minerals of Canada (Fourth Edition), by C. H. Stockwell.

Supplement to "List of Publications of the Geological Survey of Canada (1917-1952)" to August 1956.

French Versions

Memoirs:

253: *Fiedmont Map-area, Abitibi County, Quebec,* by L. P. Tremblay.

257: *Geology of a Southwestern Part of the Eastern Townships of Quebec,* by H. C. Cooke.

Mines Branch

Reports:

846: *Drilling and Sampling of Bituminous Sands of Northern Alberta, Vol. II.* (Reprint.) (Offset.)

854: *Digest of the Mining Laws of Canada,* (5th Edn.), by H. A. Graves and G. R. L. Potter.
857: *The Canadian Mineral Industry, 1954.* (Offset.)
860: *Minerals—Canada and the World,* and *Statistical Supplement to Minerals—Canada and the World.* (Offset.)

Technical Papers:

No. 16: *Master Sieves at the Mines Branch for Standardization of the Sieves of the Mining Industry,* by J. Brannen and L. E. Djingheuzian. (Offset.)
17: *Cyclone Atomizer for Briquet Binder,* by J. Visman. (Offset.)

Memorandum Series:

No. 134: *The Silica Industry in Canada,* by R. K. Collings. (Offset.)
135: *Columbium (Niobium) and Tantalum,* by R. J. Jones. (Offset.)
136: *Fifty Years of Fuel Testing and Research,* by A. A. Swinnerton. (Offset.)

French Versions

852: *The Granite Industry in Canada,* by G. F. Carr.
995: *The Canadian Mineral Industry, 1954.* (Offset.)

Memorandum Series:

No. 133: *Power and Population: Canada's Present Electricity Requirements and the Long Term Outlook,* by C. E. Baltzer and John Convey. (Offset.)

Dominion Observatories

Dominion Observatory, Ottawa

Vol. XIV, No. 18:
Bibliography of Seismology, July to December 1955, by W. E. T. Smith.

Vol. XIV, No. 19:
Bibliography of Seismology, January to June 1956, by W. E. T. Smith.

Vol. XV, No. 7:
Results of Observations made with the Reversible Meridian Circle, 1950-53, by E. G. Woolsey and R. W. Tanner.

Vol. XVII, No. 1:
Record of Observations at the Magnetic Observatories Agincourt and Meanook, 1934-35, by W. E. W. Jackson.

Vol. XVIII, No. 12:
Characteristics of Magnetic Disturbance at the Canadian Arctic Observatories, by K. Whitham and E. I. Loomer.

Vol. XIX, No. 1:
Gravity Measurements in Canada, January 1, 1954 to December 31, 1956, by M. J. S. Innes.

Vol. XIX, No. 2:
A Three-Component Airborne Magnetometer, by P. H. Serson, S. Z. Mack and K. Whitham.

Vol. XIX, No. 3:
Table of Russian Fault Plane Solutions, by A. E. Scheidegger.

Seismological Bulletins: Eastern and Western Divisions, 1955; April-June 1956; July-September 1956; October-December 1956; January-March 1957. (Offset.)

Astrophysical Observatory, Victoria, B.C.

Vol. X, No. 14:
The Stellar Photometer of the Dominion Astrophysical Observatory, by P. E. Argyle.

Vol. X, No. 15:
The Integrating Exposure Meter of the Dominion Astrophysical Observatory, by J. B. Warren and P. E. Argyle.

Vol. X, No. 16:
The Spectrographic Orbit of H.D. 123299, Alpha Draconis, by Joseph A. Pearce.

Vol. X, No. 17:
Spectrographic Observations at the 1953, and 1955-56 Eclipses of Zeta Aurigae, by A. McKellar and E. Butkov.

Vol. X, No. 18:
The Spectrographic Orbit of H.D. 24118, by Joseph E. Pearce.

Geographical Branch

Geographical Bulletin No. 9: *Land Use and Population of Central Winnipeg,* by Thomas R. Weir. *A Land Use Reconnaissance of the Annapolis-Cornwallis Valley, Nova Scotia,* by Brooke Cornwall. *Population Distribution of the Labrador Coast, Newfoundland,* by W. A. Black. *Landforms and Topography of the Lake Melville Area, Labrador, Newfoundland,* by Weston Blake, Jr.

Papers:

No. 7: *Extracts Relating to the Navigability of Canadian Inland Waterways,* by W. A. Black. (Offset.)
8: *Notes on Potential Building Sites in the Bathurst Inlet Area,* by J. B. and M. B. Bird. (Offset.)
9: *A Report on Sea Ice Conditions, Eastern Arctic, Summer 1956,* by W. A. Black. (Offset.)
10: *A Preliminary Report on Ice Conditions at Cacouna Island, Quebec,* by B. Robitaille. (Offset.)
11: *An Illustrated Glossary of Ice Types in the Gulf of St. Lawrence,* by W. A. Black. (Offset.)
12: *Gulf of St. Lawrence Ice Survey, Winter 1956,* by W. A. Black and C. N. Forward. (Offset.)
13: *Notes on Small Boat Harbours, N.W.T.,* by J. Ross Mackay. (Offset.)
14: *Gulf of St. Lawrence Ice Survey, Winter 1957,* by W. A. Black. (Offset.)

Bibliographical Series:

No. 13: *Canadian Urban Geography.* (Revised Edition.) (Offset.)
17: *Selected Bibliography of Canadian Geography with Imprint 1955.* (Offset.)
18: *Selected Bibliography on Sea Ice Distribution in the Coastal Waters of Canada.* (Offset.)

2. Articles Published in Scientific and Technical Journals

ADMINISTRATION

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