CANADA

ANNUAL REPORT 1956

FISCAL YEAR ENDED MARCH 31

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Price: 50 cents

ANNUAL REPORT

MINES AND TECHNICAL SURVEYS

FOR THE FISCAL YEAR 1955-56

SURVEYS AND MAPPING BRANCH

GEOLOGICAL SURVEY OF CANADA

MINES BRANCH

DOMINION OBSERVATORIES

GEOGRAPHICAL BRANCH

1,500-1956

CONTENTS

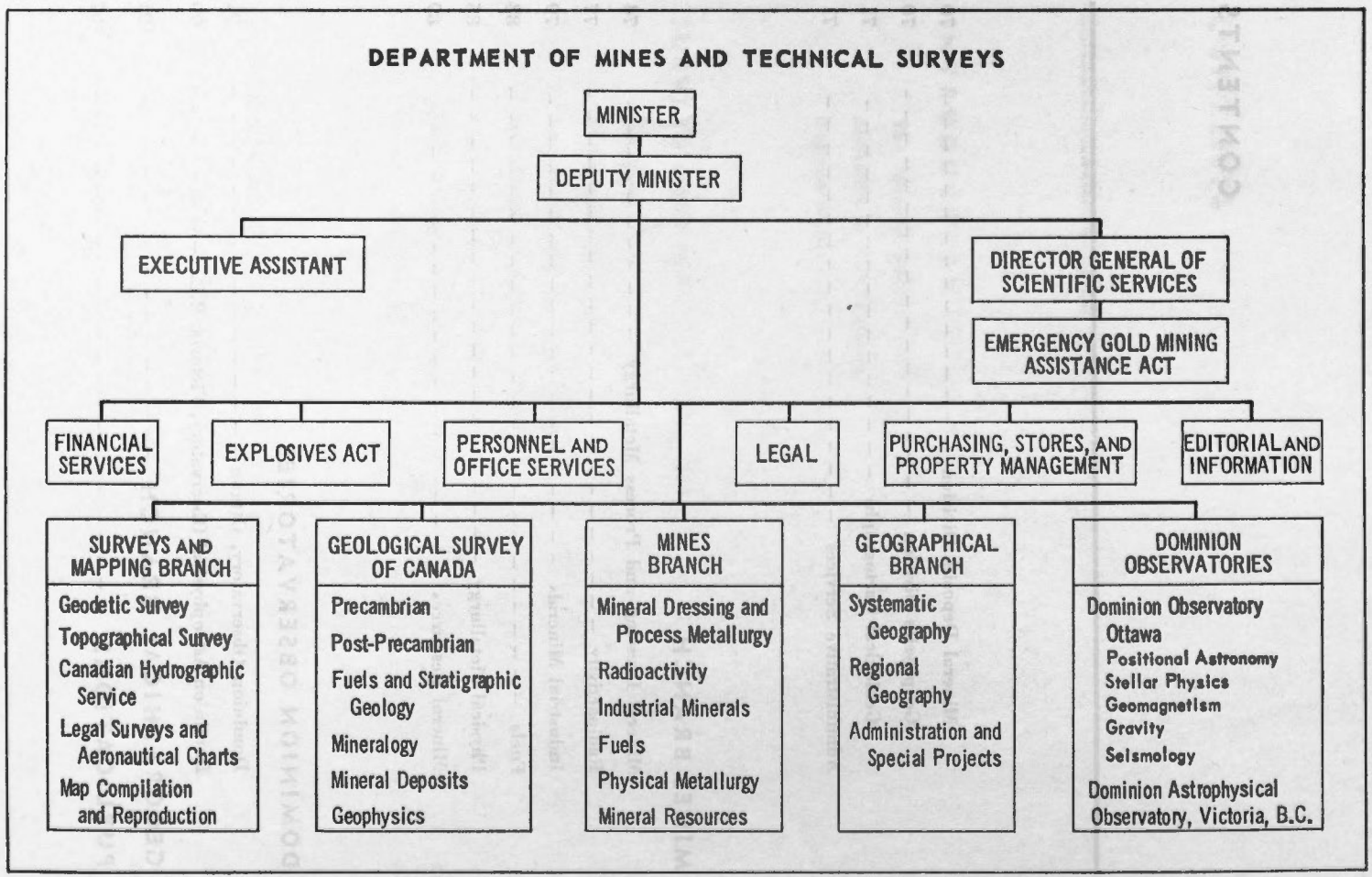
INTRODUCTION

SURVEYS AND MAPPING BRANCH

GEOLOGICAL SURVEY OF CANADA

CONTENTS

76816—1½


DEPARTMENT OF MINES AND TECHNICAL SURVEYS
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DEPUTY MINISTER
EXECUTIVE ASSISTANT
DIRECTOR GENERAL OF SCIENTIFIC SERVICES
EMERGENCY GOLD MINING ASSISTANCE ACT
FINANCIAL SERVICES
EXPLOSIVES ACT
PERSONNEL AND OFFICE SERVICES
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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 fiscal year ended March 31, 1956.

Respectfully submitted,

GEORGE PRUDHAM,
Minister of Mines and Technical Surveys.

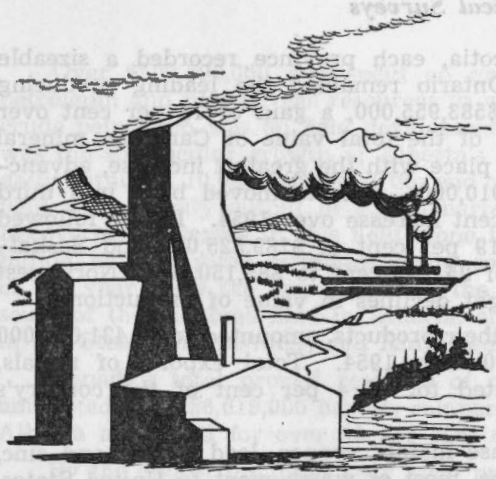
The Honourable George Prudham,
Minister of Mines and Technical Surveys,
Ottawa.

SIR:

I have the honour to submit the Annual Report of the Department of Mines and Technical Surveys, covering the fiscal year ended March 31, 1956.

Your obedient servant,

G. S. HUME,
Acting Deputy Minister.



INTRODUCTION

THE MINERAL INDUSTRY

CANADA'S mineral industry recorded outstanding progress in 1955. Its value of production reached a new high of $1,795,311,000, a gain of $306,929,000 over 1954 and the greatest single gain ever recorded in annual increases in value of output. The index of physical volume of production, which is based on the 1935-39 average equals 100, climbed 32·3 points over 1954 to 242·0.

Development activity reached record levels, particularly in the base metal areas, and capital expenditures (exclusive of crude petroleum and natural gas) climbed to a new high, with over $630,000,000 being spent on projects in progress or planned at the end of the fiscal year. Major factors in the great growth of the industry were the continued expansion in actual and potential production of crude petroleum in western Canada, the addition of uranium to the list of Canada's principal minerals, the mushroom-like growth of iron ore production, and the continued extension of base metal production facilities, particularly of nickel, copper, and zinc.

For the first time, the value of metal production passed the billion dollar mark with an output valued at $1,007,839,000, a 26 per cent increase over 1954. Mineral fuels rose 17 per cent over 1954 to $414,318,000; structural materials, 11 per cent to $228,232,000; and non-metallics, 11 per cent to $144,921,000. For the third consecutive year, crude petroleum was the leading mineral in point of value with an output worth $305,640,000. Copper moved up to second place at $239,756,000. It was followed by nickel at $215,866,000 and gold at $156,789,000. Zinc rose $28,099,000 to $118,306,000; iron ore $60,769,000 to $110,436,000; and asbestos $12,281,000 to $98,691,000. Coal, however, declined 3 per cent to $93,579,000 and lead ·1 per cent to $58,314,000.

Substantial gains were also made in volume of output. Iron ore showed an increase of 121 per cent to 14,539,000 long tons; crude petroleum 35 per cent to 129,440,000 barrels; cement 12 per cent to 25,168,000 barrels; asbestos 15 per cent to 1,064,000 tons; zinc 15 per cent to 866,714,000 pounds; nickel 8 per cent to 349,857,000 pounds; and copper 8 per cent to 651,987,000 pounds.

With the exception of Nova Scotia, each province recorded a sizeable increase in value of production. Ontario remained the leading producing province with an output valued at $583,955,000, a gain of 18 per cent over 1954, and accounted for 33 per cent of the total value of Canadian mineral production. Quebec regained second place with the greatest increase, advancing 28 per cent over 1954 to $357,010,000. Alberta moved back into third place at $325,974,000 with a 17 per cent increase over 1954. It was followed by British Columbia which gained 19 per cent at $189,525,000 and Saskatchewan which showed an increase of 25 per cent to $85,150,000. Northwest Territories and Yukon registered slight declines in value of production.

Exports of metals, minerals and their products, amounted to $1,431,000,000 in 1955, an increase of $276,000,000 over 1954. Total exports of metals, minerals and their products accounted for 33·4 per cent of the country's total export trade of $4,282,000,000.

Exports of the four principal base metals, copper, lead, nickel and zinc, in primary and fully fabricated forms, most of which went to United States, were valued at $498,156,000 compared with $416,257,000 in 1954. Exports of refined copper (in ingots, bars, and slabs) and lead showed decreases in 1955 below 1954, copper decreasing from 156,000 tons to 153,000 tons, and lead from 117,300 tons to 93,000 tons. Exports of refined zinc increased from 206,000 tons in 1954 to 214,000 tons, and of refined nickel from 91,000 tons to 106,000 tons. United States bought 11 per cent more zinc, 10 per cent more nickel, 8 per cent more copper, and 36 per cent less lead. United Kingdom bought 12 per cent more lead, 6 per cent more nickel, 4 per cent more zinc, and 8 per cent less copper. Iron ore exports rose markedly from 5,500,000 long tons in 1954 to over 13,000,000 long tons in 1955 following the opening up of the new Quebec-Labrador iron ore field. Seventy-seven per cent of the total iron ore exported went to United States.

Base metal prices continued their upward trend in 1955. Copper underwent a series of price increases, rising from 29·04 cents in January, 1955 to 46 cents in March, 1956. About two-thirds of the increase in the value of copper production was due to the increase in price. Nickel rose from 61·40 cents in January 1955 to 63 cents in November, where it remained. Zinc was in strong demand throughout the fiscal year. In January 1955 it firmed at 11·50 cents a pound, rising to 13·00 cents a pound in November and closing the fiscal year at 13·50 cents. Lead remained steady at 14·25 cents a pound until mid-September, 1955 when it moved up to 14·75 cents a pound. In January 1956 it sold briefly at 16 cents a pound, decreasing to 15·50 cents a pound at the end of the month, where it remained until the close of the fiscal year.

About 130,000 persons were employed at salaries and wages amounting to $465,000,000 in the 715 active metal mines and smelters, the 12,000 oil and gas wells, the 225 coal mines, the 940 non-metallic mines and quarries, and the 7,800 sand pits in operation during 1955.

Crude Petroleum and Natural Gas Highlighting the remarkable progress made by the mineral industry in 1955 was the continued rapid growth of the crude petroleum industry in western Canada. Crude oil production rose 35 per cent over 1954, to 129,440,000 barrels valued at $305,640,000. Output in Alberta, which accounted for over 87 per cent of the 1955 production, rose 29 per cent to 113,035,000 barrels; in Saskatchewan, 109 per cent to 11,317,000 barrels; and in Manitoba, 93 per cent to 4,100,000 barrels.

Over $500,000,000 was spent on exploration and development of crude petroleum and natural gas resources in western Canada in 1955. Emphasis in crude petroleum was on field development drilling. The greatest single event was the spectacular growth of Alberta's Pembina field from 125 wells with a daily output of 10,000 barrels at the end of 1954 to Canada's greatest producing field with a daily output of 93,000 barrels from 1,000 wells in March, 1956. Recoverable reserves in this field alone have been estimated at well over one billion barrels, some estimates being considerably higher. Other highlights of the year were the opening up of the Sundre-Westward Ho area, 80 miles south of the Pembina field in Alberta, and the discoveries of light gravity oil in the Steelman, Hastings, and Kingsford areas in southeastern Saskatchewan.

Canada's total proved reserves of crude petroleum at the end of 1955 amounted to 2,756,619,000 barrels compared with 2,415,945,000 barrels in 1954. Alberta accounted for over 80 per cent of the year's change.

By the end of the fiscal year fiscal production had risen to 461,000 barrels daily. Potential production had increased to 700,000 barrels daily, further emphasizing the need for market expansion.

Oil deliveries over Canada's pipeline system rose 30 per cent in 1955 to 224,275,000 barrels. At the end of 1955 Canada had 5,069 miles of oil pipeline compared with 4,656 miles in 1954. In addition pipeline extensions into United States carrying Canadian oil exclusively, totalled 1,514 miles. Trans Mountain Pipe Line Company more than doubled its deliveries to over 84,000 barrels daily. A 36·5 mile extension was built to serve a new refinery at Anacortes, Washington, bringing deliveries of Alberta crude to six refineries in all: one at Kamloops, three near Vancouver, and two in the state of Washington. Deliveries over the Interprovincial pipeline rose 24 per cent to 80,700,000 barrels, of which 34,300,000 barrels went to refineries in western Canada, 5,300,000 barrels to refineries in United States, and 33,900,000 barrels to Ontario refineries. The new Pembina pipeline started operations in January 1955 and by mid-November was carrying 73,800 barrels daily. At the end of 1955 the Swift Current-Regina line of South Saskatchewan Pipe Line Company, which was completed in 1954, was carrying 13,000 barrels daily. The Peace River Oil Pipe Line Company Limited built a 107-mile line from the Sturgeon Lake field to Edson, Alberta where it joins the Trans Mountain line. Deliveries over the new line, which has a design capacity of 57,000 barrels daily, are scheduled to start in 1956.

Some $101,000,000 was spent on oil refinery construction in Canada in 1955 compared with $84,000,000 in 1954. At the end of 1955, Canada had 42 operating refineries with a total daily throughput capacity of 618,450 barrels.

Natural gas reserves in western Canada were in excess of 20 trillion cubic feet at the end of 1955, and were rising at an annual rate of at least 2 trillion cubic feet.

Top development in natural gas was the approval given by the Federal Power Commission of United States to Pacific Northwest Pipeline Corporation, also of United States, to import Canadian natural gas from Westcoast Transmission Company Limited into the Pacific northwest states at the British Columbia-Washington border, thus opening up market outlets to Peace River natural gas. Westcoast Transmission will deliver 300,000,000 cubic feet of gas daily from fields in the Peace River area of Alberta and northeastern British Columbia to Sumas on the international boundary. Construction of the 650-mile, $153,000,000 line is scheduled to be completed in 1957.

76816—2

Plans to supply eastern Canadian markets with Alberta natural gas remained incomplete at the end of the fiscal year. Trans-Canada Pipe Lines Limited obtained six-month extensions on its provisional permits from the Board of Transport Commissioners for Canada and the Alberta Government in April 1955, in September 1955, and again in March 1956, in which to complete financing arrangements for its proposed $375,000,000, 2,327-mile line from Alberta to Toronto and Montreal. A change in the proposed route through northern Ontario from the Lake Superior to the "clay belt" route was authorized by the federal Government. To assist in getting the pipeline project under way, a proposal was put forward during the year that the Ontario and federal Governments jointly finance the northern Ontario line between the Manitoba border and Kapuskasing. Meantime, the decision of the Federal Power Commission of United States was awaited on the export of gas by the company into United States at Emerson, Manitoba, and the import of gas from United States into Canada at Niagara in Ontario, until the line through northern Ontario is completed.

The Metals Expansion proved to be the keynote of the metal-mining industry in 1955. The first two privately owned uranium mines were brought into production; operations were started at a number of new base metal properties; and exploratory and development activity reached new levels in many regions, as in the Chibougamau area in western Quebec and the Bathurst area in New Brunswick.

Events in the uranium industry firmly established uranium as one of Canada's major metals and indicated the possibility of it becoming, in a few years, Canada's top metal in point of value. Appearing before Parliament's Special Committee on Research after the close of the fiscal year, the president of Eldorado Mining and Refining Limited forecast an annual value of $300,000,000 for Canadian uranium production within a few years. Present and planned sales contracts, he said, were "well in excess of $1·25 billion".

In August 1955, the federal Government announced that, on the basis of the information at hand, it was unlikely that special price contracts would be negotiated after March 31, 1956. To obtain such a contract, the company concerned had to give satisfactory evidence that production would commence not later than April 1, 1957. This date has since been extended to the end of September 1957. All contracts require that deliveries must be completed by March 31, 1962.

Canada's output of uranium was substantially boosted in 1955 with the entry into production of the property of Gunnar Mines Limited in the Beaverlodge area of northern Saskatchewan and that of Pronto Uranium Mines Limited in the Blind River area of northern Ontario, following incredibly short periods of preproduction development. At the end of the fiscal year each was milling at a rate of approximately 1,250 tons daily.

In the Beaverlodge area six properties were in production: the new Gunnar mine, Eldorado's Ace-Fay property, and those of Consolidated Nicholson Mines Limited, National Explorations Limited, Nesbitt LaBine Uranium Mines Limited, and Rix-Athabasca Uranium Mines Limited. The last four shipped ore to the Eldorado plant in 1955. Preparations were begun for increasing the capacity of the Eldorado treatment plant to a rated 2,000 tons daily, the completion of which is expected in 1957.

In the Blind River area where reserves of uranium ore, considered to be among the largest in the world have been blocked out, two companies, Algom Uranium Mines Limited and Consolidated Denison Mines Limited, were on the

verge of production, and several other companies were carrying out exploratory and development activity on various properties. Algom negotiated a contract with Eldorado early in 1955 for the delivery of uranium precipitates to the value of $206,910,000. Shafts were sunk and the construction of 3,000 tons-a-day leaching plants was begun at each of the company's two properties, the Quirke Lake, which is scheduled for production in 1956 and the Nordic Lake which is expected to be put into operation in 1957. Consolidated Denison negotiated a contract for the sale of precipitates to the value of $182,250,000. The company commenced the sinking of two shafts and the construction of a leaching plant with a daily capacity of 5,700 tons. The property is expected to enter production in 1957.

Additional uranium production was in the offing from properties in the Bancroft area of eastern Ontario, where Bicroft Uranium Mines Limited was preparing for production in 1956 at a daily rate of 1,000 tons. The company negotiated a contract with Eldorado in 1955 for the delivery of precipitates valued at $35,805,000. In the same area, Faraday Uranium Mines Limited entered into contract in January 1956 with Eldorado for the delivery of $29,754,800 worth of precipitates, and Nu-Age Uranium Mines Limited built a 300-ton-a-day concentrator, using a new dry process. In southern Ontario, Eldorado completed the expansion of its refinery facilities at Port Hope.

Developments in iron ore mining in eastern Canada and particularly the opening up of the New Quebec-Labrador iron ore field brought about the 121 per cent increase in production in 1955 to 14,539,000 long tons, and headed Canada toward an anticipated output of between 45,000,000 and 60,000,000 tons of iron ore annually within the next decade.

In New Quebec-Labrador, Iron Ore Company of Canada, in its second year of operation, produced 7,722,000 long tons, an increase of 6,000,000 long tons over its output in 1954. In northwestern Ontario Steep Rock Iron Mines Limited doubled its 1954 production to 2,266,000 long tons following the extensive development work carried out on its orebodies. In the Michipicoten area, Algoma Ore Properties Limited increased its output from 992,000 long tons in 1954 to 1,432,000 long tons, and made considerable progress in carrying out its four-year program to open up new sources of ore. In Newfoundland, Dominion Wabana Ore Limited increased its shipments of beneficiated hematite to 2,377,000 long tons compared with 2,156,000 long tons in 1954 and completed various phases of an expansion program under way at the property.

New iron ore production at a designed mill capacity of 500,000 tons of pellets annually, was commenced in April 1955 from the low-grade, open-pit mine of Bethlehem Steel Company at Marmora in southeastern Ontario.

New iron ore production also came from the treatment of pyrite and pyrrhotite. Output from the newly constructed sulphur plant of Noranda Mines Limited at Port Robinson near Welland in southern Ontario was small in 1955 but the company expects to produce 70,000 tons of iron oxide sinter in 1956. In northern Ontario, The International Nickel Company of Canada Limited obtained its first production of high-grade iron ore from the treatment of pyrrhotite tailings in its new $19,000,000 plant at Copper Cliff. The new plant will eventually produce 1,000,000 tons of high-grade iron ore annually. Falconbridge Nickel Mines Limited is producing a high-grade iron by-product from pyrrhotite concentrates on a pilot-plant basis.

Nickel production reached an all-time high of 349,857,000 pounds as a result of the extensive expansion in the nickel-producing facilities of International Nickel and Falconbridge Nickel in the Sudbury area and new

76816—2½

production from the Lynn Lake property of Sherritt Gordon Mines Limited in northern Manitoba. International Nickel delivered 290,000,000 pounds of nickel in all forms in 1955 compared with 282,000,000 pounds in 1954 and 251,000,000 in 1953. Falconbridge Nickel, which has an expansion program under way to raise its annual output to 55,000,000 pounds by 1960, reached a production rate of 41,000,000 pounds. In northern Manitoba Sherritt Gordon produced 90,000 tons of nickel concentrate from its Lynn Lake property, and operated its refinery at Fort Saskatchewan in Alberta at a rate of about 18,000,000 pounds of nickel annually.

Copper production rose to 652,000,000 pounds, an increase of 46,000,000 pounds over 1954 and 4,000,000 pounds short of the all-time peak of 656,000,000 pounds in 1940. The great increase in output came from the expansion of the nickel-copper industry in the Sudbury area, the addition of new output from Sherritt Gordon's Lynn Lake property, and two new producers in Quebec's Chibougamau area, Campbell Chibougamau Mines Limited and Chibougamau Explorers Limited. Overall copper production will be further substantially increased when the $40,000,000 project of Gaspé Copper Mines Limited, which began operations in 1955, gets into full production in its new 6,500-ton mill in 1956.

The spectacular increase in the price of copper brought about a marked upsurge in copper-mining activity. Quebec's Chibougamau area is shaping up into one of Canada's most promising copper areas. Already three properties are annually producing concentrates containing 50,000,000 pounds of copper, and several other properties are under active development. First production was realized from the area at the end of 1953. In northwestern Ontario new copper production is expected in 1957 from the Manitouwadge area where Geco Mines Limited is pressing forward the preproduction development of its recently discovered copper-zinc property, and across Canada several copper properties are being prepared for production, including the old Tilt Cove mine on Notre Dame Bay in Newfoundland, and the Granduc property northwest of Stewart in northern British Columbia.

Canada's production of zinc in 1955 of 867,000,000 pounds was 114,000,000 pounds greater than in 1954 and the highest on record. The marked increase in output came mainly from British Columbia where The Consolidated Mining and Smelting Company of Canada Limited increased its output of refined zinc by 29 per cent.

Lead production declined 7 per cent below 1954 to 406,000,000 pounds. The decrease resulted mainly from a reduction in the output of refined lead by Consolidated Mining and Smelting, which operates Canada's only lead smelter at Trail, British Columbia. Little change was noted in the demand for lead at the end of the fiscal year. Promising new lead-zinc properties were under development toward large-scale production in the Bathurst-Newcastle area of New Brunswick. The establishment of a large metallurgical-chemical industry was planned in conjunction with these developments.

Canada's gold production rose 4 per cent over 1954 to 4,541,962 fine ounces. The increase came mainly from Ontario. The levelling out of the differential in the exchange rate between the Canadian and the United States dollars brought the average Mint price for gold up to $34.52 a fine ounce, the highest for several years. One new gold mine, Forty-Four Mines Limited in the Rice Lake district of Manitoba, was brought into production in 1955, and Quebec had a new producer in the offing, Eldrich Mines Limited in the Noranda area. Cost-aid payments by the federal Government under the Emergency Gold Mining Assistance Act amounted to

approximately $9,300,000 or $3.10 a production ounce. Amending legislation was passed by Parliament extending the Act to the end of 1956 at a reduced rate of assistance.

Coal Coal production declined to 14,818,880 tons, the fifth successive decline since the high of 19,139,000 tons in 1950. By far the greatest loss was in Alberta, the chief producer, which showed a decrease of 404,000 tons to 4,455,279 tons. Gains in output were recorded in Saskatchewan, British Columbia, and New Brunswick.

Industrial Minerals Marked advances were made in the production of industrial minerals in line with the great growth of the country's construction and chemical industries. Overall value of production advanced $37,647,000 to $373,153,000. The chief gains were made by asbestos, cement, and gypsum.

Most of the increase in asbestos production came from four new mills in the Eastern Townships of Quebec, which had begun production in 1954. Over $70,000,000 was being spent on a further expansion of production facilities in the area. One of the major projects under way is the draining of Black Lake by Lake Asbestos of Quebec Limited to get at the deposits beneath. Production is expected to start at the property in 1958 at the rate of 5,000 tons daily. Output from the McDame Lake deposit of Cassiar Asbestos Corporation Limited in northern British Columbia almost doubled to 17,187 tons in 1955 as a result of mill expansion and the construction of an aerial tramway from the deposit at the top of the mountain to the foot, which will lengthen the quarrying season considerably.

Despite the continued expansion of Canada's cement-production facilities, demand still far exceeds supply. Production in 1955 rose 2,731,000 barrels over 1954 to 25,168,000 barrels. A number of expansion programs were under way, and the completion of all present and planned construction was expected to raise Canada's overall production capacity to 34,000,000 barrels, just twice the country's production five years ago.

Gypsum output in 1955 reached a record high of 4,668,000 tons, an 18 per cent increase over 1954. The biggest single development was the bringing into production of the huge gypsum deposit near Milford in Nova Scotia.

Canada in 1955 recorded its first important production of lithium concentrates when Quebec Lithium Corporation put its property near Val d'Or in western Quebec into operation in early December. Lithium is the lightest of the metals, and possesses broad applications in the manufacturing industry. The prospect of additional lithium production is indicated from newly discovered properties in the Lake Nipigon area of northwestern Ontario and from properties in the Winnipeg River-Cat Lake area of southeastern Manitoba.

Several significant developments occurred in other industrial minerals. The production and export of coarse salt showed a marked increase because of the opening up of a new rock salt mine, Canada's second, at Ojibway in southern Ontario, where The Canadian Rock Salt Company Limited commenced production from its underground deposit on a large scale in August, 1955. Canada's overall production of salt increased 28 per cent over 1954 to 1,245,000 short tons. The production of mined rock salt increased from 81,000 tons to 275,000 tons and salt exports rose from 1,200 tons in 1954 to 146,000 tons in 1955.

Much interest continued to be centred on potash developments in Saskatchewan, where what are believed to be some of the world's largest reserves of potash underlie the province's salt basin, which extends diagonally across the

central part of Saskatchewan. Several companies are carrying out exploratory drilling and two are sinking shafts to deposits. First potash production is expected in 1957.

The output of fluorspar, over 99 per cent of which came from Newfoundland, reached a new high of 128,000 tons valued at $2,708,000 compared with the previous high in 1954 of 119,000 tons valued at $2,987,000. Exports, all of which went to United States, rose 12 per cent to an all-time high of 39,000 tons.

Canada's output of sulphur from by-product pyrites and smelter gases rose from 532,400 tons in 1954 to 628,400 tons in 1955, and of elemental sulphur from natural gas from 18,600 tons to 26,000 tons. Plans were made and construction was set under way to make further use of domestic sources of sulphur. Noranda Mines Limited is building a plant at Cutler in the Blind River area of northern Ontario to produce sulphuric acid from pyrite for use in the processing of uranium ores in the area. In western Canada, Shell Oil Company of Canada completed the expansion of the capacity of its plant at Jumping Pound in Alberta to 80 tons a day while Royalite Oil Company Limited continued to produce 30 long tons of sulphur daily from its Turner Valley plant. Canadian Gulf Oil Company started the construction of a sulphur plant at Pincher Creek, with an initial production of 225 long tons of sulphur daily, production to start late in 1956.

ACTIVITIES OF THE DEPARTMENT

Emphasis was again placed on the topographical and geological mapping of Canada's vast northern regions in line with the steadily increasing interest in the Canadian North. The size of the task ahead led the Department to continue the use of helicopters on large-scale mapping projects, so as to assess the mineral potential of these regions within the foreseeable future, and at the same time to permit the making of sound long-term plans for their development and settlement. Experience during the past few years has shown that the use of the helicopter north of the timber line in Northwest Territories, and in Yukon and the Arctic Islands has considerably extended the field season, and resulted in efficient, more rapid surveys at a substantially lower cost than would be possible by conventional ground methods.

In 1955 the Department carried out two aerial geological reconnaissance operations: Operation Thelon in which five geologists mapped 61,000 square miles in the eastern part of the District of Mackenzie, and Operation Franklin, the greatest project of its kind yet undertaken, in which 11 geologists mapped 120,000 square miles of the Queen Elizabeth and adjacent Arctic Islands. These operations were supplemented with airborne geophysical surveys to assist in obtaining a more complete geological picture of the areas thus mapped. The Department now plans to adopt the helicopter technique to extensive geological reconnaissance surveys in the mountainous areas of British Columbia and Yukon, and in the timbered Mackenzie River Valley.

Two large helicopter-equipped topographical parties accounted for 49,000 square miles of mapping in the Canadian North, one in defence priority areas in northern Yukon and the lower reaches of the Mackenzie River, which are also being prospected for oil, and the other in the iron-rich area west of Ungava Bay in northern Labrador.

In all, the Department placed 143 parties in the field in 1955, including 70 geological, 17 geodetic, 29 topographical, and 11 legal surveys parties. Charting operations were carried out by nine ships and seven shore-based parties using large echo sounding equipped launches.

Using shoran trilateration, an electronic method of distance measurement, the Department continued to extend the framework of mapping control into the Far North, and in 1955 it completed the establishment of a shoran network over Yukon, and extended this network into the western part of the Arctic Islands. Previous shoran work from 1949 to date had resulted in the establishment of a network covering the northern parts of Alberta, Saskatchewan, Manitoba, Ontario and Quebec, and the southerly part of Baffin Island.

The final reports on the Ontario-Manitoba and the Alberta-British Columbia provincial boundaries were published.

Through its work with the airborne radar altimeter, the Department continued to contribute to the safety of air transportation in Canada by obtaining data, of sufficient accuracy, on contours and critical heights of land terrain for air navigation charts. In many cases, the information obtained was useful in correcting critical heights along air routes.

Mineral developments in Northwest Territories and in the Ungava Bay district of New Quebec continued to emphasize the need for charts of Canada's northern waters, particularly of the Hudson Bay route from the Atlantic Ocean to Churchill. To this end the Department in 1955 assigned two hydrographic ships to carry out extensive surveys of these waters. Hydrographers were also assigned to northern supply vessels of the Department of Transport and to the ice-breaker, H.M.C.S. "Labrador", to work in Arctic waters. Meantime, the constuction of the new modern vessel, the "Baffin", especially designed for Arctic work, neared completion.

The Department continued to assist private uranium properties into production through the development of economic treatment methods for specific ores. Increased effort was given to the economic processing of lower grade uranium ores and of the refractory ores coming to light in eastern Canada, which contain, in addition to low values in uranium, values in niobium, tantalum, rare earths, and thorium.

Continuing projects under way in ore-dressing investigations include the beneficiation of low-grade iron ores, particularly those from Ungava and Labrador, and the upgrading of low-grade manganese material in an effort to obtain commercial-grade manganese concentrates.

A marked increase was noted in the number of samples of industrial minerals received for identification, evaluation or processing, reflecting the steadily growing importance of these minerals in Canada's industrial expansion. Materials in use or of potential use in the chemical and construction industries were predominant.

The coal industry was given all possible technical assistance to help it to maintain its position.

Astronomical observations for time, which form the basis of Canada's time service, were made nightly throughout the year. In its work in geophysics, the Dominion Observatory made extended observations of the earth's magnetic field for the construction of magnetic maps for the use of aerial navigators, surveyors, and prospectors. These maps are of special importance to Arctic flying because of the wide variation of the compass from true north in the Arctic.

Preparations were begun for Canadian participation in the International Geophysics Year of 1957-58, which will feature scientific observations in southern Canada and in Arctic stations.

Construction was started on the new Mines Branch building to house the Branch's chemical laboratories, Radioactivity Division, and administrative staff. Plans for the new Geological Survey building were near completion, and for the departmental administration building were well advanced. Tenders are expected to be called for the former in July, 1956. In addition, plans were under way for the new Surveys and Mapping Building.

A summary of revenue and expenditures for the fiscal year follows:

	Revenue	Ordinary Expenditures
Minister of Mines and Technical Surveys	$	$ 17,000.00
Departmental Administration	....	469,278.51
Explosives Act	6,435.98	93,336.32
Mines Branch	24,787.39	3,024,813.92
Geological Survey of Canada	26,106.98	2,388,595.16
Surveys and Mapping Branch	125,298.16	8,859,735.32
Geographical Branch	393.54	252,246.80
Dominion Observatories	2,927.72	668,767.77
General—		
To provide for payments under the Emergency Gold Mining Assistance Act	....	9,305,900.17
Payments for aerial photography and committee expenses	....	1,798,317.17
Provincial and territorial boundary surveys	....	52,371.37
	$185,949.77	$26,930,362.51

EXPLOSIVES DIVISION

The amendment of Part VI of the Explosives Act Regulations increasing the maximum amount of explosives permitted to be transported by road or private railway, went into effect in December 1954, and in 1955 a total of 156 permits was issued for the transportation of explosives by truck in quantities between 4,000 and 10,000 pounds. The increase in permissible loads has been of particular benefit to resources development projects in remote areas of Canada serviced as yet only by road.

A consolidation of the Explosives Act and the Explosives Regulations, as amended in 1954 was re-drafted and submitted to the Privy Council. The new Regulations were passed by Order-in-Council P.C. 1956-349, 1 March 1956, and became effective by publication in the *Canada Gazette*, 14 March 1956.

The recently revised Table of Safety Distances used in the enforcement of the British Explosives Act was adopted for use in the consideration of applications for factory and magazine licences.

A pamphlet, "Safety with Explosives", intended primarily for the user of small quantities of explosives, was printed and distributed to all licenced dealers with the request that they hand copies to purchasers who might benefit from them. Dealers showed considerable interest in the pamphlet.

It was agreed with the Department of Mines of New Brunswick to allow federal magazine licences in effect in that province to lapse as they expire, following the province's revision of its licencing regulations under the Explosives Act.

Manufacturing and Licensing In all, 132,824,400 pounds of commercial explosives were produced in Canada in 1955 compared with 122,405,000 pounds in 1954.

Licences for manufacturing and storage were issued as follows:

	1955	1954
Factories	19	17
Magazine depots	1	1
Permanent magazines	466	472
Temporary magazines	924	888
Registered premises	108	106
Inspections		
Factories	43	36
Magazines	1,705	1,515
Registered premises	142	172
Unlicenced premises	778	3,631

Accidents No fatal accidents occurred in the manufacture of commercial explosives in 1955 but 11 persons were injured, most of the injuries being minor.

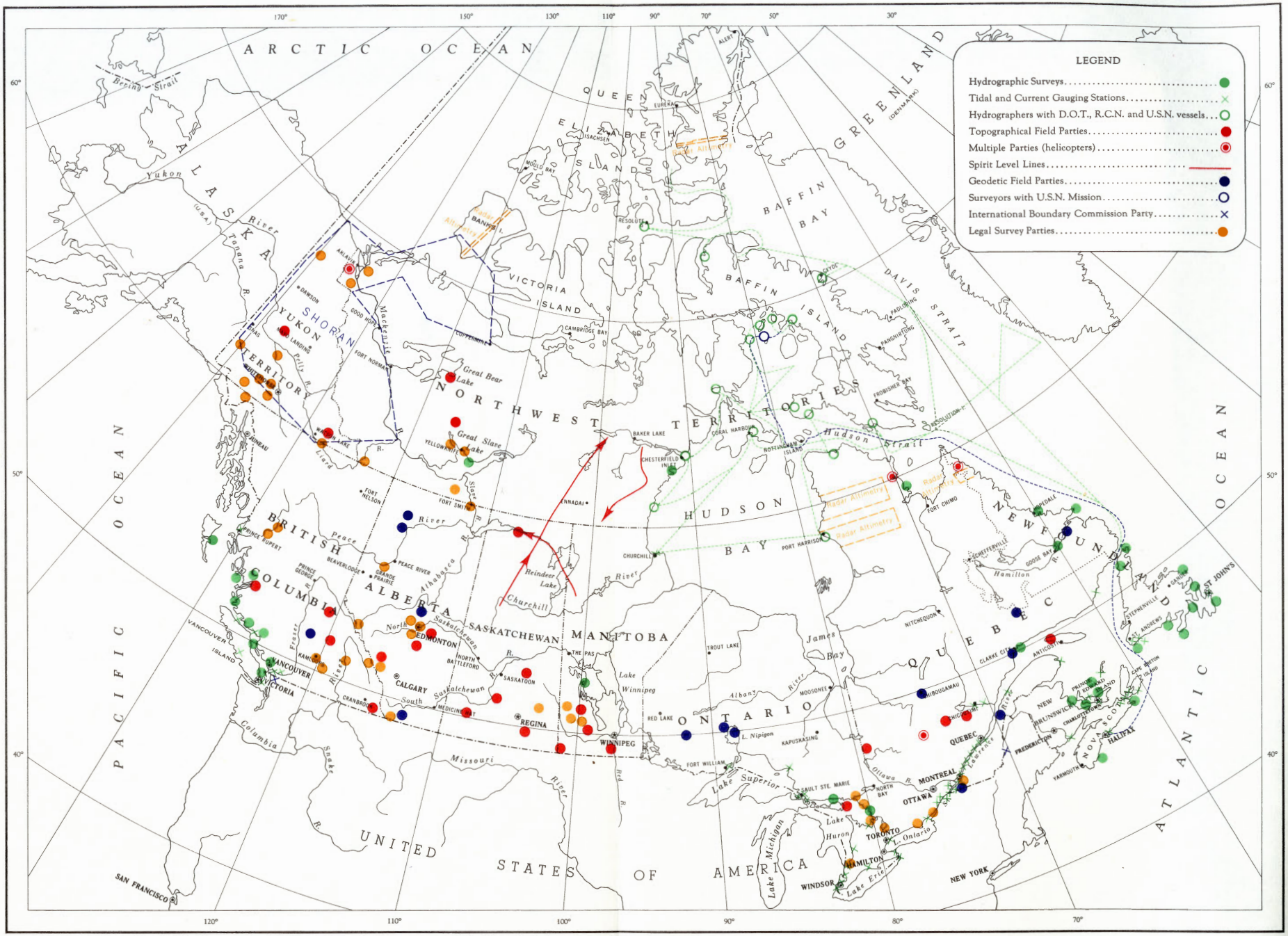
Playing or tampering with explosives resulted in the death of six persons and injuries to 42. Most of these accidents involved children.

In the use of explosives, 23 accidents occurred in mines and quarries, in which 3 persons were killed and 26 injured. In logging, construction, and elsewhere in industry, there were 22 accidents involving 11 deaths and 21 injured persons.

	1955	1954
Imports		
Permits* issued	1,053	823
*Covering fireworks, distress signals, nitro-cotton for paint and lacquer manufacture, and explosives for oil exploration.		
Testing		
Samples of explosives tested	545	477

Prosecutions

Convictions were obtained in 18 of the 19 cases prosecuted. One case was pending at the end of the year.



SURVEYS AND MAPPING BRANCH FIELD PARTIES, 1955

SURVEYS AND MAPPING BRANCH

W. H. Miller,
Director

The rapid pace of resource development, the continuous increase in defence requirements, and a greater appreciation of the fact that maps and charts are essential for economical development and administration together have resulted in an ever growing demand for maps, charts and survey information.

Every effort is being made to meet these additional needs, and at the same time carry out the previously formulated, long-term mapping and charting program. A major accomplishment was the coverage of areas totalling 120,000 square miles by surveys required for mapping. Helicopters were again used to expedite the mapping of more northerly regions and areas difficult of access. In the office, the adoption of new methods and new techniques resulted in a further increase in map and chart production.

GEODETIC SURVEY OF CANADA

The Division had 17 parties in the field compared with 18 in the previous fiscal year. The following distribution by provinces is approximate only, as some parties crossed provincial boundaries in the course of the seasons' work.

	Shoran	Triangulation	Precise Levelling	Astronomy and Base Lines	Total 1955–56	Total 1954–55
Yukon	1	0	0	0	1	0
Northwest Territories	0	0	0	1	1	1
British Columbia	0	0	1	0	1	1
Alberta	0	4	1	0	5	5
Manitoba	0	0	0	0	0	1
Ontario	0	2	0	1	3	4
Quebec	0	1	3	1	5	1
New Brunswick	0	0	0	0	0	1
Newfoundland	0	1	0	0	1	4
Totals	1	8	5	3	17	18

Triangulation

First-order triangulation was carried on in Alberta, Ontario, and Quebec, and the second-order network in Labrador was further extended.

One party working on the Alberta-Saskatchewan boundary completed the Primrose Lake network, undertaken at the request of the Department of National Defence.

Three parties operated in Alberta. One party concentrated on reconnaissance along the northern section of the Mackenzie Highway. A second was engaged in station preparation and the observation of horizontal and vertical angles along a distance of about 70 miles on the highway towards Great Slave Lake, and a third party on similar work, closed a gap of about 125 miles between Lesser Slave Lake and Edmonton, completing another triangulation loop (Edmonton—Williams Lake—Prince George—Dawson Creek—Edmonton). This party moved on to Prince Albert, Sask., where it carried out reconnaissance in preparation for a northerly extension of an arc of first-order triangulation.

In Ontario, two parties worked on the westerly extension of the first-order net of southern Canada from Lake Nipigon towards Winnipeg. One party concentrated on reconnaissance, and selected sites for 28 stations. The second was engaged mainly in tower building, but also covered 25 miles in the observation of angles.

In Quebec, operations were commenced on a first-order arc of triangulation from Oskelaneo through Knob Lake to the Labrador coast-line. Horizontal and vertical angles were observed at 24 stations for an axial progress of 175 miles. Four stations were selected and 3 others tentatively chosen in preparation for the 1956 field season.

The second-order triangulation net along the Hamilton River valley in Labrador was extended 145 miles from Goose Bay through Lake Melville to the Atlantic coast to connect with previous work by the United States Navy Hydrographic Service, extending along the coast from Belle Isle.

The results of the two years' field work may be summarized as follows:

	1955-56	1954-55
Shoran		
Lines measured	62	27
Stations established	12	5
Triangulation		
Linear miles of network completed	540	620
New stations occupied	86	107
Precise Levelling		
Linear miles completed	943	1,212
Bench marks established	392	551
Astronomy and Base Lines		
Base lines measured	0	3
Precise astronomic azimuth determinations	1	4
Precise astronomic position determinations	9	4
Second-order astronomic position determinations	7	4

Shoran

The usual calibration of shoran equipment was carried out at Winnipeg before and after the season's operations. The existing shoran network was extended to cover Yukon, and two stations were established, one each on Banks Island and Victoria Island, in the Arctic Archipelago. Reconnaissance was extended farther into the islands, and several station sites were tentatively selected in preparation for operations in the 1956 field season.

Arrangements were made with the United States Army Map Service for a general adjustment of the whole Canadian shoran network, involving 405 measured lines and nearly 100 shoran stations. This adjustment is beyond the capacity of the Division's desk computing machines, and is being undertaken by the Army Map Service by means of the "Univac" electronic digital computer. Observational data were carefully checked and tabulated at Ottawa, and forwarded to Washington.

The following table shows the distribution of triangulation position determinations by provinces.

Region	Primary	Secondary Occupied	Secondary Unoccupied	Total 1955-56	Total 1954-55
Alberta	26	0	1	27	31
Ontario	4	0	0	4	9
Quebec	24	0	0	24	1
Newfoundland	0	26	8	34	59
Totals	54	26	9	89	100

The Primrose Lake scheme, being on a local datum, is not included.

Precise Levelling

Precise levelling operations were carried out in British Columbia, Alberta and Quebec. In all, 943 miles of levelling was run, and 392 new bench marks were established.

In British Columbia, level lines were run from Marguerite to Ashcroft via Clinton, and from Vernon to Lumby. Several bench marks were re-established at Okanagan Landing, involving about 5 miles of levelling.

In Alberta, level lines were run from Stirling to Cardston, from Macleod to Cardston, from Cardston to Pincher via Waterton, and from Cardston to Milk River. Branch lines were run to the International Boundary and to Waterton Park, and an ornamental bench mark was established at Leduc.

In Quebec, a line required in connection with the St. Lawrence Seaway was run from Valleyfield to St. Anicet at the request of the Department of Transport. Lines were also run from Rimouski to Levis, and from Lacolle to Delson Junction, completing a precise levelling connection made over the past 10 years from Father Point to Rouses Point, N.Y. Precise levels were also run from Seven Islands to Oreway along the Quebec North Shore and Labrador Railway and, at the request of the Canadian National Railway, levels were run to the Quebec bridge to check the stability of the piers.

Comparative Table of Levelling by Provinces, Fiscal Years 1954-55 and 1955-56

Region	Mileage		Bench Marks Established	
	1955-56	1954-55	1955-56	1954-55
British Columbia	208	205	25	57
Alberta	265	..	135	..
Manitoba	..	299	..	144
Ontario	..	429	..	217
Quebec	470	193	232	90
New Brunswick	..	86	..	43
Totals	943	1,212	392	551

Mileage of Levelling in Canadian Net to end of March, 1956

Region	Precise	Secondary	Public Works	Total
Yukon	1,333	26	..	1,359
British Columbia	5,852	52	..	5,904
Northwest Territories	93	..	..	93
Alberta	4,850	3,799	..	8,649
Saskatchewan	4,203	5,098	..	9,301
Manitoba	3,262	468	113	3,843
Ontario	7,983	1,376	2,012	11,371
Quebec	5,428	1,429	1,750	8,607
New Brunswick	1,349	..	403	1,752
Nova Scotia	1,024	..	309	1,333
Prince Edward Island	284	..	..	284
Newfoundland	835	..	..	835
Minnesota (U.S.A.)	89	..	..	89
Vermont (U.S.A.)	6	..	..	6
New York (U.S.A.)	43	..	..	43
	36,634	12,248	4,587	53,469

Geodetic Astronomy and Base Lines

An officer attached to *H.M.C.S. Labrador,* at the request of the Department of National Defence, established the latitudes and longitudes of seven points in the Foxe Basin area of the Arctic Islands by astronomic observations.

In northern Ontario, a small party established a Laplace station on Jackfish Island in Lake Nipigon. The establishment of a Laplace point involves the determination to first-owner accuracy, of astronomic latitude, longitude and azimuth.

An astronomic party in Quebec was engaged in isostasy observations for scientific purposes.

At the request of the Defence Research Board, observations were made to determine the accurate orientation of the polar axis of a radio telescope being installed near Ottawa.

Mathematical Adjustments and Computations

The final adjustment of the triangulation arc extending from Dawson Creek to Edmonton was completed. The closing error in this loop was 58 feet. The previously determined positions at Dawson Creek and Edmonton were held fixed, and the closing error was distributed over the 400 miles of triangulation between these two points.

The final adjustment of the second-order triangulation on the south coast of Newfoundland was also completed. The closing error of 39 feet was distributed over about 200 miles of triangulation from Hermitage Bay to Cape Ray.

Field work was completed on the second-order triangulation in Labrador. The Hamilton River net was extended to connect with previous United States Navy triangulation along the coast of Labrador. A junction had been effected, in the vicinity of Dominion Lake, between a northerly extension of the Natashquan River net and the Hamilton River net in 1954. The closing errors in the Hamilton River net were 20 and 84 feet respectively. Final adjustment of these closures is being held in abeyance pending the completion of more first-order work in the same general area.

Computation and adjustment of the triangulation scheme at Primrose Lake were completed, and the positions of all stations were converted to rectangular coordinates. The final results were transmitted to the Department of National Defence.

Modifications made in the Division's computational methods are proving most advantageous for making preliminary adjustments before final adjustment is possible.

Scientific Work

One party determined the astronomic positions of triangulation stations on the north shore of the Gulf of St. Lawrence. These data are used for a more precise determination of the size and shape of the earth.

An astronomic party in northern Ontario made a further test of the new method of observing for longitude and azimuth tried out in the previous fiscal year in Alberta with promising results. This new method would allow precise azimuth determination with the same instrument as is used for precise latitude and longitude observations. A partial account of the Alberta work has been published.

A study was commenced of the slow vertical movements taking place in the earth's crust. A similar study, based on the records of water level gauges on the Great Lakes, had been carried out previously. With the completion of new precise levelling from tide water at Father Point to Kingston, Ontario, a more thorough investigation is now possible.

TOPOGRAPHICAL SURVEY DIVISION

Twenty-nine parties were placed in the field as in the previous fiscal year. However, because of excellent weather conditions and the increased use made of photogrammetrical equipment, the area controlled was 9 per cent

greater at 120,000 square miles. Emphasis in 1955 was on the extension of work into remote regions in line with the increased demand for topographical maps of these areas. No field parties were placed in Nova Scotia, New Brunswick, Prince Edward Island or on the island of Newfoundland as the mapping of these regions is already well in hand.

Two large parties equipped with helicopters secured control for areas approximating 80,000 square miles: one of these operated in Alberta, and later in northern Yukon and Northwest Territories west of the Mackenzie River; and the other was in the Ungava Bay district and northern Labrador, and later in an area between Laurentides Park and the upper Ottawa River.

An air-supported party continued the program of establishing basic levels in Canada's northern interior by extending spirit levels in the Northwest Territories a distance of 1,100 miles by the water-transfer method from Selwyn Lake down the Dubawnt River to the Thelon River, and from Baker Lake south to Nueltin Lake. This program is being carried out to meet the demand for maps containing more complete information on Canada's northern regions.

One hundred and seventy miles of traversing was carried out during the winter in the forested area northwest of Maniwaki to establish horizontal control for a series of priority maps.

A field party assigned to checking certain sections of the survey control on the prairies succeeded in localizing errors and effecting much improved position determinations. The correlation of the Dominion Land Survey system of control and the geodetic system establishes a strong horizontal control framework for mapping.

New contoured maps compiled covered areas totalling 85,900 square miles, 23 per cent more than the previous fiscal year, and maps forwarded for reproduction, 80,700 square miles, an increase of 14 per cent.

Several new precision photogrammetrical plotters were purchased to make more effective use of high altitude photography. The development of an electronic measuring device, being made under contract to specifications laid down by the Division, was retarded because of unexpected technical problems encountered by the contractor.

The Survey continued to lose trained and experienced personnel. These were replaced by recruited staff requiring training. The death of J. W. Spence, Chief of the Field Section, and the retirement of two senior members of the staff, E. J. Wight and E. S. Fry were serious losses.

The work of the Army Survey Establishment of the Department of National Defence is closely coordinated with that of the Topographical Survey.

Field Survey Section

Fifty-five officers of the survey were organized into 29 parties assigned to carry out original surveys for control of mapping from aerial photographs. Two-thirds of the 120,000 square miles covered was for detailed or 1:50,000 mapping and the remainder for medium-scale or 1:250,000 mapping. The two helicopter parties accounted for 60 per cent of the total area controlled.

A summary of the field projects follows:

Province	No. of Parties		Type of Work	Publication Scale	Area Controlled (Square Miles)
Northwest Territories	(W) 1	(H)	Topographic	1:250,000	28,000
	1		Topographic	1:50,000	2,470
	(X) 1		Vertical control	1:50,000	2,400
	(X) 1		Spirit levels	—	1,200 miles
Yukon	(W) 1	(H)	Topographic	1:250,000	7,600
	2		Phototopographic	1:50,000	5,800
British Columbia	2		Phototopographic	1:250,000	7,800
	2		Phototopographic	1:50,000	4,300
Alberta	1		Phototopographic	1:50,000	1,680
	2		Vertical control	1:50,000	6,100
Saskatchewan	6		Vertical control	1:50,000	6,550
Manitoba	3		Vertical control	1:50,000	5,450
	1		Topographic	1:31,680	250
Manitoba-Sask.	1		Horizontal control		685 miles chaining
Ontario	(Y) 1		Topographic	1:50,000	800
Quebec (incl. tip of Labrador)	(Y) 1		Topographic	1:50,000	2,000
	(Z) 1	(H)	Topographic	1:50,000	15,100
	(Z) 1	(H)	Vertical control	1:50,000	22,400
	2		Interpretation	1:50,000	52 map sheets
	1		Horizontal control (Winter)	—	170 miles
	1		Spirit levels	—	120 miles

(H) equipped with helicopter
(W) (X) (Y) (Z) same parties

The field staff plotted topographic detail for 5,700 square miles of 1:50,000 mapping and 12,500 square miles of 1:250,000 mapping, for which planimetry was compiled by the Air Survey section.

The former Computations and Control section was incorporated into the Field section and called the Computation and Control unit.

Coordinates required for mapping control were computed for certain provincial railway and highway surveys, and the work of computing and adjusting township corners in the Dominion Land Survey system was continued. the adjustments being made to conform to the most recent ties by the Geodetic Survey and Topographical Survey.

Air Survey Section

A total of 109,874 square miles of planimetric and topographical mapping was completed, an increase of approximately 22 per cent over the area compiled in 1954-55. A comparison of the total areas covered during the past three years follows:

	1953-54	1954-55	1955-56
Planimetric, square miles	74,286	42,563	48,112
Contoured, square miles	31,439	50,212	61,762
Photo mosiac, square miles	69,233	92,729	128,079

Considerable progress was made in adapting scribing techniques to pantograph plotting using the larger equipment available. The advantages of scribing are that far "sharper" advanced prints can be produced; the scribed negative is helpful in the final drafting stages, and the work load on cameras is reduced. Additional equipment acquired will assist in compiling areas covered by high altitude photography where 1:50,000 maps are required.

Considerable progress was made in plotting bi-camera control flights in advance of field work for areas on the north shore of the St. Lawrence lying east of the Quebec North Shore and Labrador Railroad. This method was developed by the Photogrammetrical section of National Research Council on the suggestion of Topographical Survey.

A summary of the plotting of planimetric and topographic maps follows:

Province	No. of Map Sheets	Scale of Publication	Area in Square Miles
1. *Planimetric*			
Yukon	2	1:250,000	8,123
Northwest Territories	1	1:250,000	4,436
British Columbia	1	1:250,000	5,966
Saskatchewan	..	1:50,000	5,717
Manitoba	..	1:50,000	2,219
		Compilation Scale	
Special Projects*			
Yukon	3	1″ to 2 miles	8,868
Northwest Territories	1	1″ to 2 miles	4,728
	2	1:25,000	160
British Columbia	1	1:40,000	347
Alberta	2	1″ to 2 miles	5,966
		1:40,000	546
Saskatchewan	1	1:40,000	380
Manitoba	1	1:25,000	70
New Brunswick	1	1:31,680	411
Nova Scotia	1	1:31,680	175
Total planimetric mapping			48,112
2. *Contoured Maps*			
Yukon	16	1:50,000	3,840
Northwest Territories	12	1:50,000	3,134
British Columbia	9	1:50,000	2,747
British Columbia-Alberta	2	1:50,000	764
Alberta	26	1:50,000	8,791
Ontario	1	1:50,000	400
Quebec	57	1:50,000	18,628
Quebec-New Brunswick	6	1:50,000	2,306
New Brunswick	7	1:50,000	2,472
Quebec-Newfoundland	5	1:50,000	1,818
Newfoundland	49	1:50,000	16,298

Special Projects*		Compilation Scale	
Yukon	1	1″ to 2 miles	50
British Columbia	1	1:40,000	300
Alberta	1	1:40,000	100
Saskatchewan	1	1:40,000	100
Ontario	2	1:500	8
		1:6.000	4
Prince Edward Island	1	1:4,800	2
Total contoured mapping			61,762

3. *Mosaics*	No. of Mosaics	
Northwest Territories	2	1,050
British Columbia	2	200
British Columbia-Alberta	1	40,000
Saskatchewan	10	29,700
Quebec	13	55,327
Newfoundland	1	1,575
Total mosaic mapping		128,079

*Special projects for other Divisions of the Branch, for Geological Survey of Canada. Dominion Observatory, Department of Agriculture, and Department of Northern Affairs and National Resources.

Map Inspection and Editing Section

In all, 184 map sheets were inspected, edited and forwarded for publication, 15 less than the previous fiscal year's all time high of 199 sheets. The area covered, however, is 10,000 square miles greater.

Much use was made of the precision coordinatograph. Four hundred and seventy-two projections were drawn at various scales and numerous index maps, charts and special drawings prepared.

Map Sheets Forwarded for Publication

	1:50,000	1:250,000	Total	Area (Sq. Miles)
Newfoundland	51	..	51	17,058
Newfoundland-Quebec	5	..	5	1,810
New Brunswick	4	..	4	1,263
New Brunswick-Quebec	3	..	3	1,206
Quebec	44	..	44	13,586
Ontario	2	..	2	836
Manitoba	7	..	7	2,369
Manitoba-Saskatchewan	2	..	2	774
Saskatchewan	13	..	13	4,969
Alberta	13	..	13	4,546
Alberta-British Columbia	1	..	1	643
British Columbia	12	1	13	8,893
Northwest Territories	12	1	13	7,558
Yukon Territory	11	2	13	15,191
	180	4	184	80,702

Map Sheets Inked or Traced for Advance Information Prints

New Brunswick	1
Manitoba	15
Manitoba-Saskatchewan	1
Saskatchewan	32
Alberta	8
British Columbia	2
Northwest Territories	1
Yukon Territory	2
	62

National Air Photo Library

The library has on file one print of each aerial negative exposed by or for the federal government. In all, 78,927 photos were added, bringing the total to 2,339,157.

Complete records pertaining to all federal government photography are kept on file and facilities for stereoscopic examination of prints are available. Many government agencies and private companies make use of the photo prints filed in the library.

A total of 3,887 requisitions, involving the purchase of 401,468 prints, was prepared and forwarded to the Photographic Establishment of the R.C.A.F. at Rockcliffe, Ont. These prints were for various federal and provincial government departments, mining and industrial concerns, and private individuals engaged in the development of Canada's resources. Index maps were supplied in practically every case.

The *Air Photo Coverage Map of Canada* was revised to include the 1955 photo coverage. Copies of this map are available on request.

Records and Supplies Section

A total of 14,600 advance information prints were forwarded to federal, provincial and private agencies throughout Canada and 260,000 photographs were handled. Approximately 50,000 new photographs were indexed and checked for quality and coverage, and reports on this photography prepared for the Chief Topographical Engineer, who is technical adviser to the Interdepartmental Committee on Air Surveys.

CANADIAN BOARD ON GEOGRAPHICAL NAMES

The Board adopted names for 175 new maps, 28 new hydrographic charts and 26 map or chart revisions as well as amendments, new names, name changes, etc., for 280 maps or charts.

The *Gazetteer of Manitoba,* the third volume of the Gazetteer of Canada series, was published and the fourth volume, the *Gazetteer of New Brunswick,* is in press.

Seven provincial members or their representatives attended the annual meeting on January 31, 1956.

The present membership of the Board is:

Chairman	C. H. Smith
Executive Committee	C. H. Smith
	F. C. G. Smith
	E. D. Baldock
Members	Norman Fee
	A. McFarlane
	Dr. N. L. Nicholson
	Dr. H. S. Bostock
	G. W. Rowley
	S. G. Gamble
Provincial Members:	
British Columbia	W. R. Young
Alberta	D. I. Istvanffy
Saskatchewan	A. I. Bereskin
Manitoba	H. E. Beresford
Ontario	F. W. Beatty
New Brunswick	J. G. B. Pugh
Nova Scotia	J. P. Messervey
Prince Edward Island	P. S. Fielding
Newfoundland	L. E. F. English
Secretary	G. M. Munroe

The province of Quebec has an independent Board, which cooperates with the Canadian Board on Geographical Names on matters pertaining to that province.

CANADIAN HYDROGRAPHIC SERVICE

Nine ships and seven shore-based parties using large echo-sounding equipped launches were engaged in charting operations. Two ice-strengthened chartered ships were assigned to Hudson Strait and Hudson Bay, three ships and one launch to Newfoundland waters, one ship to the Gulf of St. Lawrence, and two launches to the Atlantic coast of Nova Scotia. Two launches carried out charting in Lake Huron and Georgian Bay, one in Lake Winnipegosis and one in Great Slave Lake. Three ships were employed in charting Pacific coast waters. Hydrographic officers were assigned to the Department of Transport ships *C. D. Howe* and *d'Iberville*, and the naval ice-breaker, *Labrador*. Construction of the major hydrographic ship *Baffin*, especially designed for Arctic work, was well advanced.

The use of electronic equipment in the hydrographic vessel *Kapuskasing* in high-accuracy charting work proved most satisfactory, and it is proposed to instal similar equipment in other vessels of the fleet. This new method permits the determination of the positions of soundings in fog or out of sight of land with extreme accuracy.

Atlantic Coast

Gulf of St. Lawrence

The *Kapuskasing*, using an electronic positioning device, carried out charting operations in the Gulf of St. Lawrence, and accomplished three times the amount of an average season's ship-sounding. The area sounded extended from Cape Breton Island to New Brunswick and from Prince Edward Island to the

Magdalen Islands. The ship's launches operated in the inshore waters of the north coast of Prince Edward Island between Tracadie Bay and Cape Tryon. Summerside Harbour was re-surveyed. As a result of the season's work a new edition of an existing chart will be published, and much data were obtained for several other charts.

SUMMARY OF SEASON'S WORK

Ship sounding	7286	linear nautical miles
Boat sounding	1505	" " "

Nova Scotia—Southeast Coast

The launch *Henry Hudson* continued charting the Atlantic approaches to the Strait of Canso. A new chart of the area will be published.

SUMMARY OF SEASON'S WORK

Boat sounding	1170	linear nautical miles
Coastlining	70	" " "
Shoals examined	254	

The launch *Anderson* continued the survey of the inshore waters along the southeast coast of Nova Scotia between Port Mouton and Shelburne. Several previously uncharted shoals were found.

SUMMARY OF SEASON'S WORK

Boat sounding	1446	linear nautical miles
Coastlining	105	" " "
Shoals examined	80	

Newfoundland—South Coast

The *Fort Frances* continued charting in the vicinity of Fortune and Hermitage Bays. Two new charts will be published.

SUMMARY OF SEASON'S WORK

Sounding (ship and boat)	3816	linear nautical miles
Coastlining	198	" " "
Shoals examined	457	

The launch *Dawson* continued sounding the inner portion of Placentia Bay. A new chart of this area is in hand.

SUMMARY OF SEASON'S WORK

Boat sounding	1448	linear nautical miles
Coastlining	81	" " "
Shoals examined	132	

Newfoundland—East Coast

The veteran hydrographic ship *Acadia* with 45 years of service, charted the harbours of Trinity, Hearts Content, New Perlican and Old Perlican. The charting of the coastal area from Renews northwards to St. John's and Cape Freels, a distance of 130 nautical miles, was completed. In all, eight modern harbour and five modern coastal charts will be issued. The past season's surveying resulted in the completion of one coastal and two harbour charts. The important direction-finding station of Cape Race was calibrated.

SUMMARY OF SEASON'S WORK

Ship sounding	2353	linear	nautical	miles
Boat sounding	1549	"	"	"
Coastlining	146	"	"	"
Shoals examined	226			

New Brunswick, Labrador and Quebec

The *Carter's* charting operations were principally: Richibucto, N.B., Terrington Basin and approaches to Hamilton Inlet, Labrador, and Seven Islands, Quebec. Minor projects were carried out at Flowers Cove, Newfoundland, and Father Point, Quebec.

SUMMARY OF SEASON'S WORK

Ship sounding	912	linear	nautical	miles
Boat sounding	1397	"	"	"
Coastlining	63	"	"	"
Shoals examined	10			

Ungava Bay—Hudson Strait

The chartered sealer *Algerine* continued the survey of the west coast of Ungava Bay, the main project being the charting of Hopes Advance Bay as a prospective iron-ore shipping port. From the results of this season's work a chart of the area is being published.

SUMMARY OF SEASON'S WORK

Ship sounding	1566	linear	nautical	miles
Boat sounding	1860	"	"	"
Coastlining	258	"	"	"
Shoals examined	32			

Hopedale, Labrador—Rankin Inlet, Hudson Bay

The *Theron,* a chartered ice-strengthened ship, continued charting operations at Hopedale and Rankin Inlet. In addition, a special survey of Port aux Basques, Newfoundland, was carried out to provide the National Research Council with hydrographic data for construction of a test model of the harbour.

As a result of the season's work, a new chart of Rankin Inlet is being produced, and additional hydrography and soundings are being added to two Hopedale charts.

SUMMARY OF SEASON'S WORK

Ship sounding	290	linear	nautical	miles
Boat sounding	2193	"	"	"
Coastlining	74	"	"	"
Shoals examined	282			

The Arctic

One hydrographer was assigned to each of the Department of Transport vessels, *C. D. Howe* and *d'Iberville.* Much important hydrographic information was obtained for use on eastern Arctic charts.

SUMMARY OF SEASON'S WORK

C. D. Howe

Ship sounding along vessel's track	8492	linear nautical miles
Boat sounding	811	" " "

d'Iberville

Ship sounding along vessel's track	2764	linear nautical miles

H.M.C.S. Labrador

Four hydrographers attached to this naval ice-breaker carried out important charting operations in Arctic waters hitherto uncharted.

Inland Waters

Georgian Bay

The launch *Bayfield* completed the charting project "Barbara Bank to Bateau Island" in the Parry Sound vicinity. A new chart of the area will be made available.

SUMMARY OF SEASON'S WORK

Boat sounding	1613	linear nautical miles
Coastlining	30	" " "
Shoals examined	435	

Lake Huron—North Channel

The launch *Boulton* continued the charting of North Channel and obtained sufficient information for the publication of a new chart.

SUMMARY OF SEASON'S WORK

Boat sounding	2700	linear nautical miles
Coastlining	50	" " "
Shoals examined	11	

Lake Winnipegosis

This unit continued charting in Lake Winnipegosis for the benefit of the fishing industry. A chart of the central portion of the lake will be issued.

SUMMARY OF SEASON'S WORK

Boat sounding	2043	linear nautical miles
Coastlining	202	" " "
Shoals examined	21	

Great Slave Lake

The launch *Rae* continued sounding the dangerous shoal-strewn approach to Yellowknife Bay. A new chart will be published.

SUMMARY OF SEASON'S WORK

Boat sounding	1397	linear nautical miles
Coastlining	37	" " "
Shoals examined	102	

Pacific Coast

The *Wm. J. Stewart* continued charting the east coast of Moresby Island, Queen Charlotte Islands. Surveys of Fife Sound and adjacent channels were completed in the waters east of Queen Charlotte Sound. Charting operations were also carried out in Wells and Catala Passages.

SUMMARY OF SEASON'S WORK

Ship sounding	983	linear nautical miles
Boat sounding	2204	" " "
Coastlining	235	" " "
Shoals examined	770	

The *Marabell* surveyed the approaches to Allison Harbour, Slingsby Channel and entrances to Seymour Inlet in the Queen Charlotte Sound area. In addition, a survey of Burke Channel was continued and in the Gulf Islands, portions of Trincomali and Navy Channels were charted.

SUMMARY OF SEASON'S WORK

Ship sounding	156	linear nautical miles
Boat sounding	1294	" " "
Coastlining	241	" " "
Shoals examined	246	

The *Parry* was engaged in nautical charting of Sutil Channel, Bute Inlet, and Frederic Arm. Tidal surveys were carried out in Johnstone and Queen Charlotte Straits and in Vancouver Harbour.

SUMMARY OF SEASON'S WORK

Boat sounding	288	linear nautical miles
Coastlining	78	" " "
Shoals examined	49	
Current metering	191	hours
Current observations	1246	"
Slack waters observed	126	"

As a result of the season's work on the Pacific coast, four new charts will be published, and four others are partially completed.

Chart Production

Output was as follows:

Standard Charts (first editions)	28
New editions of existing charts	44
Reprints and Overprints	19
Arctic Charts (first editions)	22
New editions	12
Reprints	10
Special Charts (plotting and instructional)	7

76816—3

Pilots and Sailing Directions

Pilots and Sailing Directions volumes supplement the information given on charts and describe in detail the nature of the coasts and shipping routes.

A new publication, "The Labrador and Hudson Bay Pilot", was issued. New editions of the following were in press:

St. Lawrence River Pilot, Quebec to Kingston, 2nd Edition;
Great Lakes Pilot, Vol. II, 1955, combining former Great Lakes Pilots, Volumes II and III.

Nautical Research

The Canadian Hydrographic Service examines and evaluates the arctic navigational material received from many sources. The compiled information has been an invaluable aid in the preparation of provisional charts of northern waters.

Precise Water Levels

The Service is responsible for the continuous and precise recording of water levels along the 1,400 miles of St. Lawrence-Great Lakes waterways from Quebec to Port Arthur. During the fiscal year some 15,700 sheets of information were supplied through regular mailing lists or upon request to engineering, power and marine interests. Self-registering gauges were maintained at 49 strategic stations.

Hydrologic Projects

The Service continued to take an active part in the various studies of the International Co-ordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data. Included in the studies is the effect of movements of the earth's crust on water levels.

Close cooperation was continued with engineers of the International Joint Commission and the St. Lawrence Seaway Authority relative to the many hydrologic problems encountered in their activities pertaining to the Great Lakes and St. Lawrence River.

Tidal and Current Survey

Fifteen principal tidal stations were maintained in continuous operation to provide information for local use and for the tide tables. Additional permanent tidal stations were erected at St. John's, Nfld. and Port Alfred, Que. Three secondary tidal stations were installed in the Gulf of St. Lawrence for the use of the *Kapuskasing*.

The operation of secondary tidal stations in the Strait of Canso was continued, and a report "Tidal Changes in the Strait of Canso" was prepared and distributed.

A tidal and wave investigation of Port aux Basques harbour, Nfld., was carried out to provide data for the National Research Council hydraulic model of the harbour.

On the Pacific coast, current surveys were carried out in Johnstone and Queen Charlotte Straits to provide data on current velocities for charts of the area and to establish a basis for slack water predictions. A current survey was made of Vancouver harbour, which confirmed reports of changes in current patterns.

Nautical Geodesy

Work in this field included the adjustment of the field triangulation networks, the computation of geographical positions, the provision of tables for computing geodetic positions in northern latitudes, the supply of coordinates for regular and special chart projections, and the conducting of classes for mathematical training of hydrographic field assistants. Tables were compiled and supplied for electronic positioning control.

Distribution of Hydrographic Publications

The distribution of standard charts for the fiscal year 1955 was the highest on record, exceeding the previous high in 1944 by 17 per cent. The number of special charts issued, including instructional and provisional charts, increased 59 per cent over that of 1954. Hydrographic publications distributed were as follows:

Catalogues of charts, sailing directions and tidal information, with index maps	1,662
Standard navigation charts	74,980
Instructional, special charts, etc.	34,354
Pilots and Sailing Directions	1,651
Supplements to Pilots and Sailing Directions	379
Tide Tables, 10 editions	55,000
Water level bulletins, graphs, etc.	15,624

In accordance with international practice, information contained in Canadian hydrographic charts and publications is reproduced by the hydrographic offices of foreign countries for their own use. Total world circulation is, therefore, greatly in excess of the above figures.

LEGAL SURVEYS AND AERONAUTICAL CHARTS DIVISION

Provincial and Territorial Boundary Surveys

Ontario-Manitoba and British Columbia-Alberta Boundaries

The final reports and accompanying atlases on the survey of these boundaries were published and presented to the interested governments.

Alberta-Northwest Territories Boundary

A draft report on the survey of this boundary was completed, and the preparation of manuscripts and fair drawings of map sheets depicting the survey is under way.

British Columbia-Yukon-Northwest Territories Boundary

About 65 miles of the Yukon-British Columbia portion of this boundary, from the Smith River crossing to the Beaver River, was surveyed and marked. Fair drawings of map sheets depicting previously completed surveys are being compiled and drafted.

Saskatchewan-Northwest Territories Boundary

The surveying and marking of this boundary, which is in progress, was continued easterly from the termination of the 1954-55 winter survey. Sixty-seven miles of line were opened up and monumented, making a total of 119 miles of the boundary marked on the ground.

76816—3½

Legal Surveys

At the request of the Indian Affairs Branch, Department of Citizenship and Immigration, miscellaneous legal surveys were carried out in the following Indian Reserves:

Quebec	—Caughnawaga
Ontario	—Big Trout Lake, Christian Island, French River, Georgina Island, Goulais Bay, Henvey Inlet, Kettle Point, Tyendinaga
Manitoba	—Bottle Lake, Riding Mountain, Valley River
Saskatchewan	—Little Black Bear
Alberta	—Alexander, Alexis, Peace River Crossing
British Columbia	—Kamloops, Kispaiox, Kitwangar, Okanagan
Yukon	—Old Crow, Whitehorse

Yukon

Four survey parties headed by staff surveyors operated in Yukon.

One hundred and twenty-six miles of the right-of-way of the Canadian section of the oil pipe line between Haines and Fairbanks, Alaska were surveyed.

A large addition to the city of Whitehorse was subdivided into 206 lots, and access roads leading to the new subdivision and a hospital site were surveyed.

An addition to Teslin Settlement was subdivided into 48 lots.

The boundaries of 47 group lots were established and monumented. Twenty-four of these lie along the Alaska Highway between Champagne and Lower Post, six on the northwest section of the Alaska Highway, twelve on the Whitehorse-Carmacks road, one on the Dawson road, one at Carcross, and three at Old Crow. Three mineral claims at Carmacks and one at Carcross were surveyed.

Instructions were issued to private surveyors for the survey of 230 mineral claims principally in the Whitehorse and Mayo mining districts.

Northwest Territories

One survey party headed by a staff surveyor carried out miscellaneous legal surveys at Aklavik, Fort Liard, Fort McPherson, Fort Smith and Yellowknife.

Instructions were issued to a private surveyor to survey 11 mineral claims in the Yellowknife mining district.

Other Surveys

At the request of the Department of Northern Affairs and National Resources, legal surveys were carried out in the following national parks:

Ontario	—Point Pelee, St. Lawrence Islands
Alberta	—Banff, Jasper, Waterton Lakes
British Columbia	—Mount Revelstoke, Yoho

An historic site was surveyed at Ste. Anne du Bocage, New Brunswick.

The British Columbia portion of the pipe line between Haines and Fairbanks, Alaska, was also surveyed.

Instructions were issued at the request of private surveyors retained by private clients for 131 miscellaneous surveys in Indian Reserves, National Parks and in Yukon.

Office

The Division made 159 miscellaneous plans, tracings and Indian location ticket sketches; examined and recorded 350 plans and their respective field notes in Indian Affairs survey records; examined 310 plans of legal surveys and the field notes thereof; dispatched 9,706 reproductions of survey plans; and prepared 844 legal descriptions for use in transactions dealing with land, mineral claims, and petroleum and natural gas permit applications.

Aeronautical Charts

Photogrammetry (Tri-Camera)

A total of 168,193 square miles of planimetric detail was plotted from tri-camera photographs for the production of aeronautical chart bases. The areas covered are as follows:

Charts Completed—(advance prints available at 1 inch to 1.5 miles).

67 S.W., S.E. — King William Island
77 S.W., S.E. — Cambridge Bay
77 N.W., N.E. — Victoria Island East
78 S.W., S.E. — Hadley Bay
87 S.W., S.E. — Dolphin and Union Strait
87 N.W., N.E. — Fort Collinson
98 S.W., S.E. — Banks Island

Ellesmere Island South—This area comprising four 1 inch-to-8 mile charts (Devon East, Wellington Channel, Craig Harbour and Bache Peninsula) is at the sketching stage, about 80 per cent complete.

Ellesmere Island North—This area comprising four 1 inch-to-8 mile charts (Greely Fiord, Challenger Mountains, Kennedy Channel and Markham Inlet) is ready for the metal templet stage, about 70 per cent complete.

Sverdrup Islands—This area comprising four 1 inch-to-8 mile charts (Barrow Strait West, King Christian Island, Sverdrup Islands, and Nansen Sound) is at the photo-processing stage, about 60 per cent complete.

Revisions—The land area in the northwest corner of the Gaspé (22 S.E.) 1 inch-to-8 mile chart was plotted on acetate at 1 inch to 1.5 miles.

Two acetate sheets on the Hebron-Cape Territok (14 N.W.) 1 inch-to-8 mile aeronautical chart were revised by means of new vertical photography. The revised sheets were used in flying a special radar altimetry operation.

Seventeen acetate sheets covering Coates Island and the southern coast of Southampton Island were revised for the Chief Curator of the National Museum.

A revision was made of the planimetric detail on the mainland portion of the Harrington Belle Isle (12 N.E.) 1-inch-to-8 mile aeronautical chart.

The following special plots were prepared:

1. A 1-inch-to-8-mile plot of Axel Heiberg Island was made for the Geological Survey of Canada.

2. Investigations were carried out relative to contouring aeronautical Charts by means of oblique multiplex. Some 3,000 square miles of an experimental area in the southeast corner of Baffin Island has been plotted to date.

3. Oblique multiplex was also used to develop a 1-inch-to-1 mile contoured plot of the area extending from Cape Richards to Cape Columbia on the north coast of Ellesmere Island for the Defence Research Board. This work will also be used by the U.S.A.F. Cambridge Research Centre in the correlation of existing field information.

Air Information

The following new air overprint compilations and air revisions were completed:

Scale	Air Overprint New Compilation	Air Revision	Reprints Examined and Requested
8 mile-N.T.S. Aeronautical	72	44	172
1:1,000,000 World Aeronautical Charts	23	13	39
1:1,000,000 Aeronautical Route Charts	2	6	6
1:3,000,000 Navigation Route Charts	1	..	..
1:3,000,000 Navigation Plotting Charts	..	2	..
1:4,000,000 Trans Atlantic Plotting Charts	1	..	..
1:250,000 Experimental Approach Charts	2	..	..
	101	65	217

The compilation of a standard aeronautical reference for the reverse side of the 8-mile and 1:1,000,000 aeronautical charts was completed.

Canada Air Pilot—Amendments to the Canada Air Pilot are issued weekly alternating between the Eastern Volume and the Western Volume. Each amendment includes all corrections in the "master copy" and is issued as a written statement of correction in the mimeographed section or is contained in a section of new and revised sheets for the manual.

The following new and revised sheets were issued. Many sheets are revised more than once a year:

Revision to:

423 aerodrome pages
140 miscellaneous pages (facility listings, indexes, etc.)
135 Instrument Approach and Landing Charts (in 3 colours)
39 Instrument Landing System Charts (13 in 3 colours)
74 Radio Facility Charts (in two colours)

First publication of:

3 aerodrome pages for Cold Lake, Alta.; Roberval, Que.; Seattle, Wash.
15 Instrument Approach and Landing Charts (in three colours)
1 Instrument Landing System Chart (in one colour)
3 "Special Notice" sheets: one regarding "On Request" radio facilities; one on airway changes in the Regina area; and one on VOR airways in eastern Canada.

The publication of the 15 new Instrument Approach and Landing Charts, mentioned above, completed the conversion of this type of chart from a black and white format to a three-colour format. The series comprises 88 charts.

Radar Altimetry—Approximately 10,775 miles of ground profile information was obtained by radar altimeter surveys in cooperation with the Royal Canadian Air Force and by contract with a private company.

A brief description of these surveys is as follows:

1.	Chicoutimi-Rimouski area, 1,080 miles, and Ellesmere Island, 290 miles, primarily for aeronautical charting purposes (R.C.A.F.)	1,370 mi.
2.	Arctic area—primarily for shoran purposes (R.C.A.F.)	250 "
3.	Churchill area—primarily for requirements connected with Mid Canada Radar Line (R.C.A.F.)	800 "
4.	Ungava area—primarily for 1 inch-to-4 mile mapping (contract)	881 "
5.	Northern Quebec area—primarily for aeronautical charting purposes and possibly larger scale mapping (contract)	7,474 "
	Total	10,775 "

Contour and spot height information was brought to completion on 26 aeronautical charts at the 1 inch-to-8 mile scale. An alphabetical list of these charts follows:

Battle Harbour Cartwright 13 S.E. (revised)
Boothia 57 N. (spot heights only)
Cape Tatnam 54 S.E.
Churchill 54 N.E.
Cumberland Sound 26 S. (exclusive Cumberland Pen.)
English River 52 N.W.
Fort Vermilion 84 N.E.
Foxe Peninsula 26 S.
Frobisher Bay 25 N.
George River 24 N.E. (south ½)
Geraldton-White River 42 S.W.
Great Slave 85 S.E.
Hebron-Cape-Territok 14 N.W. (south ½)
Ignace-Ft. William 52 S.E.
Indian House 24 S.E.
Kenora-Ft. Frances 52 S.W.
Nain Nutak 14 S.W.
Naskaupi 13 N.W.
Prince of Wales 68 S.
Pickle Crow-Armstrong 52 N.E.
Rae Strait 57 S. (spot heights only)
Reindeer Lake 64 S.W.
Seal River 64 N.E.
Southern Indian 64 S.E.
Wollaston Lake 64 N.W.
York Factory 54 S.W.

A private company completed, on a contract basis, a program of radar altimeter research and development work, involving several modifications to a radar altimeter on loan for an indefinite period from the R.C.A.F. A 38-hour program of flight tests was undertaken to determine whether surveys carried out with the modified altimeter would be accurate enough for mapping at scales of 1 inch-to-4 miles or larger. A preliminary examination of the results, which are being analyzed by the Photogrammetric Research Section of the National Research Council, indicates that the accuracy of the altimeter had been considerably improved.

Columbia River Basin Project

Eight sheets of the detailed topographical plans of the Columbia River basin were compiled, completing the compilation of the series of 89 detailed topographical plans of the river basin.

Survey Records and Electoral Maps

The examination of field notes of surveys made in British Columbia was completed, and the notes pertaining to surveys of land now under provincial jurisdiction were transferred to that province "on loan".

There is a constant demand from other government departments and outside agencies for information available from the survey records. This consists, in part, of data on geographical positions of specified monuments, on base line and meridian control surveys, and on early surveys.

Survey Records

Field books recorded	105
Plans recorded	343
Township plans despatched	812
Settlement plans despatched	298
Blue line copies of plans and field notes despatched	639

Electoral Maps

A record is maintained of known changes in municipal or other administrative boundaries, and of new post offices throughout Canada for use in the preparation of the next series of electoral maps.

Most of the changes occur in Ontario and Quebec, and it has been necessary to prepare special sets of master maps for these provinces.

A map was prepared for the Chief Electoral Officer showing territorial electoral districts in Yukon.

Miscellaneous

A total of 975 air-line distances was determined and supplied to the DEW project, Post Office and Transport Departments, Canadian National and Canadian Pacific communications and certain air-transport companies.

The current editions of the Astronomical Field Tables were checked and proofed. There were 160 requests for copies of the tables from outside agencies and private surveyors. A stock was also supplied to provincial and federal departments, universities, and technical schools.

In all, 123 requests for technical publications were dealt with.

Board of Examiners for Dominion Land Surveyors

The Board held four meetings, principally in connection with the conduct of the annual qualifying examinations in February provided for by Section 10 of the Canada Lands Surveys Act. Examinations were held at Sackville in New Brunswick, at Ottawa, Winnipeg, Regina, Saskatoon, Edmonton, and Victoria. Seventy-one candidates were examined, of whom 24 were successful in the combined categories. Nine certificates of preliminary examination and fourteen commissions as Dominion Land Surveyor were issued as provided for in the Act.

MAP COMPILATION AND REPRODUCTION DIVISION

Maps, charts and plans printed during the fiscal year totalled 1,336, a 37 per cent increase over the previous year.

The number of new or revised small scale maps compiled decreased to 16 from 50 in 1954-55, the emphasis being on the preparation of base maps for use in the new Atlas of Canada, and on the conversion of one inch-to-one mile maps to the 1:50,000 scale. Of the 16 maps compiled, 12 were new compilations, and of the 50 in the previous year, 33 were revisions.

The number of new topographical maps produced increased to 200 over 172 in 1954-55, 148 of these being in the 1:50,000 series each comprising an east and west portion.

Distribution of National Topographic Series maps and aeronautical charts dropped 260,000 below the previous fiscal year to 630,000 owing to the transfer to the Army Survey Establishment of the distribution of aeronautical charts to the R.C.A.F.

A breakdown showing the types and numbers of maps, charts, and plans printed appears at the end of the Division's report.

Map Compilation

The compilation of the 1:2,500,000 base maps for use in the new Atlas of Canada was completed. It was decided to extend the series north to include Ellesmere Island so as to produce an up-to-date map of Canada in six sheets at a scale of 1:2,000,000.

The conversion to the 1:50,000 scale of one inch-to-one mile maps was set under way to replace a number of these which had gone out of print. This work will be continued until the entire series is available at a common scale.

Seventeen maps for the Defence Research Board were produced for an air navigation manual.

A new 1:500,000 series was developed for use as a topographic small-scale map and as an air chart base. The pilot model of this series is at the colour-proof stage.

76816—4

Summary of Compilation

Type of Map	Scale	New edition	No change in edition
National Topographic Series	1:500,000	6	
" " "	1:250,000	16	
" " " (Conversions)	1:50,000	2	65
" " "	4-mile		1
" " "	2-mile	2	
Aeronautical Chart bases	8-mile	6	3
World Aeronautical Charts	1:1,000,000	1	
Atlas of Canada		1	
Indices		7	
Park maps		2	
Miscellaneous		9	

Map Drafting

Production showed an overall increase of 39 per cent over the previous fiscal year. Major attention was given to the drafting of maps at the 1:50,000 scale and to air overprints.

Two large maps were processed: a map of New Brunswick at the scale of one inch to 7·89 miles, and the first section of the 1:2,000,000 map of Canada.

Following two years of effort the 20-mile map of Canada was completed in May, 1955 and hung in the Railway Committee Room of the House of Commons. The map was drawn on a Lambert Conformal projection with a modified polyconic above the 80th parallel of latitude. Special supplies and equipment were necessary to produce the map: the paper was buckram-backed and made in England especially for the job; a sixteen-foot "T" beam of magnesium alloy was produced by the Mines Branch for drawing the projection; and a specially-constructed table was made to accommodate this large sheet of drawing paper. The special roller type mounting was supplied by the Department of Public Works. Compilation was completed, one province at a time, on large tracing-paper grids from the original manuscript. The drawing of this map was done by hand, the draftsmen having to work in a prone position. The map contains approximately 5,000 names. The size of the lettering is increased towards the top to improve legibility. The Canadian National and Canadian Pacific railways provided considerable information on railways. The Trans-Canada Highway is shown in as far as its location has been made.

Continual research is being carried out in the field of negative scribing, and new and improved methods are being introduced constantly. New commercial materials are being tried out in the search for better, faster and less costly ways of producing maps.

Summary of Drafting

Type of Map	Scale	New edition
National Topographic Series	1:50,000	148
" " "	2-mile	4
" " "	1:250,000	24
" " "	8-mile	26
" " "	1:500,000	2
Aeronautical Chart bases	1:1,000,000	7
Aeronautical Route Charts	1:1,000,000	5
Navigation Route Charts	1:3,000,000	3
Air overprints		138
Atlas of Canada	various	17
Indices	"	14
Park maps	"	4
Columbia River Basin	"	11
Miscellaneous maps		72

Photo-Mechanical

The Division developed and is producing contact screens used in colour tints required in map reproduction.

A photo-composing machine was purchased to permit the accurate registration of multi-coloured maps, more than one-up, on a metal plate.

All units of this section have shown increased production, the most outstanding being a 33 per cent increase in negative output, and a 35 per cent increase to users of diazo processing.

Summary of Photo-Mechanical Production

Film	52,045 sq. ft.
Plastic	24,683 sq. ft.
Rolls of film	9 pcs.
Contact prints	6,178 sq. ft.
Enlargements	5,564 sq. ft.
Blue line prints on metal plates	199 pcs.
Vandyke	21,508 sq. ft.
Blueprints	1,860 sq. ft.
OCE	249,588 sq. ft.
Diazo	83,519 sq. ft.
Sensitized linen	3,350 sq. ft.
Photostat sheets	10,385
Litho plates	1,426
Multilith plates (large)	1,259
Multilith plates (small)	1,112

Lithographic Printing

By scheduling the press runs, an increase of 37 per cent was made in the number of impressions printed.

76816—41

Summary of Printing

Type of Map	Scale	Quantity
National Topographic Series	1:50,000	35
" " "	1-mile	9
" " "	2-mile	23
" " "	1:250,000	7
" " "	4-mile	10
" " "	8-mile	129
Sectional maps	3-mile	3
Aeronautical Charts (base)	1:1,000,000	18
Aeronautical Charts A.R.C.	1:1,000,000	2
Air overprints	(8-mile & 1:1,000,000)	349
Atlas of Canada	various	2
Indices	"	30
Hydrographic charts	"	189
Geological	"	51
Miscellaneous	"	209
Columbia River Basin		4
Canada Air Pilot		266

Map Distribution

Nearly 630,000 National Topographic Series maps and 175 publications were distributed in response to 30,860 requests. Revenue from sales amounted to $79,907.

The reprinting of many out-of-print maps is well in hand.

New or Revised Maps
Produced by Map Compilation and Reproduction Division

Location	Number	Name	Latitude	Longitude	Remarks
(1) Aeronautical Charts—National Topographic Series *(Scale, 1 inch to 8 miles)*					
Que.	34 NW	Port Harrison	58°00'–60°00'	76°00'– 81°00'	Prelim. Rev.
Que.	35 SW	Cape Smith	60°00'–62°00'	76°00'– 81°00'	"
Ont.	43 SE	Akimiski Island	52°00'–54°00'	80°00'– 84°00'	"
Ont.	54 SE	Cape Tatnam	56°00'–58°00'	88°00'– 92°00'	"
Man.	54 SE	Cape Tatnam	56°00'–58°00'	88°00'– 92°00'	"
Man.	54 SW	York Factory	56°00'–58°00'	92°00'– 96°00'	"
Man.	54 NW	Churchill	58°00'–60°00'	92°00'– 96°00'	"
Man.	64 SE	Southern Indian	56°00'–58°00'	96°00'–104°00'	"
Man.	64 NW	Wollaston Lake	58°00'–60°00'	100°00'–104°00'	"
Sask.	64 NW or	Wollaston Lake	58°00'–60°00'	100°00'–104°00'	"

(1) Aeronautical Charts—National Topographic Series—Concluded

(Scale, 1 inch to 8 miles)—Concluded

Location	Number	Name	Latitude	Longitude	Remarks
Alta.	83 SE	Red Deer—Edmonton.	52°00′–54°00′	112°00′–116°00′	Rev.
Alta.	84 NE	Fort Vermilion.	58°00′–60°00′	112°00′–116°00′	Prelim.
B.C.—U.S.A.	82 SW	Okanagan Kootenay.	48°00′–50°00′	116°00′–120°00′	Rev
B.C.	93 SW	Ocean Falls — Ootsa Lake.	52°00′–54°00′	124°00′–128°00′	"
B.C.	104 NE	Dease Lake.	58°00′–60°00′	128°00′–132°00′	"
N.W.T.	25 N	Frobisher Bay.			
N.W.T.	34 NW	Port Harrison.	58°00′–60°00′	76°00′– 81°00′	Prelim. Rev.
N.W.T.	35 SW	Cape Smith.	60°00′–62°00′	76°00′– 81°00′	"
N.W.T.	36S	Foxe Peninsula.	64°00′–66°00′	72°00′– 80°00′	"
N.W.T.	43 SE	Akimiski Island.	52°00′–54°00′	80°00′– 84°00′	"
N.W.T.	49 S	Craig Harbour.	76°00′–78°00′	80°00′– 88°00′	"
N.W.T.	68 N	Barrow Strait West.	74°00′–76°00′	96°00′–104°00′	"
N.W.T.	69S	King Christian Island.	76°00′–78°00′	96°00′–104°00′	"
N.W.T.	69 A, 59 A-S.	Nansen Sound.	80°00′–82°00′	88°00′–104°00′	"
N.W.T.	78 S	Hadley Bay.	72°00′–74°00′	104°00′–112°00′	"
N.W.T.	86 N	Coppermine.	66°00′–68°00′	112°00′–120°00′	Prelim.
N.W.T.	87 S	Dolphin & Union Strait	68°00′–70°00′	112°00′–120°00′	Prelim. Rev.
N.W.T.	88 S	Banks Victoria.	72°00′–74°00′	112°00′–120°00′	"
N.W.T.	97 NW–NE	Amundsen Gulf.	70°00′–72°00′	120°00′–128°00′	"
N.W.T.	98 SW–SE	Banks Island.	72°00′–74°00′	120°00′–128°00′	"

(2) Other National Topographic Series Maps

(Scale, 1:250,000 except where indicated)

Que.	32 K	Lake Evans.	50°00′–51°00′	76°00′– 78°00′	1st ed.
Ont.	31 L/SE	Mattawa *(2 mi.)*.	46°00′–46°30′	78°00′– 79°00′	"
Ont.	42 B/NE	Elsas *(2 mi.)*.	48°30′–49°00′	82°00′– 83°00′	"
Man.	63 N/2	Batty Lake *(1 mi.)*.	55°00′–55°15′	100°30′–101°00′	"
Sask.	72 G	Wood Mountain.	49°00′–50°00′	106°00′–108°00′	"
Sask.	72 I	Regina.	50°00′–51°00′	104°00′–106°00′	"
Alta.	73 L	Sand River.	54°00′–55°00′	110°00′–112°00′	"
Alta.	74 L	Chipewyan.	58°00′–59°00′	110°00′–112°00′	Rev.
Alta.	74 M	Fitzgerald.	59°00′–60°00′	110°00′–112°00′	Prelim. 2nd ed.
Alta.	82 H	Lethbridge.	49°00′–50°00′	112°00′–114°00′	1st ed.

(2) Other National Topographic Series Maps—Concluded

(Scale, 1:250,000 except where indicated)—Concluded

Location	Number	Name	Latitude	Longitude	Remarks
Alta.	83 I	Tawatinaw	54°00′–55°00′	112°00′–114°00′	1st ed.
Alta.	84 G	Wadlin Lake	57°00′–58°00′	114°00′–116°00′	"
Alta.	84 J	Vermilion Chutes	58°00′–59°00′	114°00′–116°00′	"
B.C.	82 N/SW	Glacier Park *(2 mi.)*	51°00′–51°30′	117°00′–118°00′	Rev.
B.C.	92 O	Taseko Lake	51°00′–52°00′	122°00′–124°00′	1st ed.
B.C.	93 B	Quesnel	52°00′–53°00′	122°00′–124°00′	"
B.C.	93 C	Anahim Lake	52°00′–53°00′	124°00′–126°00′	"
B.C.	93 F	Nechako River	53°00′–54°00′	124°00′–126°00′	"
B.C.	93 O	Pine Pass	55°00′–56°00′	122°00′–124°00′	"
Yukon	105 D	Whitehorse	60°00′–61°00′	134°00′–136°00′	"
Yukon	116 A	Larson Creek	64°00′–65°00′	136°00′–138°00′	"

(3) World Aeronautical Charts

(Scale, 1:1,000,000)

Ont.	2182	Sachigo River	52°00′–56°00′	88°00′– 96°00′	1st ed.
Man.	2182	Sachigo River	52°00′–56°00′	88°00′– 96°00′	"
Alta.	2140	Hay River	56°00′–60°00′	112°00′–120°00′	"
B.C.—U.S.A.	2187	Skeena River	52°00′–56°00′	128°00′–135°00′	"
Can.—U.S.A.	Spec.	Southern Ontario	42°00′–46°00′	75°00′– 83°00′	"
N.W.T.	2114	Slave River	60°00′–64°00′	112°00′–120°00′	"

(4) Aeronautical Route Charts

(Scale, 1:1,000,000)

Alta.	11	Edmonton — Fort Nelson			1st ed.
B.C.	11	Edmonton — Fort Nelson			"
B.C.	12	Ft. Nelson — Whitehorse			"
Yukon	12	Ft. Nelson — Whitehorse			"

(5) Columbia River Basin

(Scale, 1:31,680)

Location	Number	Name	Latitude	Longitude	Remarks
B.C.	36	Big Bend Area	51°43′–51°51′	117°17′–117°34′	1st ed.
B.C.	42	Upper Columbia River Area	51°07′–51°15′	116°42′–116°59′	"
B.C.	43	" " "	51°00′–51°08′	116°29′–116°46′	"
B.C.	48	" " "	50°27′–50°37′	115°55′–116°08′	"

(6) Miscellaneous

4	Maps of National Parks	*(New—Northern Affairs)*
3	Atlas of Canada Maps	*(New—Geographical Br.)*
	Wall Map of Canada	*(New—Parliament Bldg.)*
	New Brunswick	*(New)*
	Gravity Map of Southern Ontario	*(New—Dom. Obs.)*
	Arctic North America	*(New—Arctic Institute of N.A.)*

(7) Maps of 1:50,000 Series

Nfld.	1 K/14	Biscay Bay River	46°45′–47°00′	53°00′– 53°30′	1st ed.
Nfld.	1N/3	St. Catherines	47°00′–47°15′	53°00′– 53°30′	"
Nfld.	1N/13	Sunnyside	47°45′–48°00′	53°30′– 54°00′	"
Nfld.	1N/14	Hearts Content	47°45′–48°00′	53°00′– 53°30′	"
Nfld.	2D/8	Port Blandford	48°15′–48°30′	54°00′– 54°30′	"
Nfld.	2D/9	Glovertown	48°30′–48°45′	54°00′– 54°30′	"
Nfld.	2D/15	Gander Newfoundland	48°45′–49°00′	54°30′– 55°00′	"
Nfld.	2E/1	Weirs Pond	49°00′–49°15′	54°00′– 54°30′	"
Nfld.	2E/3	Botwood	49°00′–49°15′	55°00′– 55°30′	"
Nfld.	2E/4	Hodges Hill	49°00′–49°15′	55°30′– 56°00′	"
Nfld.	2E/5	Roberts Arm	49°15′–49°30′	55°30′– 56°00′	"
Nfld.	2E/12	Little Bay Island	49°30′–49°45′	55°30′– 56°00′	"
Nfld.	2E/13	Nipper's Harbour	49°45′–50°00′	55°30′– 56°00′	"
Nfld.	2L/12	Grey Islands Harbour	50°30′–50°45′	55°30′– 55°45′	"
Nfld.	12A/13	Corner Brook	48°45′–49°00′	57°30′– 58°00′	"
Nfld.	12B/15	Shag Island	48°45′–49°00′	58°30′– 58°50′	"
Nfld.	12B/16	Serpentine	48°45′–49°00′	58°00′– 58°30′	"

(7) Maps of 1:50,000 Series—Continued

Location	Number	Name	Latitude	Longitude	Remarks
Nfld.	12G/1	Bay of Islands	49°00′–49°15′	58°00′– 58°30′	1st ed.
Nfld.	12G/8	Trout River	49°15′–49°30′	58°00′– 58°20′	"
Nfld.	12H/4	Pasadena	49°00′–49°15′	57°30′– 58°00′	"
Nfld.	12H/5	Lomond	49°15′–49°30′	57°30′– 58°00′	"
Nfld.	12H/7	Sheffield Lake	49°15′–49°30′	56°30′– 57°00′	"
Nfld.	12H/8	Springdale	49°15′–49°30′	56°00′– 56°30′	"
Nfld.	12H/9	Kings Point	49°30′–49°45′	56°00′– 56°30′	"
Nfld.	12H/13	St. Pauls Inlet	49°45′–50°00′	57°30′– 58°00′	"
Nfld.	12H/16	Baie Verte	49°45′–50°00′	56°00′– 56°30′	"
Nfld.	21I/5	Bellburns	50°15′–50°30′	57°30′– 57°45′	"
Nfld.	12I/14	St. John Island	59°45′–51°00′	57°00′– 57°30′	"
Nfld.	12P/7-E	Flowers Cove	51°15′–51°30′	56°30′– 56°50′	"
N.S.	11E/11	Tatamagouche	45°30′–45°45′	63°00′– 63°30′	1st ed. conv.
N.S.	11E/14	Malagosh	45°45′–46°00′	63°00′– 63°30′	" "
N.S.	11F/6	Chedabucto Bay	45°15′–45°30′	61°00′– 61°30′	" "
N.S.	11K/1	Sydney	46°00′–46°15′	60°00′– 60°30′	2nd ed.
N.S.	11K/6	Margaree	46°15′–46°30′	61°00′– 61°30′	1st ed. conv.
N.S.	11K/15	Pleasant Bay	46°45′–47°00′	60°30′– 61°00′	1st ed.
N.S.	11K/16	Dingwall	46°45′–47°00′	60°00′– 60°30′	"
N.S.	11N/4-W	Havre Aubert	47°00′–47°15′	61°45′– 62°00′	"
N.S.	11N/5	Grindstone	47°15′–47°30′	61°30′– 62°00′	"
N.S.	11N/11-W	East Island	47°30′–47°45′	61°15′– 61°30′	"
N.S.	11N/14-W	Brian Island	47°45′–48°00′	61°15′– 61°30′	1st ed.
N.S.	20P/14	Shelburne	43°45′–44°00′	65°00′– 65°30′	"
N.S.	21A/7	Bridgewater	44°15′–44°30′	64°30′– 65°00′	"
N.S.	21B/9-E	Centerville	44°30′–44°45′	66°00′– 66°15′	"
N.S.	21H/16	Amherst	45°45′–46°00′	64°00′– 64°30′	1st ed. conv.
N.B.	21H/16	Amherst	45°45′–46°00′	64°00′– 64°30′	" "
N.B.	21I/1	Port Elgin	46°00′–46°15′	64°00′– 64°30′	1st ed.
N.B.	21I/5	Salmon River Road	46°15′–46°30′	65°30′– 66°00′	"
N.B.	21I/6	Harcourt	46°15′–46°30′	65°00′– 65°30′	"
N.B.	21I/12	Blackville	46°30′–46°45′	65°30′– 66°00′	"
N.B.	21I/15	Point Sapin	46°45′–47°00′	64°45′– 65°00′	"
N.B.	21J/8	Boiestown	46°15′–46°30′	66°00′– 66°30′	2nd ed.
N.B.	21P/11	Burnsville	47°30′–47°45′	65°00′– 65°30′	1st ed.

(7) Maps of 1:50,000 Series—Concluded

Location	Number	Name	Latitude	Longitude	Remarks
N.B.	21P/15	Caraquet	47°45′–48°00′	64°30′– 65°00′	1st ed.
Que.	21M/8	Isle-au-Coudres	47°15′–47°30′	70°00′– 70°30′	"
Que.	21N/5	St. Pacome	47°15′–47°30′	69°30′– 70°00′	"
Que.	21N/12	St. Pascal	47°30′–47°45′	69°30′– 70°00′	"
Que.	22A/3	New Carlisle	48°00′–48°15′	65°00′– 65°30′	"
Que.	22A/6	Honorat	48°15′–48°30′	65°00′– 65°30′	"
Que.	22A/14	York Lake	48°45′–49°00′	65°00′– 65°30′	"
Que.	22H/2	Cloridorme	49°00′–49°15′	64°30′– 65°00′	"
Que.	22H/3	Grande Vallee	49°00′–49°15′	65°00′– 65°30′	"
Que.	31I/3	Sorel	46°00′–46°15′	73°15′– 73°30′	2nd ed.
Ont.	31D/12	Orr Lake	44°30′–44°45′	79°30′– 80°00′	1st ed.
Ont.	41G/10	Great Duck Island	45°30′–45°45′	82°30′– 83°00′	1st ed. conv.
Ont.	41G/14	Meldrum Bay	45°45′–46°00′	83°00′– 83°30′	" "
Ont.	41G/15	Silverwater	45°45′–46°00′	82°30′– 83°00′	" "
Ont.	41H/12	Manitowaning	45°30′–45°45′	81°30′– 82°00′	" "
Ont.	41H/13	Little Current	45°45′–46°00′	81°30′– 82°00′	" "
Ont.	52A/7-W	Thunder Cape	48°15′–48°30′	88°45′– 89°00′	1st ed.
Man.	63K/15	Elbow Lake	54°45′–55°00′	100°30′–101°00′	1st ed. conv.
Sask.	72F/7	Knollys	49°15′–49°30′	108°30′–109°00′	1st ed.
Sask.	72F/10	Dollard	49°30′–49°45′	108°30′–109°00′	"
Sask.	72H/5	Willow Bunch	49°15′–49°30′	105°30′–106°00′	"
Sask.	73K/13	Primrose Lake	54°45′–55°00′	109°30′–110°00′	1st ed. conv.
Alta.	82H/3	Cardston	49°00′–49°15′	113°00′–113°30′	" "
Alta.	82H/4-W	Watertown	49°00′–49°15′	113°30′–114°00′	" "
Alta.	83C/12	Athabaska Falls	52°30′–52°45′	117°30′–118°00′	" "
Alta.	83E/14	Grande-Cache	53°45′–54°00′	119°00′–119°30′	" "
Alta.	83F/2-W	Foothills	53°00′–53°15′	116°45′–117°00′	" "
Alta.	83F/5-W	Entrance	53°15′–53°30′	117°45′–118°00′	" "
B.C.	92H/12-E	Mt. Urquhart	49°30′–49°45′	121°30′–121°45′	1st ed.
B.C.	93B/9	Alexandria	52°30′–54°45′	122°00′–122°30′	"
B.C.	93B/16	Quesnel River	52°45′–53°00′	122°00′–122°30′	"
N.W.T.	85J/16	Tuyta Lake	62°45′–63°00′	114°00′–114°30′	"

INTERNATIONAL BOUNDARY COMMISSION

Conferences of the Commissioners

The Commissioners reviewed the boundary situation between the two countries at their first meeting of the fiscal year in Ottawa from April 26 to 28, 1955, and agreed that maintenance operations should be carried out on the Quebec-Maine highlands section by one Canadian and one United States field party; on the 49th parallel east of the summit of the Rockies by a United States party; and on the British Columbia-Washington boundary by a Canadian party. It was also agreed to continue the marking of the boundary through fishing grounds in Lake Erie by lighted buoys and at Boundary Bay, B.C., by lighted ranges, and to carry out a test of basal-bark spraying for control of re-growth of trees in the boundary vista in Quebec.

The Commissioners met again in Washington, D.C., from March 20 to 23, 1956 to consider boundary matters in general and to adopt a program of maintenance for the 1956 field season. It was decided that maintenance operations should be carried out on the 49th parallel boundary east of Laurier, B.C. by a Canadian party; east of Porthill, Washington, and westward from the summit of the Rockies by United States parties; and on the Manitoba-Minnesota boundary by a Canadian party. It was also agreed that inspections should be made of control triangulation stations along the seaway section of the St. Lawrence River, and from Niagara River to St. Clair River in Ontario.

Inspections

The Commissioners visited boundary range marks at Lubec, Maine, where arrangements were made to restore Range No. 28, now hidden by buildings. Inspection was also made of boundary markers at St. Stephen, N.B., and Calais, Maine. The field engineers of the United States section were visited at Woburn, Quebec, but owing to the inacessibility of its camp in the highlands, the Canadian party was not visited. Ornamental boundary monuments Nos. 429A and 429B at Coburn Gore, the monuments at Rock Island, Quebec, and Monument 588 at North Troy, Vermont, were found in good condition. Inspection of monuments and of the boundary vista were also made at the International Peace Gardens, Manitoba-North Dakota; at Carway, Alta.; and at the Chief Mountain highway, Alberta-Montana. The work of the United States party at Waterton Park and of the Canadian party in southern British Columbia was inspected. The results of a three-year program of foliage spraying on a 17-mile section of the boundary adjacent to a gravelled road were found to be most satisfactory, with trees and bushes suppressed and grasses and ferns now predominating in the boundary vista.

An aerial inspection was made of the vista across the valleys of Taku, Sittakanay, Skagway, Klehini, Kelsall, and Tahini Rivers in southeast Alaska. Although difficult to locate from a distance, once found the vista could be clearly seen from the air. Inspection was also made of the 141st meridian boundary south of the Alaska Highway where the vista was clearly visible through timber, but was obscure in lower growth.

Engineers for the Canadian and United States sections made a joint inspection of the St. Lawrence seaway section of stations of control triangulation, setting references to one such station, liable to destruction, near Ogdensburg.

Maintenance on the International Boundary

On the Quebec-Maine highlands boundary, 22 miles of the boundary were inspected and the vista was recleared to a skyline width of 20 feet. Inspection was made of 530 monuments, of which 28 were repaired. A test of basal-bark spraying to control re-growth of cut trees was carried out in the vicinity of two road crossings. Spraying was done from pack sprayers and results will be assessed during the next few seasons.

On the British Columbia-Washington boundary, 63 monuments were inspected on 35 miles of boundary, 22 miles of vista recleared, and repairs were made to two monuments. Planetable surveys were made at three boundary crossings where changes in culture were found, and a range line was recleared at Point Angeles, Wash.

Reports of the Commission

The Commissioners' annual joint report for the year 1954 was completed and is being bound. The report contains a statement of all the inspections made, the monuments, reference monuments, and range marks repaired, relocated, rebuilt, moved and established during the year, the mileage and location of vista re-opened, together with plates and tables, certified by the Commissioners, giving the geodetic positions of the above-mentioned boundary markers. A special report on maintenance on the North Line and St. John River sections from 1925 to 1955 has been photolithographed and is being prepared for binding. Additional reports on the St. Croix River section and the central Great Lakes sections of the boundary are in preparation.

NORTHWEST TERRITORIES

1 OPERATION FRANKLIN
NORTHERN DISTRICT OF FRANKLIN
Y.O. FORTIER, R.G. BLACKADAR, H.R. GREINER, D.J. McLAREN, E.F. ROOTS, R. THORSTEINSSON, E.T. TOZER

2 AEROMAGNETIC SURVEYS
NORTHERN DISTRICT OF FRANKLIN
F.P. DuVERNET

3 PALAEONTOLOGY AND STRATIGRAPHY
RAT RIVER TO BABBAGE RIVER
J.A. JELETZKY

4 MARIAN RIVER
J.C. McGLYNN

5 OPERATION THELON
SOUTHEAST DISTRICT OF MACKENZIE
G.M. WRIGHT, B.G. CRAIG, K.E. EADE, J.A. FRASER, J.W. HOADLEY

6 AEROMAGNETIC SURVEYS
SOUTHEAST DISTRICT OF MACKENZIE
F.P. DuVERNET

7 SNOWBIRD LAKE
F.C. TAYLOR

YUKON TERRITORY

1 RECONNAISSANCE
NORTHERN YUKON
H. GABRIELSE

2 SCOUGALE CREEK AND McQUESTEN LAKE
L.H. GREEN

3 KENO HILL
E.D. KINDLE

4 MAYO DISTRICT
R.W. BOYLE

5 KASKAWULSH
J.O. WHEELER, R.L. CHRISTIE

6 WOLF LAKE
W.H. POOLE

BRITISH COLUMBIA

1 ATLIN AND TULSEQUAH
J.D. AITKEN

BRITISH COLUMBIA

2 TERRACE
S. DUFFELL

3 CHARLIE LAKE
E.J.W. IRISH

4 ANAHIM LAKE
H.W. TIPPER

5 PALAEONTOLOGY AND STRATIGRAPHY
SOUTHERN BRITISH COLUMBIA
H. FREBOLD

6 COQUITLAM
J.A. RODDICK

7 TERTIARY AND PLEISTOCENE
LOWER FRASER VALLEY
J.E. ARMSTRONG

8 GROUNDWATER
LOWER FRASER VALLEY
E.C. HALSTEAD

9 PALAEONTOLOGY AND STRATIGRAPHY
PRINCETON-COALMONT
W.L. FRY

10 KETTLE RIVER
H.W. LITTLE

11 LARDEAU
J.E. REESOR

12 CANAL FLATS
G.B. LEECH

ALBERTA

1 ADAMS LOOKOUT E 1/2
J.K. ECCLES

2 PALAEONTOLOGY AND STRATIGRAPHY
FOOTHILLS
P. HARKER

3 CRETACEOUS LITHOLOGY
CENTRAL FOOTHILLS
D.F. STOTT

4 CARBONIFEROUS LITHOLOGY
ENTRANCE TO BANFF
W.B. BRADY

ALBERTA

5 SURFICIAL GEOLOGY
HIGH RIVER
A.M. STALKER

6 LIVINGSTONE
D.K. NORRIS

SASKATCHEWAN

1 BEAVERLODGE
L.P. TREMBLAY

2 URANIUM INVENTORY
BEAVERLODGE
D.D. HOGARTH

3 MILLIKEN LAKE
C. K. BELL

MANITOBA

1 BIG SAND LAKE
H.A.QUINN

2 SPLIT LAKE
R. MULLIGAN

3 SCHIST LAKE
W.W. HEYWOOD

4 SURFICIAL GEOLOGY
ETHELBERT AND VIRDEN
J.A. ELSON

ONTARIO

1 SURFICIAL GEOLOGY
IROQUOIS FALLS
O.L. HUGHES

2 URANIUM DEPOSITS
BLIND RIVER
S.M. ROSCOE

3 MANITOULIN ISLAND
B.A. LIBERTY

4 MINERALOGICAL STUDIES
BANCROFT
S.C. ROBINSON

5 OIL AND GAS DATA
SOUTHWESTERN ONTARIO
B.V. SANFORD

QUEBEC

1 GRANITE BATHOLITH STUDY
PREISSAC AND LACORNE TPS.
K.R. DAWSON

2 OPASATIKA LAKE
W.G. JOHNSTON

3 PALAEONTOLOGY AND STRATIGRAPHY
SOUTHERN QUEBEC
G.W. SINCLAIR

4 SURFICIAL GEOLOGY
GRONDINES
P. KARROW

5 PLEISTOCENE PALAEONTOLOGY
OTTAWA-ST. LAWRENCE RIVER
MISS F.J.E. WAGNER

6 GROUNDWATER
ST. JEAN AND LACHINE
E.I.K. POLLITT

7 SURFICIAL GEOLOGY
UPTON
N.R. GADD

8 INTERPRETATION OF AEROMAGNETIC DATA
EASTERN TOWNSHIPS
A.S. MacLAREN A.L. LAROCHELLE

NEW QUEBEC-LABRADOR

1 CAMBRIAN LAKE
W.F. FAHRIG

2 AHR LAKE
W.R.A. BARAGAR

NEWFOUNDLAND

1 TWILLINGATE AND ROBERTS ARM
T.O.H. PATRICK

2 VICTORIA LAKE
G.C. RILEY

3 TERRA NOVA
S.E. JENNESS

4 PALAEONTOLOGY AND STRATIGRAPHY
EASTERN NEWFOUNDLAND
R.D. HUTCHINSON

NEWFOUNDLAND

5 DILDO AND WESTERN AVALON PENINSULA
W.D. McCARTNEY

NEW BRUNSWICK

1 BATHURST BASE METAL DEPOSITS
C.H. STOCKWELL

2 CALIFORNIA LAKE
C.H. SMITH

3 COLDSTREAM
F.D. ANDERSON

PRINCE EDWARD ISLAND

1 G.H. CROWL

NOVA SCOTIA

1 NORTH CAPE BRETON
E.R.W. NEALE

2 WHYCOCOMAGH
D.G. KELLEY

3 KENNETCOOK
I.M. STEVENSON

GENERAL

URANIUM DEPOSITS
CANADA
A.H. LANG

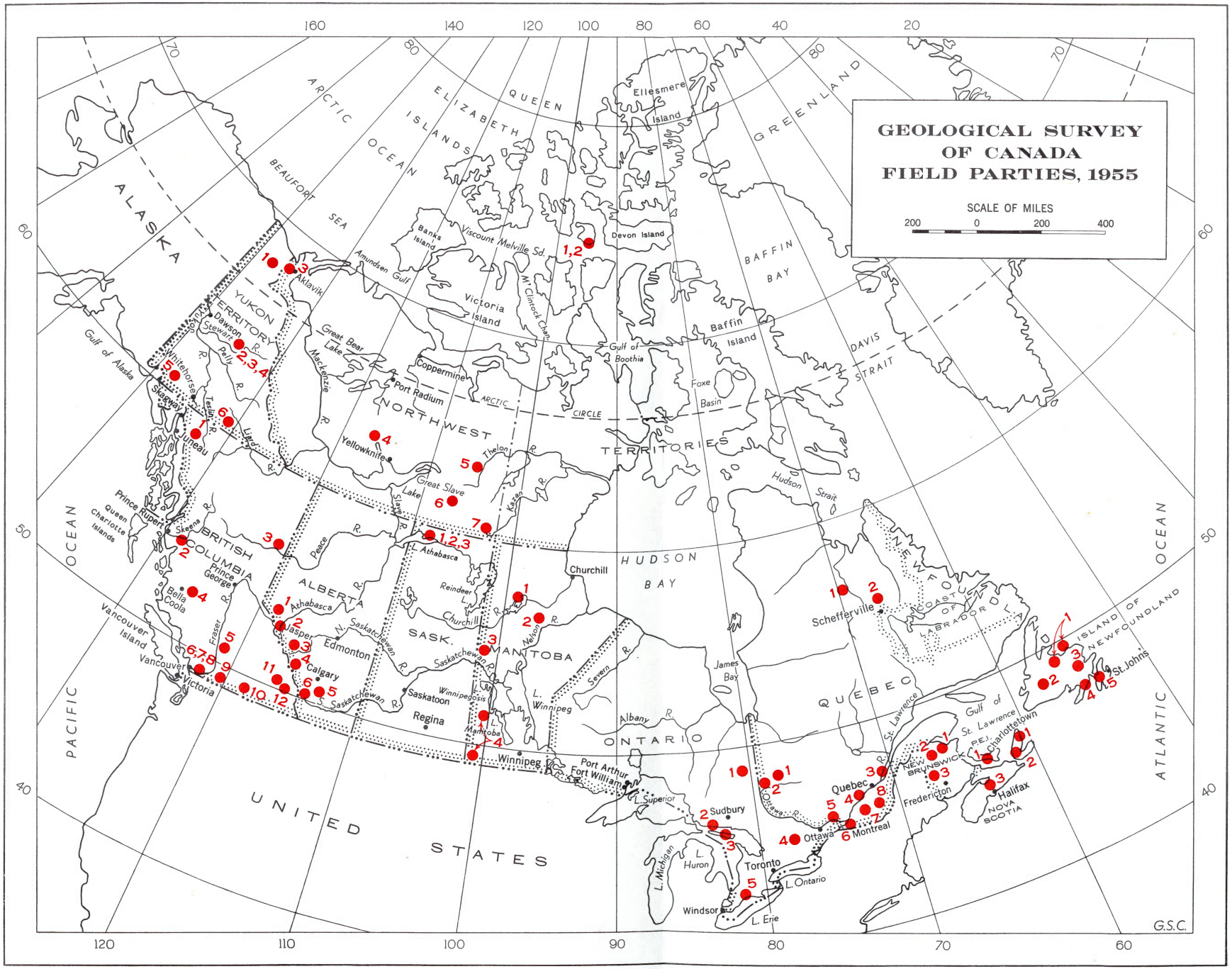
MINERAL COLLECTION
ONTARIO AND QUEBEC
R. GAUTHIER

COLUMBIUM DEPOSITS
ONTARIO, QUEBEC, AND BRITISH COLUMBIA
R.B. ROWE

COAL RESERVES
BRITISH COLUMBIA, ALBERTA, SASKATCHEWAN, AND NORTHWEST TERRITORIES
B.A. LATOUR

INSPECTION AND/OR INTERMITTENT FIELD DUTIES
W.A. BELL, J.F. CALEY, R.B. CAMPBELL, W.E. COCKFIELD, P.A. HACQUEBARD, J.M. HARRISON, C.S. LORD, L.W. MORLEY, V.K. PREST, L.J. WEEKS, R.T.D. WICKENDEN

G.S.C.


GEOLOGICAL SURVEY
OF CANADA
FIELD PARTIES, 1955
SCALE OF MILES
200 0 200 400
ARCTIC OCEAN
BEAUFORT SEA
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASK.
MANITOBA
ONTARIO
QUEBEC
HUDSON BAY
BAFFIN BAY
DAVIS STRAIT
GREENLAND
ELIZABETH ISLANDS
QUEEN
Ellesmere Island
Devon Island
Banks Island
Viscount Melville Sd.
M'Clintock Chan.
Victoria Island
Amundsen Gulf
Gulf of Boothia
Baffin Island
Foxe Basin
Hudson Strait
Aklavik
Dawson
Stewart R.
Peel R.
Whitehorse
Skagway
Juneau
Gulf of Alaska
Great Bear Lake
Mackenzie R.
Coppermine
Port Radium
ARCTIC CIRCLE
Yellowknife
Thelon R.
Great Slave Lake
Slave R.
Kazan R.
Liard R.
Teslin R.
Prince Rupert
Queen Charlotte Islands
Skeena R.
Peace R.
L. Athabasca
Churchill
Reindeer L.
Churchill R.
Nelson R.
Hudson Bay
Bella Coola
Prince George
Vancouver Island
Vancouver
Victoria
Fraser R.
Athabasca
Jasper
N. Saskatchewan R.
Edmonton
Calgary
S. Saskatchewan R.
Saskatoon
Regina
Winnipegosis
L. Manitoba
L. Winnipeg
Winnipeg
Saskatchewan R.
Severn R.
Albany R.
James Bay
Port Arthur
Fort William
L. Superior
Sudbury
Ottawa
Ottawa R.
Toronto
L. Ontario
L. Erie
L. Huron
L. Michigan
Windsor
Quebec
Montreal
St. Lawrence R.
Gulf of St. Lawrence
Schefferville
Labrador
Coast of Labrador
Newfoundland
Island of Newfoundland
St. John's
P.E.I.
Charlottetown
New Brunswick
Fredericton
Halifax
Nova Scotia
PACIFIC OCEAN
ATLANTIC OCEAN
UNITED STATES
G.S.C.

technique has proved consistently successful as a rapid and economic means of obtaining good quality reconnaissance maps. By the end of the fiscal year, plans were well advanced towards adapting the method to an extensive reconnaissance survey of northern British Columbia where present mapping methods are slow and expensive or, because of rugged terrain, impracticable.

Geological assistance afforded other federal government agencies included: E. Hall, on loan throughout the year to the Department of Nothern Affairs and National Resources, investigated geological problems concerning potential damsites and other features of the Columbia River project; E. B. Owen completed another year as full-time geological advisor to the St. Lawrence Seaway Authority; resident geologists at Whitehorse and Yellowknife advised the Department of Northern Affairs and National Resources on geological matters relative to the administration of mineral lands; a coal deposit near Aklavik was examined at the request of the above Department; various surveys were made to locate ground-water supplies for the Department of Citizenship and Immigration and the Department of Agriculture; and the Department of National Revenue was given geological advice on tax benefits for deep-test oil wells.

Plans were completed for a new eight-storey building designed to permit the housing of all Ottawa laboratories and personnel of the Geological Survey under one roof and to allow for reasonable expansion.

Fourteen grants-in-aid totalling $25,000 were awarded to eight universities for the stimulation and support of fundamental geological research. The grants were made, as in the past 4 years, on the basis of recommendations by the National Advisory Committee on Research in the Geological Sciences. Twenty-nine research projects in ten universities are being supported; 15 projects have been completed. Since the grants were initiated in 1951, some 29 papers have been published in scientific periodicals recording the results of projects supported by the grants, and a number of other papers are in preparation or in press. In addition, the results of 8 projects are recorded in six master theses and three doctorate. Without doubt, the grants are stimulating research in the universities. They are also raising the standard of research of both faculty and graduate students by helping to provide much-needed equipment and technical assistance, and as shown by the published papers, the research is producing results of interest and value. This year, as in past years, the fund required to cover the cost of the worthwhile projects applied for greatly exceeded the amount of money available for distribution.

The death of W. E. Cockfield, officer in charge of the British Columbia office, and a senior geologist with more than 35 years' service, is recorded with the deepest regret. The Survey lost the services of another of its most senior employees, S. G. Alexander, superintendent of cartography, through retirement. W. E. Cockfield was succeeded by J. E. Armstrong, and S. G. Alexander by A. E. Hale. E. C. Halstead was moved from Ottawa to the British Columbia office, and J. A. Roddick from that office to Ottawa.

A reorganization of the Survey in March 1955 resulted in the formation of six technical divisions as follows: Precambrian Division, acting chief, J. M. Harrison; Post-precambrian Division, acting chief, L. J. Weeks; Fuels and Stratigraphic Geology Division, acting chief, J. F. Caley; Mineralogy Division, acting chief, E. Poitevin; Mineral Deposits Division, acting chief, A. H. Lang; and Geophysics Division, acting chief, L. W. Morley. All divisions are responsible to the director's office, which includes the director, chief geologist, and administrative officer.

FIELD WORK AND MAPS PUBLISHED

Northwest Territories—District of Franklin

Field Work

Y. O. Fortier directed Operation Franklin, an aerial geological reconnaissance of about 120,000 square miles of the Queen Elizabeth and adjacent Arctic Islands. Specialists from the Survey staff who participated in the project were R. G. Blackadar, H. R. Greiner, D. J. McLaren, A. W. Norris, E. F. Roots, J. G. Souther, R. Thorsteinsson, and E. T. Tozer. Twelve other geologists and geologically-trained students also took part in the operation. The project resulted in making available basic information on stratigraphy, structure, and fuel and mineral resources, which otherwise would have taken decades to collect. Large, freight-type helicopters were used for the first time, and the success of the operation amply demonstrated the suitability of these aircraft for extensive geological reconnaissance throughout the Arctic Islands.

D. J. McLaren, A. W. Norris, and E. T. Tozer spent four and a half months in the Arctic Achipelago with Operation Franklin, carrying on stratigraphic reconnaissance and mapping of Ordovician, Silurian, Devonian, Pennsylvanian, Permian, Triassic, Jurassic, Cretaceous and Tertiary rocks.

L. W. Morley and F. P. DuVernet conducted a reconnaissance aeromagnetic survey of the Queen Elizabeth Islands to supplement the geological data obtained from Operation Franklin.

Northwest Territories—Districts of Mackenzie and Keewatin

Field Work

J. C. McGlynn started and completed geological mapping of the Marian River area (longitude 116°30′ to 117°, latitude 63°15′ to 63° 30′), which includes the Rayrock and other important uranium occurrences.

F. C. Taylor commenced and completed reconnaissance geological mapping of the Snowbird Lake area (longitude 102° to 104°, latitude 60° to 61°), which includes rocks which are the continuation of the uranium-bearing belt at Black Lake, Sask.

G. M. Wright with J. W. Hoadley, K. E. Eade, J. A. Fraser, and B. G. Craig, completed an aerial reconnaissance of about 61,000 square miles, mainly in eastern District of Mackenzie. The survey, known as Operation Thelon, extended the work of Operation Baker (1954) and Operation Keewatin (1952) so that nearly all of the mainland Canadian Shield in Northwest Territories south of the Arctic Circle and west of longitude 90° has now been mapped. These three operations, each employing two helicopters, covered a total of 185,000 square miles, and outlined several areas of promising prospecting ground. Operation Thelon permitted revision of the boundaries of the Thelon game sanctuary to exclude some areas favourable for prospecting.

B. G. Craig accompanied Operation Thelon to map and interpret surficial deposits. Ground observations afforded a rapid means of interpreting and integrating air photo studies of this vast region to provide a basic knowledge of its glacial deposits and glacial history. Such information will prove useful to military and civilian personnel in the region.

F. P. DuVernet made an aeromagnetic survey of approximately 15,000 square miles of the southeastern part of the District of Mackenzie (longitude 106° to 107°30′, latitude 60° to 63°; and longitude 104° to 106°, latitude 62° to 63°). The survey will provide data for aeromagnetic maps intended to facilitate and to supplement geological mapping by helicopter and ground methods.

B. A. Latour, at the request of the Department of Northern Affairs and National Resources, examined coal deposits near Aklavik to obtain preliminary data on the feasibility of using coal as a fuel in a proposed steam plant for the new townsite.

J. A. Jeletzky commenced a detailed stratigraphic and palæontological study of Cretaceous rocks in the northeastern Richardson Mountains, District of Mackenzie.

Yellowknife Office

The facilities of this office, under the resident geologist, J. C. McGlynn, continued to be available to prospectors of the area. The resident geologist continued the mapping of the Marian River area, and collected additional data for a revised publication on the mineral industry of Northwest Territories. Geological advice and supervision were also given on projects of the Department of Northern Affairs and National Resources. The Canadian Institute of Mining and Metallurgy was assisted in its courses for prospectors.

Maps Published

55-9 O'Connor Lake (West Half); District of Mackenzie; scale, 1 inch to 1 mile.....Preliminary geological map. Paper 55-9.

55-10 Abitau Lake; District of Mackenzie; scale, 1 inch to 4 miles .....Preliminary geological maps. Paper 55-10.

55-17 Central District of Keewatin (2 sheets); scale, 1 inch to 8 miles .....Preliminary geological maps. Paper 55-17.

252G Klokol Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

253G Barr Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

254G Latimer Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

255G White Partridge Island; District of Mackenzie (advance edition); scale, 1 inch to 1 mile..Preliminary aeromagnetic map.

256G Gothe Island; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

257G Simons Island; District of Mackenzie (advance edition); scale, 1 inch to 1 mile ....Preliminary aeromagnetic map.

258G Kakoot Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

259G Linklater Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile ....Preliminary aeromagnetic map.

260G Mallet Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

261G Three Wives Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile ....Preliminary aeromagnetic map.

262G Casimir Island; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .... Preliminary aeromagnetic map.

263G Taitna Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

264G Blue Island; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

265G Kakarmik Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile ....Preliminary aeromagnetic map.

266G Enekatcha Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile ....Preliminary aeromagnetic map.

267G Blue Lake; District of Mackenzie (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

Yukon Territory

Field Work

H. Gabrielse was attached to a party of the Topographical Survey, equipped with helicopters, in northern Yukon north of Porcupine River and on the west flank of the north part of Richardson Mountains. This region had not been investigated by the Geological Survey since 1906, and is virtually unexplored. In recent years, some prospects for gold, tungsten and coal have been found there, and the possibilities of oil in the western part of the region are being investigated by oil companies.

R. B. Campbell, the resident geologist at Whitehorse, commenced the investigation of mineral properties in Yukon.

E. D. Kindle completed the geological mapping of the Keno Hill area (longitude 135° to 135°30′, latitude 63°45′ to 64°), which includes the main productive silver-lead-zinc mines of Yukon.

L. H. Green continued the geological mapping of the Scougale Creek area (longitude 134°30′ to 135°, latitude 64° to 64°15′).

J. O. Wheeler and R. L. Christie completed the geological mapping of the accessible parts of the Kaskawulsh area (longitude 138° to 139°, latitude 60°30′ to 61°). The area which is adjacent to the Alaska Highway, contains gypsum, placer gold, coal deposits, and an important new copper discovery. It affords the best exposures for the study of the rocks of the Kluane Ranges in which recently discovered nickel-copper deposits are being developed.

W. H. Poole continued geological mapping of the Wolf Lake area (longitude 130° to 132°, latitude 60° to 61°), which is traversed by the Alaska Highway and contains deposits of lead-silver, zinc, and tungsten.

R. W. Boyle completed a detailed geochemical and geological study of the soils, streams, springs, and silver-lead-zinc deposits of the Mayo district. Geochemical anomalies that may possibly lead to the discovery of buried mineral deposits were found in some streams, and the technique of analyzing soils for minute amounts of heavy metals was shown to be useful in tracing veins in unglaciated areas.

Whitehorse Office

The regional office for Yukon and northern British Columbia, maintained at Whitehorse, Yukon, is under the direction of R. B. Campbell. His main duties are to aid, by all practicable geological means, those concerned with the exploration and development of this region. Geological advice was given to the Department of Northern Affairs and National Resources on matters concerning mineral exploration. A course for prospectors, started the previous winter, was successfully repeated with over 100 registrants.

Maps Published

54-20	Teslin; scale, 1 inch to 4 miles	Preliminary geological map. Paper 54-20.
55-12	Keno Hill; scale, 1 inch to 1 mile	Preliminary geological map. Paper 55-12.
55-21	Wolf Lake; scale, 1 inch to 4 miles	Preliminary geological map. Paper 55-21.

British Columbia

Field Work

J. D. Aitken completed the geological mapping of the Atlin area (longitude 132° to 134°, latitude 59° to 60°), and began the mapping of the Tulsequah area, adjoining it on the south, between the same longitudes and latitude 58° to 59°. The latter area contains the important Taku mining camp and other prospecting fields.

S. Duffell completed the geological mapping of the Terrace area (longitude 128° to 129°, latitude 54° to 55°), which contains the new town of Kitimat and is traversed by the Canadian National Railway to Prince Rupert. The area includes the east flank of the Coast intrusions with which many of its mineral deposits are associated.

H. W. Tipper continued the geological mapping of the Anahim Lake area (longitude 125° to 126°, latitude 52° to 53°). The area covers part of the flank of the Coast intrusion belt with which its contained mineral deposits are associated, and it is traversed by the road joining Williams Lake on the Pacific Great Eastern Railway to Bella Coola on the Pacific Coast.

J. A. Roddick completed geological mapping of the Pitt Lake area, formerly referred to as the Coquitlam area, (longitude 122° to 123°, latitude 49° to 50°). The area contains a complex of igneous rocks favourable for mineral deposition. Although it is close to the city of Vancouver and the main transportation lines, and although important mines occur in adjacent areas, the area has received little attention from prospectors.

H. W. Little continued geological mapping of the Kettle River area, east half (longitude 118° to 119°, latitude 49° to 50°). The area includes several old mining camps among which Lightning Peak, Greenwood, Phoenix, and Franklin were important in the past.

J. E. Reesor continued geological mapping of the Lardeau area (longitude 116° to 117°, latitude 50° to 51°), immediately north of the Sullivan lead-zinc-silver mine at Kimberley. The area contains a number of silver-lead prospects and the Paradise Mine at Invermere.

G .B. Leech continued the geological mapping of the Canal Flats area (longitude 115°30′ to 116°, latitude 50° to 50°15′). The area lies north of the Sullivan lead-zinc-silver mine at Kimberley and contains complexly folded, Precambrian rocks.

J. E. Armstrong completed a study of the Tertiary, Pleistocene and Recent rocks of the Lower Fraser valley. The results are expected to be of value to users of construction materials, and to engineers engaged in building foundations for heavy structures.

E. C. Halstead continued the study of ground-water resources in the Lower Fraser valley and completed his work within Matsqui and Sumas municipalities.

E. J. W. Irish commenced geological mapping in the Charlie Lake area (longitude 120° to 122°, latitude 56° to 57°) which embraces some of the natural gas fields of northeastern British Columbia. The work consists of stratigraphic studies to determine the nature of surface and subsurface structures of this gently-folded part of the Interior Plains region.

H. Frebold made detailed studies of the Jurassic strata and their faunal content in the Ashcroft, Harrison Lake, and Fording River areas. This work

will assist greatly in the study of stratigraphic correlations with the economically important Jurassic rocks of Alberta and adjoining regions of northern United States.

W. L. Fry continued a study of the stratigraphy and fossil floras of the Tertiary sedimentary basins in the Princeton-Coalmont areas of British Columbia. A brief investigation was made of a fossil forest on the west side of Chilko Lake.

E. Hall continued to assist the Department of Northern Affairs and National Resources with geological problems concerning the Columbia River project, including the examination and correlation of drill cores and cuttings from potential damsites.

British Columbia Office

The Survey's office at Vancouver gave local assistance in connection with ground-water supplies, engineering geology, and occurrences of metallic and industrial minerals and of construction materials. Determinations were made of many rock and mineral specimens, and reports and maps were distributed in response to requests from the public. The number of registered visitors to the office was at an all time high of 5,647, and a record total of 12,877 maps and reports were distributed. The office was under the direction of the late W. E. Cockfield until September 30, 1955. He was succeeded by J. E. Armstrong.

Maps Published

54-9 Atlin; Cassiar District; scale, 1 inch to 4 miles ..... Preliminary geological map. Paper 54-9.

Alberta and British Columbia

Field Work

P. Harker examined critical sections of Mississippian rocks in the Rocky Mountains and foothills of Alberta in collaboration with geologists from several oil companies in order to check detailed correlations with the petroliferous Mississippian formations on the subsurface. He also made brief palæontological studies of late Palæozoic strata in the Kettle River area, British Columbia.

Alberta

Field Work

J. K. Eccles completed the geological mapping of the east half of Adams Lookout area (longitude 118°30′ to 118°45′, latitude 53°30′ to 53°45′). The area contains coal deposits. The stratigraphic and structural information obtained should aid in the exploration for oil and natural gas in this region.

D. K. Norris commenced geological mapping of the Livingstone River area (longitude 114°15′ to 114°30′, latitude 50° to 50°15′). Structural data, which will assist in the interpretation of structures associated with the recently discovered Savanna Creek gas field, were obtained. A detailed examination of the coal occurrences at Corbin outlined new areas favourable for strip-mining operations.

D. F. Stott commenced detailed stratigraphic studies of the formations comprising the Upper Cretaceous Alberta group in the central foothills of Alberta. This project will furnish data on the correlation and lateral variations of the strata and their potentialities as source and reservoir rocks for oil and gas.

W. B. Brady completed detailed stratigraphic studies of Mississippian rocks in the region of the central foothills and Banff. Data obtained show the lateral variations of the formations and the nature and extent of the porous zones within the system, thus contributing to the evaluation of these rocks as potential sources of and reservoirs for oil and gas.

A. M. Stalker completed the mapping of the surficial deposits of the High River area (longitude 113° to 114°, latitude 50° to 51°). Gravel deposits were found in pre-glacial valleys and in deltas built into glacial lakes. These deposits form reservoirs for ground-water and are valuable for construction purposes.

Western Oil and Natural Gas Office, Calgary

This office conducts regional subsurface geological studies of the sedimentary formations of western Canada, maintains a collection of rock samples from drill holes, a small laboratory, and a geological library, and makes these facilities available to the oil industry for study and reference. It also distributes Survey reports and maps as a service to the industry. R. T. D. Wickenden is in charge.

The office acquired 270,111 samples of rock from wells drilled for oil and gas. Of these, 2,972 were from wells drilled in Northwest Territories, 20,198 from wells in British Columbia, 154,707 from wells in Alberta, 76,637 from wells in Saskatchewan, and 15,597 from wells in Manitoba.

The technical staff continued to study the detailed stratigraphy and problems of correlation of subsurface formations in the Interior Plains of western Canada. Further progress was made in the study and correlation of oil- and gas-bearing formations of Devonian age in northwestern Alberta, and a summary account of the results of this study was published. Similar studies of the formations in central and northwestern Alberta were commenced. A study of formations of Lower Cretaceous age in Saskatchewan was continued, and subsurface structure and formation thickness maps are being prepared for publication. Further progress was made on the study of late Palæozoic and early Mesozoic, particularly Jurassic, formations as penetrated by wells in northeastern British Columbia.

The results of a geological study of samples from wells in Northwest Territories was published by the Department of Northern Affairs and National Resources as part of a schedule of wells of that region.

A total of 3,161 Survey reports and maps were distributed.

Other Activities

H. Frebold and P. Harker acted as co-ordinators of committees set up by the Alberta Society of Petroleum Geologists to establish detailed correlations of the Jurassic and Mississippian rocks of Alberta. The results of this work were presented as two symposia under their respective chairmanships at the regional meeting of the American Association of Petroleum Geologists at Jasper in September 1955.

Maps Published

1039A Alberta, Oil and Gas Fields (second edition); scale, 1 inch to 20 miles .....For separate distribution.

54-19 Adams Lookout (West Half); West of Sixth Meridian; scale, 1 inch to 1 mile .....Preliminary geological map. Paper 54-19.

55-14 Two Lakes; West of Sixth Meridian; scale, 1 inch to 1 mile .....Preliminary geological map. Paper 55-14.

55-18 Blairmore; West of Fifth Meridian; scale, 1 inch to 1 mile .....Preliminary geological map. Paper 55-18.

Saskatchewan

Field Work

C. K. Bell continued detailed geological investigations of the Milliken Lake area (longitude 108°30′ to 109°00′, latitude 59°15′ to 59°30′) on the Crackingstone peninsula in Lake Athabasca, where important deposits of uranium occur, including those of the Gunnar mine. Relationships between structures, rock types, and localization of ore are becoming apparent although much remains to be done.

L. P. Tremblay continued detailed geological mapping in the Beaverlodge Lake area which contains the Ace-Fay mine of Eldorado Mining and Refining Limited, and other uranium deposits. A relationship between the deposits and certain structures is strongly indicated.

D. D. Hogarth and D. H. Loring investigated uranium deposits in the province to obtain data required for the inventory of Canadian deposits of uranium and thorium.

Maps Published

54-15 Uranium City (2 sheets); scale, 1 inch to 800 feet .....Preliminary geological maps. Paper 54-15.

55-4 Forcie Lake; scale, 1 inch to 1 mile .....Preliminary geological map. Paper 55-4.

Saskatchewan and Manitoba

Field Work

J. A. Elson completed his investigation of the surficial deposits of the Virden area (longitude 100° to 102°, latitude 49° to 50°). The sequence of glacial events in southwestern Manitoba has been clarified. The work provides data on the location of gravel deposits and ground-water aquifers in this area, where both are in short supply. It also provides the basic information necessary for the differentiation of soil types pertinent to the full agricultural development of the region.

Manitoba

Field Work

W .W. Heywood continued detailed geological mapping of the Schist Lake area (longitude 101°47′ to 101°53′; latitude 54°37′ to 54°43′) in which deposits of copper and zinc are known. Evidence is being assessed on the relationship between base metal ores and types of geological structure.

R. Mulligan began and completed reconnaissance geological mapping of the Split Lake area (longitude 96° to 98°, latitude 56° to 57°) where belts of greenstone and sedimentary rocks, mostly covered with overburden, were found.

H. A. Quinn commenced and completed reconnaissance geological mapping of the Big Sand Lake area (longitude 98° to 100°, latitude 57° to 58°). Small areas of greenstone and basic intrusions favourable for the deposition of valuable metals were found.

G. W. Sinclair studied the stratigraphy and palæontology of the Ordovician rocks in the Red River area.

Maps Published

55-8 Knee Lake; scale 1 inch to 4 miles .....Preliminary geological map. Paper 55-8.

Ontario

Field Work

O. L. Hughes commenced mapping the surficial deposits in the Iroquois Falls area (longitude 80° to 81°, latitude 48°30′ to 49°). This field investigation will provide basic data on a late-stage glacial advance, little understood at present. Concepts of the origin of the parent soil types depend on an adequate interpretation of the glacial record.

B. A. Liberty continued the geological study and mapping of the bedrock formations of Manitoulin Island. Stratigraphic and structural information of value in assessing the oil and gas possibilities of the island was obtained.

B. V. Sanford continued the work of locating and establishing the elevation of wells drilled for oil and gas in southwestern Ontario to provide the data necessary for the compilation of contour maps showing bedrock topography and thickness of glacial overburden.

E. B. Owen continued on loan as geological advisor to the St. Lawrence Seaway Authority.

S. C. Robinson continued a mineralogical study of the uranium deposits in the Haliburton-Bancroft area.

S. M. Roscoe continued the special study of the geology, origin, and distribution of the important uranium ores of the Blind River region. A preliminary map providing useful data for those exploring deposits in the area was issued in limited quantity to the holders of claims in the area. It is anticipated that a regular publication will be issued later.

Maps Published

197A Fort William and Port Arthur Sheet; Thunder Bay District (Surface Deposits); (Reprint); scale, 1 inch to 1 mile .....Geology. For Memoir. 167.

1046A Renfrew; Renfrew and Lanark Counties; scale, 1 inch to 1 mile .....Geology. For separate distribution.

54-21 Lindsay; Victoria, Durham, Ontario, and Peterborough Counties (Surficial Geology); scale, 1 inch to 1 mile .....Preliminary geological map. Paper 54-21.

289G Kirkland Lake; Timiskaming District (advance edition); scale, 1 inch to 1 mile....Preliminary aeromagnetic map.

293G Timmins; Timiskaming and Cochrane Districts (advance edition); scale, 1 inch to 1 mile..Preliminary aeromagnetic map.

295G Ramore; Cochrane and Timiskaming Districts (advance edition); scale, 1 inch to 1 mile..Preliminary aeromagnetic map.

296G Matheson; Cochrane District (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

297G Porquis Junction; Cochrane District (advance edition); scale, 1 inch to 1 mile ....Preliminary aeromagnetic map.

298G Pamour; Cochrane District (advance edition); scale, 1 inch to 1 mile .....Preliminary aeromagnetic map.

Ontario and Quebec

Maps Published

222G Cobden; Renfrew and Pontiac Counties; scale 1 inch to 1 mile .....Preliminary aeromagnetic map.

224G Waltham Station; Renfrew and Pontiac Counties; scale, 1 inch to 1 mille .....Preliminary aeromagnetic map.

Quebec

Field Work

W. R. A. Baragar completed geological mapping of the Ahr Lake area (longitude 66°30′ to 67°, latitude 55°30′ to 55°45′). Important information was obtained on the stratigraphy and structure of the iron-formations and associated rocks of the belt holding the iron ore deposits of the Knob Lake district.

W. F. Fahrig completed reconnaissance geological mapping of the Cambrian Lake area (longitude 68° to 70°, latitude 56° to 57°), which includes a large section of the Ungava iron-formation belt. Deposits of non-ferrous metals are known to occur also in the area.

W. G. Johnston completed the geological revision of the Opasatika Lake area (longitude 79° to 79°30′, latitude 48° to 48°15′), as part of the systematic study of the Quebec gold and copper belt.

A. S. MacLaren completed the geological mapping of the Amos area (longitude 78° to 78°30′, latitude 48°30′ to 48°45′).

N. R. Gadd completed mapping the surficial deposits of the Upton area (longitude 72°30′ to 73°, latitude 45°45′ to 46°). This, and previous similar studies in adjacent areas, have provided much useful data on the physical properties and general geological relationships of the unconsolidated deposits. The information gained has broad economic applications in the search for ground-water supplies and in the fields of engineering geology and agricultural development. The work has also outlined geological factors responsible for the landslides which commonly occur in this region.

P. F. Karrow commenced mapping the surficial deposits of the Grondines area (longitude 72° to 72°30′, latitude 46°30′ to 46°45′). This investigation will broaden knowledge on the stratigraphic relationships in the St. Lawrence Lowlands and provide data on the origin of the St. Narcisse moraine. The work has applications in the fields of agriculture and engineering.

F. J. E. Wagner continued examination of the Pleistocene deposits and fauna of the Champlain sea with special reference to the glacio-fluvial deposits in the area of the St. Lawrence seaway operations. This work will aid in the search for deposits of sand and gravel suitable for construction purposes.

G. W. Sinclair commenced a stratigraphic and palæontological study of the Ordovician rocks of the lower St. Lawrence River area of Quebec.

E. I. K. Pollitt commenced the study of the ground-water supplies of a part of the area adjacent to the St. Lawrence seaway (longitude 73°15′ to 74°, latitude 45°15′ to 45°30′). The results of this work will serve to outline the most productive aquifers, particularly for the large housing projects and industries which are expected to be developed following the completion of the seaway.

K. R. Dawson completed the detailed geological study and mapping of the Preissac-Lacorne batholith.

A. S. MacLaren and A. LaRochelle, working in a part of the Eastern Townships (longitude 70°30′ to 73°, latitude 45° to 45°30′), commenced a study of the correlation between aeromagnetic maps and detailed geological maps to establish additional criteria for the interpretation of aeromagnetic data.

Maps Published

55-1 Lac Herodier; New Quebec; scale, 1 inch to 4 miles ..... Preliminary geological map. Paper 55-1.

55-2 Manicouagan Lake-Mushalagan Lake area; scale, 1 inch to 4 miles ..... Preliminary geological map. Paper 55-2.

216G Pythonga Lake; Pontiac and Gatineau Counties; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

217G Cheneville; Papineau and Labelle Counties; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

219G Lac Duval; Pontiac County; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

225G Blue Sea Lake; Pontiac and Gatineau Counties; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

Quebec and New Brunswick

Maps Published

55-15 Edmundston; Madawaska and Temiscouata Counties (Surficial Geology); scale, 1 inch to 1 mile ..... Preliminary geological map. Paper 55-15.

New Brunswick

Field Work

F. D. Anderson completed the geological mapping of the Coldstream area (longitude 67° to 67°30′, latitude 46°15′ to 46°30′), near the southwest end of the central mineral belt. Copper-bearing boulders were found in the east central part of the area near Sisson Brook.

C. H. Smith commenced the geological mapping of the California Lake area (longitude 66° to 66°30′, latitude 47°15′ to 47°30′), which contains recently discoverted zinc-lead deposits.

C. H. Stockwell continued detailed geological mapping in the vicinity of the large zinc-lead-copper deposits under development in the Bathurst-Newcastle area. He found them to be replacement deposits in sedimentary and volcanic rocks of pre-Silurian age and to consist of pyrite, sphalerite and galena with minor pyrrhotite and chalcopyrite.

Nova Scotia

Field Work

D. G. Kelley began the geological mapping of the Whycocomagh area (longitude 61° to 61°30′, latitude 45°45′ to 46°). Gypsum deposits were found in the east part of the area.

E. R. W. Neale completed the geological mapping of that part of Cape Breton Island north of latitude 46°30′. He discovered copper minerals along the Cape North shoreline.

I. M. Stevenson commenced the geological mapping of the Kennetcook area (longitude 63°30′ to 64°, latitude 45° to 45°15′). Gypsum and limestone are quarried here, and gold and antimony were mined earlier.

W. A. Bell and M. J. Copeland made a brief investigation of the Mississippian stratigraphy, flora, and fauna between Great Village and Riversdale.

Sydney Coal Petrography Laboratory

This office, under the direction of P. A. Hacquebard and maintained by the Geological Survey of Canada in cooperation with the Nova Scotia Department of Mines and the Nova Scotia Research Foundation, continued detailed petrographic and palynological studies of Nova Scotia and western Canada coal seams. In Nova Scotia, the emphasis was on the Mabou coalfield where, with the aid of fossil spores, a correlation of the different coal horizons has been made, thus assisting in the interpretation of the stratigraphy and structure of the field.

In cooperation with the Mines Branch, petrographic studies of coals from the Springhill coalfield in Nova Scotia and from the Coleman and Fernie fields in Alberta were carried out as part of a study of rock pressures and outbursts in coal mines.

On the basis of fossil spores contained in coal from the South Nahanni River district, Northwest Territories, the coal was dated as Lower Carboniferous in age. Carboniferous coals had not been reported previously from western Canada. A report dealing with these spores has been prepared for publication.

The study on the spontaneous combustion of coal, initiated in 1953, has been reported on in a doctorate thesis, a copy of which is in the Geological Survey library at Ottawa.

An investigation was started to evaluate the effects of heat, pressure, dispersing agents, and petrographic composition on the briquetting of coal.

Samples for petrographic and palynological investigations were collected from various coal areas of Nova Scotia.

Maps Published

1040A Grand Narrows; Cape Breton, Richmond, Victoria, and Inverness Counties, Cape Breton Island; scale, 1 inch to 1 mile ..... Geology. For separate distribution.

55-13 Dingwall; Victoria County, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary geological map. Paper 55-13.

226G Bras d'Or; Cape Breton and Victoria Counties; Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

76816—5

227G Sydney; Victoria and Cape Breton Counties, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

231G Larrys River; Guysborough County; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

232G Louisburg, Cape Breton County, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

233G Framboise; Richmond and Cape Breton Counties, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

234G Mira; Cape Breton and Richmond Counties, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

235G Grand Narrows; Cape Breton, Richmond, Victoria and Inverness Counties, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

236G St. Peters; Richmond County, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

237G Chedabucto Bay; Guysborough and Richmond Counties; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

238G Port Hawkesbury; Richmond, Guysborough, Inverness and Antigonish Counties; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

239G Whycocomagh; Inverness County, Cape Breton Island; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

240G Antigonish; Antigonish and Guysborough Counties; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

241G Guysborough; Guysborough and Antigonish Counties; scale, 1 inch to 1 mile ..... Preliminary aeromagnetic map.

242G Country Harbour; Guysborough County; scale, 1 inch to 1 mille ..... Preliminary aeromagnetic map.

Prince Edward Island

Field Work

G. H. Crowl continued the geological study and mapping of the bedrock and surficial deposits of the island, a project commenced by V. K. Prest in 1953. The work showed that the bedrock is continental in origin and of little economic interest except as a source of road materials. The study supported the view that the Pleistocene glaciers moved westward over the east end of the island. The correct interpetation of glacial events will aid in the proper evaluation of soil types.

Newfoundland

Field Work

T. O. H. Patrick completed the geological mapping of Twillingate area (longitude 54°30′ to 55°, latitude 49°30′ to 49°45′), which contains several base metal occurrences.

W. D. McCartney completed the geological mapping of the Dildo area (longitude 53°30′ to 54°, latitude 47°30′ to 47°45′), and commenced the mapping of the Avalon area (longitude 53° to 54°, latitude 47° to 48°), of which the Dildo area is a part. Manganese beds of sedimentary origin were investigated.

G. C. Riley completed the geological mapping of the Victoria Lake area (longitude 57° to 58°, latitude 48° to 49°). The copper-bearing rocks of Notre Dame Bay are believed to extend southwest into this area.

S. E. Jenness started the geological mapping of the Terra Nova area (longitude 54° to 55°, latitude 48° to 49°), and completed most of the eastern half. The work by Jenness and Riley is part of a program of systematic 4-mile mapping of a strip across Newfoundland between latitudes 48° and 49°, which will give new information on the rock sequences, rock types, and structures, and should materially assist in the search for new mineral wealth.

R. D. Hutchinson completed a study of the stratigraphy and fauna of the Cambrian and Ordovician rocks of southeastern Newfoundland to aid in the geological mapping of that region.

Maps Published

1043A	Geological Map of the Island of Newfoundland; scale, 1 inch to 12 miles	Geology. For separate distribution.
55-11	Argentia; scale, 1 inch to 1 mile	Preliminary geological map. Paper 55-11.
250G	Puddle Pond; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
268G	Stephenville; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
269G	Harrys River; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
274G	Mainland; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
275G	Serpentine; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
276G	Shag Island; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

General

Field Work

B. A. Latour collected data from mines, prospects, and occurrences in Northwest Territories, Alberta, and Saskatchewan for use in estimating coal reserves.

C. H. R. Gauthier, working in eastern Canada, collected five tons of minerals and rocks from which educational collections will be prepared for sale.

A. H. Lang visited uranium properties in various parts of Canada.

R. B. Rowe continued the investigation of deposits of niobium (columbium) in British Columbia, Ontario, and Quebec.

Maps Published

900A	Canada; Principal Mineral Areas (fifth edition); scale, 1 inch to 120 miles	For separate distribution.
1045A	Geological Map of Canada; scale 1 inch to 120 miles	Geology. For separate distribution.

OFFICE, LABORATORY, AND OTHER ACTIVITIES

The office, laboratory, and related activities of the Geological Survey comprised mainly scientific investigations and studies directed to the assembly, interpretation and preparation for public use of data accumulated from the above-listed and previously completed field investigations. Other scientific and supporting activities, some of which are mentioned below, were of a more general nature, not readily described by provinces.

Fuels and Stratigraphic Geology Division

A total of 152,563 samples were received from wells drilled for oil and natural gas, bringing the total available for study and reference at Ottawa to

76816—5½

1,945,082. Samples received represented 629 wells, of which 401 were drilled in Alberta and 228 in Ontario. In all, 152,867 samples were prepared for microscopic examination.

Acknowledgement is made to the following persons and organizations through whose cooperation information and samples were received: Petroleum and Natural Gas Branch, Department of Mines, Victoria, B.C., for well samples and for interim reports and maps dealing with exploratory activity and leasing; Petroleum and Natural Gas Conservation Board, Alberta, for periodic drilling reports, interim reports, electric logs, and for samples of wells drilled in Alberta; Department of Mineral Resources, Regina, Sask., for monthly reports on drilling activity and production, for current information on oil and gas field boundaries, and for well cuttings: Department of Mines and Natural Resources, Winnipeg, Man., for well cuttings and for periodic drilling and production reports; A. R. Crozier, Chairman, and W. D. Brittain, Chief Inspector, Ontario Fuel Board, for drillers' logs and for samples of wells drilled in Ontario; C. S. Evans, Union Gas Company of Canada, Limited, Chatham, Ont., for information regarding wells drilled in Ontario: W. A. Roliff, Imperial Oil Limited, for general information on drilling and exploratory activities in eastern Canada; and to officials of numerous oil companies for much useful information on oil and gas activities in many parts of Canada.

In cooperation with the Mines Branch, the Geological Survey advised the Department of National Revenue regarding tax benefits in special cases on deep-test oil wells. Technical examinations and appraisals were made of a number of individual applications from oil companies for such benefits.

The services of the Division at Ottawa were extended to visiting geologists of several operating oil companies who examined well cuttings and records made available to them. Geological advice and information were given to other government departments, notably the Indian Affairs Branch, Department of Citizenship and Immigration, the Department of Northern Affairs and National Resources, and the International Economics and Technical Co-operation Division, Department of Trade and Commerce.

A special report on coal reserves of Canada was prepared for submission to the Royal Commission on Canada's Economic Prospects. Detailed reports were prepared on fossil collections submitted by officers of the Geological Survey, by oil and mining companies, and other organizations and individuals. Several members of the section took an active part in the field work of Operation Franklin and the detailed study of the fossil collections made then has formed the main part of the office work. A total of 280 boxes containing many thousands of individual specimens were received; 155 reports on fossil collections were prepared, of which 123 were for the Geological Survey, 13 for commercial companies, and the remainder for provincial governments, other federal government units, and private individuals.

To aid the research carried on by the Survey, 500 mounted thin sections, 63 polished sections, and 258 plaster casts were prepared. Ten collections of fossils were supplied to educational institutions.

Acknowledgement is made to Dr. G. Clifford Carl of the Provincial Museum, Victoria, B. C. for the donation of a rare new species of fossil plant from the Nanaimo coal field.

Mineralogy Division

A laboratory for chemical preparation and analysis of specimens for age determination was completed. Lead tetramethyl samples are prepared in this laboratory for isotopic analysis in the mass spectrometer laboratory. A small

geochemical laboratory was renovated for use in the calibration of standards used in the field and for special trace element analysis of geochemical and biogeochemical samples. Laboratories for crushing, sampling, and mineral separation are being prepared and some equipment is in operation.

More than 7,000 specimens submitted by the public were examined and identified, and 1,000 reports or letters were written on the results of this work and in reply to enquiries on mineral localities. Interviews were given to 300 persons seeking information on the mineral industry. One thousand and forty-two X-ray identifications for research and for compilation of a collection of standard patterns were made, and 156 quantitative X-ray fluorescence analyses were carried out. One hundred and ten mineral separations were made for the age determination project. Mineralogical studies were carried out on collections from several localities including Ferguson Creek, Yukon; Blue River, B.C.; and clay minerals from District of Franklin. The X-ray fluorescence unit was modified to give greater sensitivity and was recalibrated. A high-temperature X-ray powder diffraction camera with ancillary equipment was purchased and is being calibrated.

Thirty-nine complete rock analyses, 19 partial rock analyses, and 14 special mineral analyses, involving 550 separate determinations were made. For age determinations, 114 lead tetramethyl preparations were made, 53 specimens were chemically concentrated, and 82 quantitative analyses were carried out. Semi-quantitative spectrographic silicate analyses were made on 463 samples, and qualitative analyses on 264 samples. The considerable increase in analytical output reflects improvements in facilities. However, increased work in geochemistry and petrology has increased the demand for analyses.

In all 367 isotope analyses were made on 142 samples of lead, 154 sulphide samples were converted to SO_2, and 164 sulphur isotope analyses were carried out. From this work, geological ages were determined for 107 samples, and 199 ratios of non-radiogenic isotopes were calculated for such purposes as geological correlation studies of petroleum genesis and studies of fractionation in supergene alteration. A vacuum line for conversion to SO_2 was built, and another one for extraction of agron is under construction.

A total of 3,601 educational collections composed of 127,426 specimens of rocks and minerals were prepared and sold at a nominal cost. Distribution was as follows:

	Specimens	Collections
Ontario	41,572	1,124
Alberta	33,673	946
British Columbia	20,578	600
Quebec	9,342	284
Nova Scotia	4,401	140
Manitoba	2,980	81
Saskatchewan	2,920	86
Prince Edward Island, Northwest Territories, and Yukon	2,399	69
New Brunswick	2,158	60
Newfoundland	1,051	29
Foreign Countries	2,406	65
Ottawa	3,946	117

About 400 mineral specimens of museum quality were added to the permanent collection of the Survey. Grateful acknowledgement is made to all who contributed specimens, and in particular to Silver-Miller Mines Limited, Iron Ore Company of Canada, and Mr. W. J. Symons, Madoc, Ontario. The 15,000 specimens which have been acquired for this collection during the history of the Survey, and which are temporarily stored in various buildings throughout Ottawa, were catalogued and properly packed in more than 500 cases pending suitable quarters for permanent storage and display.

Mineral Deposits Division

As agent for the Atomic Energy Control Board, the Geological Survey, through the Mineral Deposits Division, received many reports of new uranium discoveries, and reports of work done on properties in advanced stages of exploration and on properties in production. The number of exploration permits from the Atomic Energy Control Board in force at the end of March, 1956 was 432, although some of these were inactive, and the number of mining permits was six. This information was supplemented by field examinations of a large number of properties by members of the Division, and incorporated in the confidential inventory of Canadian deposits of uranium and thorium, which is revised annually. A shorter summary of non-confidential information was issued as the annual review entitled "Uranium in Canada, 1955".

The Radiometric Laboratory, which deals particularly with mineral identifications and radiometric assays of radioactive samples from prospectors, made 1,077 radiometric assays, 118 identifications of radioactive minerals, and 205 mineral separations on fine-grained samples. Numerous additional special tests were made in connection with field studies.

A third and completely revised edition of "Prospecting in Canada" was prepared and forwarded for publication. It includes general information on the fundamentals of geology, mineralogy, and the geology of Canada, and instruction on conventional and special methods of prospecting, the appraisal and exploration of discoveries, mining laws, and related matters.

The acting chief of the Division was a delegate to the International Conference on the Peaceful Uses of Atomic Energy held in Geneva in 1955. Papers describing Canadian uranium deposits, and uranium prospecting in Canada, were presented at the conference and published by the United Nations.

Geophysics Division

One hundred and thirty-eight aeromagnetic maps covering areas in Newfoundland, Nova Scotia, Saskatchewan, Alberta, and the Northwest Territories were compiled on a scale of 1 inch to 1 mile.

Instrumentation work included: the development of a portable, transistorized meter for measuring the magnetic susceptibilities of rocks in situ; the construction of an astatic susceptibility meter for absolute determinations of magnetic susceptibilities; the improvement of the existing rotating remanent magnetometer to a sensitivity of 10^{-5} c.g.s. units of magnetic moment; and the development of an automatic alarm system for the Division's airborne scintillation counter whereby an anomalously high radiation intensity is automatically indicated by a flashing light.

At the end of 1955, four standard geological maps, six preliminary geological maps, and nine map figures were in press. Work was in progress on five standard geological maps, 13 preliminary geological maps, 45 preliminary aeromagnetic maps, one aeromagnetic index map, three maps for a water supply paper, and 36 map figures.

Geological Cartography

One hundred and thirty-three maps and scientific figure drawings were drafted for reproduction by photolithography or by zinc-cut process for illustrating memoirs, bulletins, reports, and papers.

ADMINISTRATIVE SERVICES

Geological Information and Distribution

In all, 247 separate reports and maps were issued of which 117 were reprints. New editions included one memoir, 4 geological bulletins, 22 preliminary papers, 48 geophysics papers (maps), one topical report, 2 miscellaneous geological reports, 6 standard geological maps, and, in cooperation with Mines Branch, one map of mineral areas of Canada. Distribution totalled 144,000 maps and reports, of which 57,200 were maps.

Library

Acquisitions

Books and pamphlets acquired by purchase	602
Books (complete unbound) acquired by purchase	551
Books by transfer, gift, or exchange	617
Canadian periodicals	1,165
Canadian government periodicals	2,108
British and foreign government periodicals	5,298
Proceedings, transactions, and bulletins of societies	2,980
British and foreign periodicals	6,300
Total	19,621

Other data

Recorded loans, books, pamphlets, periodicals	30,047
Inter-library and occasional loans	3,007
Books borrowed from other libraries	591
Maps and charts added to library	3,190
Maps and charts loaned	378
Cards added to lantern slide catalogue	110
Volumes bound	520
Volumes accessioned	1,416
Cards added to general catalogue	17,798
Cards added to map catalogue	377
Letters and cards received	4,195
Letters and cards sent	5,515
New serials received and catalogued	173

Photography

General

Contact prints, up to 11" x 14"	18,627	
Dry plate negatives	3,095	
Lantern slides	448	
Photographs dry mounted	2,791	
Bromide enlargements, up to 24" x 30"	3,027	
Auto-radiographs	122	
Magnetometer films developed	16,723	ft.
Magnetometer films printed	2,502	ft.
Exposures developed, field work	4,581	
Photo-micrographs	256	

Map Reproductions

Kodalith negatives	1,085	
Prints, up to 38" x 48"	183	
Sensitized linen prints	63	
Ferro-prussiate blue-line impressions	291	
Vandyke prints	3,127	

Reproductive Processes

Blueprints	229,396	sq. ft.
OCE prints	15,612	sq. ft.
Photostats (18" x 22")	9,503	sheets
Mimeograph	960,142	impressions

Lapidary

Thin sections	4,332
Polished sections	223

MINES BRANCH

John Convey,
Director

THE continued prosperity of the mineral industry gave rise to an increased demand for the investigation of new techniques on the extraction of metals and industrial minerals.

Major attention in ore dressing investigation work was again given to low-grade and complex ores, many of which are proving very difficult to treat economically. Low-grade iron ores were predominant in the shipments received for ore treatment, reflecting the active search under way for new sources of the metal. Shipments included ores containing manganese, used in the steel industry; niobium, a metal of rising importance; and zirconium, of increasing value in the field of atomic energy.

Commercial processes were developed for the extraction of uranium concentrates from the ores of a number of major Canadian uranium deposits. This work involved full-scale pilot-plant operations.

The growing importance of industrial minerals in Canada's industrial expansion was shown in the record number of requests received for investigative work on these minerals, particularly in relation to construction needs. Ore dressing work on kyanite from deposits in northern Ontario resulted in the development of a new stable refractory material equal to that made from imported high-purity kyanite.

Fuels research continued to be directed to methods to improve the quality of coal. At the same time attention was given to problems in the refining of low-grade oils and bitumen of high-sulphur content, of which western Canada has substantial reserves.

In the field of physical metallurgy, much trouble-shooting was done for industry, Atomic Energy of Canada Limited, and the defence services. Research was continued into the properties and behaviour of specific metals and alloys, and into the development of new techniques for handling specific metals and alloys of importance to the atomic energy program.

76816—6

The Mines Branch cooperated with the Royal Commission on Canada's Economic Prospects by supplying information as requested.

Two special sections with staff and services continued work for the Royal Canadian Navy and Atomic Energy of Canada Limited.

MINERAL DRESSING AND PROCESS METALLURGY DIVISION

A substantial part of the work of the Division was connected with investigations on base metal and iron-bearing materials.

Shown below are the nature and origin of the various shipments received for major investigational work. The diversity of the samples received reflects the growing diversity of the Canadian mining and metallurgical industry.

Nature of sample	N.W.T.	B.C.	Alta.	Man.	Ont.	Que.	N.B.	N.S.	Total
Copper-cobalt	—	—	—	—	1	—	—	—	1
Copper-lead-zinc	—	—	—	—	—	—	3	—	3
Copper-nickel	—	—	—	—	4	3	—	—	7
Gold	1	1	—	2	6	—	—	1	11
Gold-silver-lead-zinc	—	—	—	—	—	—	1	—	1
Iron	—	1	1	—	4	—	—	—	6
Iron-manganese	—	—	—	—	5	1	5	—	11
Iron-titanium	—	1	—	—	3	7	—	—	11
Iron-titanium-zirconium	—	1	—	—	—	1	—	—	2
Lead	—	—	—	—	1	—	—	—	1
Lead-barite	—	1	—	—	2	—	—	—	3
Manganese	—	—	—	—	—	—	4	—	4
Molybdenum	—	—	—	—	1	—	—	—	1
Niobium	—	—	—	—	4	1	—	—	5
Niobium-iron	—	—	—	—	—	1	—	—	1
Silver-lead-zinc	—	—	1	—	—	—	—	—	1
Tin	—	—	—	—	2	—	—	—	2
Titanium	—	—	—	—	—	8	—	—	8
Tungsten	—	—	—	—	—	1	1	—	2
Uranium	—	—	—	—	1	—	—	—	1
Zinc	—	—	—	—	1	—	—	—	1
Asbestos mill tailings	—	—	—	—	—	1	—	—	1
Blast furnace flue dust	—	—	—	—	1	—	—	—	1
Carborundum	—	—	—	—	1	—	—	—	1
Red mud	—	—	—	—	—	1	—	—	1
	1	5	2	2	37	25	14	1	87

Aside from the above, 25 investigations were carried out by metallurgists of various mining companies working in association with the Division and using its facilities. The quantities of ore used in these tests varied from 100 pounds up to carload lots.

In its work on iron ores, the Division carried out a pilot-plant investigation on 75 tons of high-silica, low-grade iron ore from deposits west of Ungava Bay in Quebec with a view to obtaining commercial-grade iron concentrates. Ungava contains extensive areas of iron formation in which the iron content is too low to constitute an ore without concentration. Investigation of material with 35 per cent iron showed that the problem was chiefly one of grinding, which was successfully solved. Twenty-five tons of commercial grade iron concentrates, averaging 64 per cent iron, and 5·5 per cent silica were produced, with an iron recovery of 84 per cent.

Another pilot-plant investigation involved the processing of 54 tons of an iron ore, grading 50 per cent, from Texada Island, B.C., which is valueless as mined, contaminated as it is with copper, sulphur and siliceous material. The iron was economically separated from both the copper and the siliceous material, and an iron concentrate containing over 68 per cent iron was produced. The copper was concentrated at the same time into a saleable concentrate. The sulphur in the iron concentrate was removed by sintering, and 25 tons of commercial-grade iron sinter were produced. The sinter was then smelted in the 250 KVA electric smelting furnace to produce a pig iron of excellent quality. The results of the investigation were reported to the industrial interests concerned.

Treatment of the titaniferous iron sands from the large deposits which occur along the shores of the Natashquan River in Quebec, is being investigated with the object of recovering saleable concentrates of titanium and zirconium along with the iron. Titanium and zirconium are expected to become increasingly important for certain uses.

Considerable work was done on the treatment of low-grade manganese ores. Canada has substantial tonnages of manganiferous iron ores in Labrador and Quebec. Their development is of great interest as this continent has no known high-grade deposits of manganese which is essential in the making of steel. The Division obtained commercial-grade manganese concentrates on a laboratory scale from ores from manganese-iron deposits in Quebec by roasting to reduce the hematite to magnetite, followed by magnetic separation. Although the economics of the process would require time to establish, it appears that the deposits would be available for use in an emergency. In the case of most Canadian manganese deposits, however, ore-dressing methods cannot yield commercial-grade concentrates, but these methods can be useful in upgrading material prior to leaching or smelting operations, both of which have possible applications.

The possibilities of electric smelting in the treatment of manganese ores were shown in the smelting of 35 tons of low-grade ore from New Brunswick, containing 12 per cent manganese, in the 250 KVA electric furnace, using a novel technique recently developed by private interests. Commercial grades of silico-manganese and medium-carbon ferromanganese were produced. As a result of this investigation, a pilot plant is now under construction in the Niagara Falls area of Ontario, financed by private capital, to test the process on a larger scale.

In another investigation, 60 tons of ore containing only 5 per cent manganese after calcination, from another large deposit of manganiferous ore, was smelted to produce a grade of silicospiegeleisen which would be readily marketable.

The leaching of manganese ores has been investigated on a small scale only. However, novel methods are under development for converting the manganese in certain ores to manganese sulphate and for separating the manganese sulphate as pure crystals. The manganese sulphate can be converted either to a premium-grade manganese oxide or used directly for the production of electrolytic manganese.

Electric smelting was also used to convert a waste material into a useful product. Huge tonnages of a tailing material containing small amounts of nickel are discarded annually during asbestos mining operations in Quebec. Eighteen tons of this material was smelted to produce a ferronickel alloy. The slag produced was further smelted to produce ferrosilicon and forsterite. Of

76816—6½

these products, both ferronickel and ferrosilicon would be readily marketable, while the forsterite might find application in the production of refractories for high-temperature use. This process will be tested in the above-mentioned plant under construction at Niagara Falls.

The smelting investigations showed that cold dry top smelting has the advantage over other methods in lower power requirements, lower electrode consumption, lower dust losses, and lower volatilization losses. Moreover, fine materials can be smelted directly without prior agglomeration. Cold dry top smelting requires large quantities of cheap carbonaceous materials such as wood waste, and the method might well be considered wherever such materials are available.

Research on the efficient treatment of niobium ores, which has presented ore-dressing engineers and metallurgists with some very difficult problems, has shown that a process first used in Europe can be successfully applied to certain Canadian niobium ores to yield preliminary concentrates with good recoveries. Substantial tonnages of niobium ores have been discovered in Canada. The process has the advantage that in certain cases it simultaneously concentrates other values in the ores, such as phosphorus and rare earths. The further treatment of the preliminary concentrates is under investigation.

A thorough miscroscopic examination of the nature of niobium ores in Canada was set under way as the first step in working out the efficient recovery of their values. These ores are very complex, more than 30 minerals having been identified in one deposit. In the course of this study, divisional scientists discovered a new niobium-bearing silicate mineral which has been named niocalite. Its properties are still under investigation.

Research on the production and refining of metallic titanium was continued. Major attention was given to the investigation of the behaviour of titanium metal and titanium compounds in molten salt baths, a matter of fundamental importance in some of the methods of metal production. Canadian workers in this field, both industrial and academic, are being kept apprised of the results.

Research on problems connected with the development of nuclear power reactors was continued in collaboration with Atomic Energy of Canada Limited, Eldorado Mining and Refining Limited, and certain Canadian industries. One of the most difficult problems is the construction and maintenance of fuel elements in the reactors. Divisional engineers worked out methods in detail for preparing a new and very promising material, uranium dioxide, for use as fuel elements, and these procedures are being adapted to large-scale production by Canadian companies.

The Division continued to advise industry and government departments, particularly the Department of National Defence, on problems involving metal corrosion and protective coatings. Examples of corrosion in military vehicles, in diesel engines for use in the Far North, and in radar equipment were investigated among other problems, and in each case the cause of corrosion was determined and suitable remedial action prescribed. Methods for producing protective coatings to prevent corrosion were also investigated, and officers of the Division visited industrial plants and military depots to assist in improving corrosion prevention techniques. Officers of the Division also served on various committees of the Canadian Government Specifications Board in preparing specifications for protective coatings.

Throughout its investigations, the Division continued to search for and apply new ideas in its laboratories. The technique of X-ray emission spectrometry was investigated in detail, and it has proved most useful in the rapid

analysis of niobium, tantalum and rare earth minerals. Radioactive isotopes have also been used to study various methods of separating niobium and tantalum, and a new very effective method for this separation was developed. The Division developed a novel centrifuge tube for use in mineragraphic work, which has been adopted by other laboratories.

Fifty-four complete microscope studies of ores, involving the preparation and examination of 789 polished sections and 200 thin sections, were made. In addition 210 prospectors' samples were examined and reported on. Over 1,500 X-ray diffraction patterns were prepared. In the chemical analysis laboratory, 23,741 determinations were made on 7,457 samples, and in the spectrographic laboratory, 16,737 determinations were carried out on 1,202 samples. The Division issued 122 reports of investigations, and its officers published or presented 22 technical papers during the fiscal year. Two patents bearing the names of divisional officers were granted.

RADIOACTIVITY DIVISION

Mining companies planning uranium production requested much assistance in working out suitable concentration and extraction methods for individual ores. In all, 827 radioactive ore and product samples were received for investigation, of which 96 were for concentration and extraction investigation, 3 were for mineralogical studies and assays only, and 728 for assays only.

Technical staff for uranium extraction plants and for chemical and radiometric assay laboratories at new mines received training and instruction in the Division's laboratories.

Mineralogy

Mineralogical examinations were completed on 35 samples. Detailed mineralogical examinations of uranium ores, sent in from various properties for concentration and extraction investigations, were made to provide mineralogical data which are an essential guide in ore treatment studies. Reconnaissance mineralogical examinations were made on samples of certain ores for the collection of data to assist in the evaluation of new showings.

Ore Treatment

Regional origins of samples received for ore treatment work on concentration and extraction were:

Northwest Territories	9
British Columbia	2
Saskatchewan	35
Ontario	38
Quebec	9
Australia	3
	96

Pilot-plant operations were completed on uranium ores from the Nordic Lake property of Algom Uranium Mines Limited in the Blind River area of northern Ontario, and from the properties of Lorado Uranium Mines Limited in the Beaverlodge area of northern Saskatchewan, and of Bicroft Uranium Mines Limited, Faraday Uranium Mines Limited and Dyno Mines Limited,

all in the Bancroft area of eastern Ontario. These pilot-plant projects provide data necessary for full-scale plant design. They are carried out in close cooperation with the companies concerned and their engineering consultants. For each ore, the pilot-plant work involves initial crushing and grinding operations on bulk samples, followed by the operation and detailed study of various subsequent processing steps through to a final product, which has to meet concentrate specifications. Before the end of the fiscal year, the first four of the above-mentioned companies had negotiated production contracts with Crown-owned Eldorado Mining and Refining Limited.

Two uranium companies, Gunnar Mines Limited in the Beaverlodge area and Pronto Uranium Mines Limited in the Blind River area, for which the Division had previously done process development work, including pilot-plant operation to provide plant design data, were brought into production in 1955. Also in 1955, Eldorado took steps to enlarge the capacity of its Beaverlodge plant to 2,000 tons of ore a day. The additional ore production is to be treated by an atmospheric pressure carbonate leach process initially developed by the Division.

During the fiscal year assistance was given to other companies with properties in early stages of development. This assistance included much small-scale exploratory work to determine the manner in which the individual ores would respond to treatment, and what method of treatment appeared most promising in each case.

Five patents were issued covering uranium ore-leaching processes developed in the Division's laboratories.

The Division supplied technical assistance and made equipment available in its laboratories to Eldorado for pilot-plant treatment of ore from its Verna property in the Beaverlodge area.

Analytical Chemistry

In all 18,149 assays were completed on 13,053 samples, requiring 22,591 individual determinations.

During the latter half of the fiscal year an umpire analysis program came into operation whereby the Division performs umpire analyses on concentrates when the producing mine as vendor and Eldorado as purchaser are unable to reach the required agreement on uranium or impurity content. A total of 82 umpire samples had been received by the end of the fiscal year.

Research and development work were continued on methods for various analytical determinations required in connection with product specifications and ore treatment process control.

An improved "thoron line" apparatus was designed and constructed for the determination of thorium in ores by scintillation counting of alpha particles from the decay of thorium emanation. This method combines chemical and radiometric procedures.

In connection with the ion exchange process now being widely used for the recovery of uranium from leach liquors, a resin life tester was constructed to carry out repeated loading, eluting and washing cycles automatically. The device is being used to determine the long-term effect of liquors from individual ores on the capacity and properties of the resin. Investigations were made of used ion exchange resin from pilot-plant operations to determine the cause of any change in resin performance, and to compare the properties of the used resin with fresh resin.

Training and instruction were provided in the Division's laboratory to the analytical staffs of seven mining companies, and advice and assistance on analytical apparatus were supplied to several others. Many requests were received for detailed information on various analytical procedures in use in the Division's laboratories.

Physics and Electronics

Over 2,000 assays were performed in the regular radiometric assay service maintained by the physics and electronics laboratory. In Canada and abroad there was further adoption of the beta-gamma assay method for radioactive ore analysis developed by the Division, and information and assistance in the use of the method were furnished to interested parties. Training and instruction in the use of radiometric methods and equipment were again provided in the Division's laboratory to assayers from a number of uranium mines. Standard uranium and thorium-bearing samples were supplied to other laboratories for radiometric and chemical assay purposes.

Further attempts were made, with partial success, to solve the problem of direct radiometric determination of thorium in mineral samples without prior chemical treatment. Much use was made of transistors in new electronic equipment now under development especially for surveying and mining applications. The survey instruments are considerably lighter and more compact, and are expected to prove more reliable than previous units. In cooperation with industry and other laboratories, increased attention was paid to possible applications of radioactive tracer techniques to various problems in analytical chemistry, mining, metallurgy and mineral dressing. Experimental work is being done, for instance, on a scheme to incorporate an active isotope in explosives, so that unexploded dynamite in drill holes can be located safely by a radiation detector.

Patents covering plastic scintillation phosphors developed in the Division for use as radiation detectors, were granted in Canada and in United States.

INDUSTRIAL MINERALS DIVISION

The continued high level of industrial activity throughout Canada, and the consequent increasing demand for industrial minerals and their products were reflected in the record number and variety of samples sent in for identification, evaluation or processing. More than 2,450 such samples were received, of which 225 were processed in the industrial minerals mill, and laboratory reports issued on the results. Over 1,700 enquiries for information on the technology of industrial minerals were answered. Staff members served on committees connected with the mineral industry and upon request, gave their services in a consulting capacity to various industries, commissions, and other government departments.

Samples from all ten provinces and from Yukon and Northwest Territories were processed in the Division's laboratories. The regional origins and variety of these samples are shown in the following table.

Samples	Yukon & N.W.T.	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	Nfld.	P.E.I.	Totals
Andalusite		1										1
Anhydrite					2			1	1			4
Apatite						2	1					3
Asbestos	4					1	3					8
Barite						1			3			4
Bentonite		2	9									11
Brucite							4					4
Corundum						1						1
Diatomite		3				2						5
Diopside							1					1
Dolomite					1	8				4		13
Feldspar									2			2
Fluorspar							1		1			2
Garnet				1								1
Granite		3			1	4	10					18
Graphite		2				1	1		1			5
Gypsum						3		2	2			7
Kyanite		1				1						2
Limestone		5	10		5	15	15	10	3			63
Magnesia							8					8
Magnesite										47		47
Marble							6			2		8
Mica						2	2					4
Mineral Insulation						4	2					6
Nepheline Syenite						18						18
Potash				5								5
Pyrophyllite						1				1		2
Rare Element Minerals		3					12					15
Roofing Granules		1				2	1					4
Silica			1		1	10	4	1	4			21
Sillimanite									1			1
Spodumene					5	3	3					11
Talc						3	6					9
Vermiculite		1				20						21
Concrete Aggregate:												
(a) Crushed Stone						7	17					24
(b) Sand and Gravel			1			3		6				10
(c) Manufactured Sand						6	9					15
Lightweight Aggregate:												
(a) Clays and Shales		10	10		9	2	41					72
(b) Perlite		36										36
(c) Other						2						2
Ceramic Clays and Shales		17	20		1	19	24	18	3	1	3	106
Ceramic Products		1				8	15					24
Totals	4	86	51	6	25	149	186	38	21	55	3	624

Research on Canadian resources of kyanite, which came into prominence largely through the work of a divisional engineer, was intensified and brought to a satisfactory conclusion. Kyanite is an aluminum silicate mineral highly valued as a raw material for the making of super refractories. It is found in the massive state in Kenya and India, which were the main sources of kyanite until recently, when the supply became most uncertain. Known deposits of kyanite on this continent are of the disseminated type which, prior to this, had not yielded a product suitable for the making of refractory brick. Research in the Division has, however, surmounted the objectionable features of domestic kyanite, and products comparable with those made from the best imported kyanite have been obtained. This has stimulated interest in the deposits in northern Ontario, and a company has been formed to develop the large deposit near Sudbury when an adequate market has been established.

Because of Canada's great potentialities as a source of lithium products, a major investigation was undertaken into methods of recovering lithium minerals from their associated pegmatite minerals in newly discovered

properties in Quebec, Ontario and Manitoba. A concentrating process appliable to the major occurrences in each district was worked out, and concentrates containing more than the usual marketable grade of 5 per cent lithia (Li_2O) were obtained on a pilot-plant scale, with recoveries in excess of 84 per cent. Where the lithium mineral occurs in small crystals disseminated through the host rock, the recovery process is based on froth flotation. Where the lithium mineral occurs in large crystals, heavy media separation has proved effective in making a preliminary concentrate prior to flotation. These results are of interest to several companies engaged in the search for and development of sources of lithium.

The survey of industrial water resources of Canada, which has been in progress since 1946 is nearing completion. During the sumer of 1955 the mobile water-analysis laboratory was operated throughout Quebec, and on-the-spot tests of industrial water supplies were made. Civic water supplies were also sampled and data on the use of water were obtained. Over 900 water samples were analysed in the industrial waters laboratories of the Division during the fiscal year. Samples are being collected from 44 sampling stations in Newfoundland, the Gaspé peninsula, and along the north shore of the St. Lawrence River.

The Division continued to maintain analytical control of boiler waters at 13 army camps in Canada for the Department of National Defence (Army), and a new survey of water quality at all army establishments was commenced to assist the Public Utilities Section of the Army. Other projects undertaken included the sampling and analysis of the waters of rivers and lakes near uranium mining camps; the sampling and analysis of all hot springs in National Parks at the request of the Department of Northern Affairs and National Resources; and an investigation into the mineral content of the waters of certain lakes in the Mont Tremblant district of Quebec in cooperation with the Quebec Department of Fish and Game.

Water Survey Report No. 7, "Saskatchewan River Drainage Basin", is in press, and the manuscripts of Water Survey Report No. 8, "Mackenzie and Yukon Rivers Drainage Basin", and Water Survey Report No. 9, "Mississippi and Churchill Rivers Drainage Basin", were completed. A special report, "Hardness of Major Canadian Water Supplies", summarizing available data on water hardness throughout the country, is in press.

Research was continued into the manufacture of sand and of coarse aggregate from limestone, dolomite, and sandstone. Most of the work was done in cooperation with The St. Lawrence Seaway Authority, and The Hydro-Electric Power Commission of Ontario to determine suitable sources for the fine and coarse aggregate needed in the concrete for the seaway and power project. Samples of up to 50 tons of various rocks were processed and the products tested. Mineralogical and petrographic studies were also made of the various types of rock used in the tests, which enabled the drawing up of proper plant flowsheets for large-scale production at the several quarries adjacent to the areas where the locks and dams are being built.

The treatment of gravels by heavy media separation was investigated for the removal of deleterious constituents, such as chert, shale, and mud balls, and to make the gravels suitable for concrete aggregate. This work was primarily undertaken for the New Brunswick Power Commission in connection with the low-grade gravels available in the vicinity of the Beechwood dam under construction on the St. John River. A heavy media separation plant

has since been put into operation at the damsite. Heavy media separation investigations are also being carried out on gravel from Point Fortune, Quebec, for the Quebec Hydro-Electric Commission.

The possibilities of producing sand suitable for glass manufacture and chemical use from Canadian deposits of sand and sandstone continued to receive attention. Mechanical scrubbing and acid leaching processes were used with good effect on several samples of sand from deposits in Manitoba and Ontario.

In its work on the production of lightweight aggregates from Canadian clays and shales, the Division investigated operating variables such as range of firing temperature, retention time in the kiln, kiln atmospheres, effect of feed size, and pelletized versus extruded clay as feed. To assist in making the most effective use of these aggregates in construction, work is being done on the design of lightweight concretes, and on the effect of additives in improving the physical properties of lightweight concrete. The preparation of lightweight aggregate from samples of perlite and vermiculite from Canadian sources is also under investigation. Canada's lightweight aggregate industry has grown rapidly since 1953 when the Division completed a survey of, and the publication of, reports on clays and shales available for lightweight aggregate production throughout the country. The industry now comprises six plants in western Canada and one in eastern Canada.

The Division cooperated with the Royal Canadian Navy and with the Canadian Government Specifications Board in preparing specifications for thermal insulating materials used in marine construction. This work necessitated laboratory investigations of the raw materials.

The long-term project involving the complete testing of all types of refractory materials used in marine and stationary boiler furnaces being done at the request of the Royal Canadian Navy and the Canadian Government Specifications Board was continued, and 13 samples were tested. The results are also being given to the makers of the products tested, together with a notation on how the products can be improved. This work is proving valuable in the drawing up of specifications.

Research into the possibilities of making certain refractory products from the fireclay and semi-fireclay deposits near Shubenacadie in Nova Scotia was undertaken and is yielding promising results. The extensive work done previously by the Division on the clays in these deposits has resulted in the construction of a large clay-working plant at the deposits for the manufacture of buff face-brick.

Work in cooperation with the Naval Research Establishment, Defence Research Board, on the development of piezo-electric ceramics for use in ultrasonic equipment was continued. Several thousands of ceramic shapes prepared by improved methods and submitted for testing, met all requirements.

A number of large samples of marginal grade barite were received from properties in Nova Scotia for beneficiation. Treatment of the fines by Humphreys Spiral and of the coarse by heavy media separation processes proved it possible to recover most of the barite present in the samples and to obtain products of marketable grade.

FUELS DIVISION

Considerable attention was again given to the technical problems of the coal industry, which continues to lose marketing ground to crude petroleum and natural gas. This work is concerned with the evaluation of cleaning performance and the briquetting of coal fines at mine plants, the evaluation of coking properties of coal in western Canada, and the study of stress phenomena in mining.

However, greater emphasis is being placed on research on bitumen and crude oil in view of the ever increasing importance of oil to the nation. Research in petroleum is directed mainly to problems in the refining of heavy crudes and bitumens, and to the chemical evaluation of oils and bituminous substances for classification and genetic purposes.

Much time was devoted to investigations and consultations on the efficient utilization of fuels.

Over 1,700 solid, liquid and gaseous fuel samples were analysed during the fiscal year, involving 20,000 determinations.

Bitumen and Petroleum Research

Construction was completed of the high-pressure pilot plant which the Division started to design in 1945 for the study of the removal of sulphur from low-grade oils and from the bitumen in the bituminous sands of Alberta, at pressures up to 20,000 pounds per square inch. The plant was tested and operated at pressures up to 10,000 pounds per square inch with encouraging results. The project is unique on the North American continent in continuous hydrogenation at such an elevated pressure, which is twice the pressure used in German commercial refineries of this type. It is anticipated that liquid fuel products capable of withstanding high temperatures may be produced at economic prices by high-pressure hydrogenation. These products should make an important contribution toward the growing requirements of jet-air transportation.

Experimental work was undertaken to give more immediate assistance to small refineries using low-grade western Canadian crude oils for the manufacture of hard pitch. A series of pilot-plant experiments showed the feasibility of producing hard pitches with properties acceptable to the fibre-board industry.

The evaluation and classification, by chemical methods, of oils and bituminous substances with reference to their geologic occurrence was continued, and in this connection the absorption spectroscopy laboratory constructed for this purpose was found to be of great value. The results of this work are being used to facilitate the refining of bitumens and crude oils of high-sulphur content.

Substantial progress was made in the use of a physicochemical technique for characterizing bituminous substances.

Absorption spectroscopy was also used in the evaluation of pitches used as binder in the manufacture of electrodes for the aluminum industry. A method was developed for predicting the performance of the pitches.

A survey of the Canadian consumption of motor fuel was completed, and a sampling and analytical investigation of natural gas was conducted in western Canada with particular attention to the most recently discovered natural gas occurrences.

Coal Research

Coking Properties of Coal in Western Canada A special study was undertaken of the variation in coking properties of the large coking coal resources in western Canada, which are presently being used in a limited way only. These resources are accessible through prevailing shallow or strip-mining operations and are of great potential value to the metallurgical industry, which requires cokes of uniform grade. Laboratory and plant test procedures are also being investigated to determine the nature and scale of a test that will provide the most effective evaluation of a coke for metallurgical use.

Coal Beneficiation The study of factors influencing the production of briquettes was continued at several mine plants. Major attention was given, with encouraging results, to the use of a cyclone nozzle, recently designed by an officer of the Division, in the dispersal of the asphaltic binder. Work on the project is continuing. A new briquetting press with increased flexibility was installed for test work.

The evaluation of the commercial performance of the first washing plant to be erected in New Brunswick was undertaken at the operator's request. A performance test was also conducted in a modern central washery recently installed in Nova Scotia.

In view of the rigid specifications for quality, including both size and purity, demanded in the highly competitive coal market, an extensive study was undertaken to determine the physical characteristics of Canadian coals, with particular reference to the effect of their friability on meeting the various size specifications. This investigation includes the study of the effect of mechanized mining, both of the conventional and continuous types, on the breakdown of coal.

The non-uniform character of coal has always posed the problem of collecting accurate samples. A research project was undertaken in cooperation with international standardizing organizations, to develop methods of greater simplicity and accuracy from studies of the theory of sampling.

Commercial Coal Survey Divisional officers continued to maintain an up-to-date analysis directory of Canadian coals. Considerable time was devoted to the collection and analysis of samples of commercial coal and to the preparation of a supplement to the second edition of the Analysis Directory of Canadian Coals issued in 1953.

Cyclone Smelting A series of test runs on the economics of this process was conducted on the rebuilt and larger furnace unit and experimental results are being evaluated. This research project arose out of the tests originally conducted and the experience gained with the cyclone combustor in the coal-fired gas turbine project, its purpose being to investigate the possibilities of smelting fine-sized ores with coal fines. The test runs during the fiscal year showed that a number of factors relative to possible application in the metallurgical industry require further study.

Coal-Fred Gas Turbine The difficulties experienced with slag formation and corrosion of the tubes in the hot heat exchangers were investigated, and the experimental unit installed in the Gas Dynamics Laboratory of McGill University at Ste. Anne de Bellevue was redesigned in the light of information obtained. The reconstruction of the apparatus was completed and further tests are being carried out.

Deep Mining Project Work was continued on the long-term project of evaluating the complex mechanism of stress relief in mines with particular reference to bumps and outbursts in certain coal mines of eastern and western Canada, in the hope that mining at depth can be made safe and economical. The project is being conducted jointly with industry, provincial governments, the Geological Survey of Canada, and other divisions of the Mines Branch.

Laboratory work continued on rock specimens from strata enclosing the coal seams in these mines and from European mines with somewhat similar geological structural conditions. These tests have indicated that the rocks from the Canadian mines under investigation are in the main considerably stronger than those usually encountered in coal mines in Europe. A series of installations were made in mines for the measuring of strata movements and the measuring of stress changes in the solid strata. Special techniques for drilling holes for insertion of instruments and their installation had to be devised, as considerable difficulty was encountered in the coal or rock under stress in the mines.

Further progress was made in the evaluation of stresses in the submarine iron ore mine in Newfoundland. A program of load cell measurements was completed, and an initial test with a sonic instrument for measuring the fissuring of ore pillars under stress was undertaken.

Testing Mine Air At the request of the provincial mining departments the Division continued to provide facilities for the periodic testing of mine air, because of the increasing use of diesel engines underground both in coal and metal mines. Several samples of exhaust gas from engines were analyzed at the request of operators.

Electrical Equipment Certification The laboratory for testing electric equipment used in coal mines was set up, and the testing equipment, which includes that for the rapid analysis of explosive gas mixtures, was tested. Several applications were received from manufacturers for the certification of flameproof apparatus.

This service was inaugurated at the request of provincial authorities as a contribution to safety in Canadian coal mines. A federal certification officer had been appointed in 1954.

Thermal Power Studies In view of the increasing role that thermal power is playing in the ever growing demands for electric power, studies were continued to provide a coordinated evaluation of present and projected regional requirements of power. These studies should provide reliable estimates of the contribution that fuels are making and will make to an increasing degree, in this important field of the country's economy.

PHYSICAL METALLURGY DIVISION

Activities in physical metallurgy in 1955 were centred on investigational work and research into the properties and behaviour of metals, and the development of new alloys and of new metal-working, welding and foundry techniques. Such work was designed to meet the needs of industry, defence, and Atomic Energy of Canada Limited.

Investigations

The effect of boron and rare earth additions on the mechanical properties of a low-carbon cast steel, originally developed in the United Kingdom for wrought products, was investigated. One of the main advantages of this boron steel is that the increased strength imparted by the boron addition may be realized by an air-cooling heat treatment, and thus the danger of cracking which accompanies liquid quenching may be avoided. The boron addition was found to increase the yield strength by about 50 per cent without loss of ductility. Rare earth additions had no effect on the tensile properties of the steel, but partly restored the impact values which were lowered by the boron additions.

Inspection of facilities and training of operators for the radiographic inspection of castings for use in R.C.A.F. aircraft continued to be an important function of the Division. This inspection and training has ensured that all critical castings going into use are of the quality required by the Air Force.

As in previous years, the Division was asked to investigate a number of aircraft accidents, since failure of metal parts was suspected. Such failures were found in many cases, and recommendations were made for the correction of the faulty conditions.

Examples of fractured piles, taken from damaged wharves were examined for the Department of Public Works, one of the principal users of sheet-steel piling in Canada. Two new specifications were prepared covering the steel and the flame-cutting and welding techniques. Adoption of these specifications should reduce piling failures to an acceptably low level, or possibly eliminate them completely.

The welding procedures used to instal steam lines in Canada's latest destroyer escort vessels were reproduced and tested to ensure that the welds produced are of the highest quality. Welded high-pressure, high-temperature steam lines are being used for the first time in these vessels.

A program of fatigue tests of welded joints, under pulsating tension, on three selected aluminum alloys was completed in 1955. Aluminum-alloy plate is being used in the stressed parts of naval vessels, and a knowledge of the fatigue characteristics of welded joints is necessary so that ship designers may have accurate data for their calculations. The tests showed the relative merits of plain butt joints as compared with joints utilizing several types of cover plate, and it was found that the use of cover plates was actually harmful in fatigue.

Continued assistance was given to industries concerned with the production of newer metals such as titanium and niobium. Facilities were improved and enlarged for the determination of gases which have such an important influence on the physical properties of these metals; and the spectrographic technique developed by the Division to detect segregation was successfully applied to commercial titanium alloys.

Considerable time was spent on reviewing existing standards and the issuance of new standards, particularly for the Canadian Standards Association. At the request of the Association, standards for aluminum and aluminum alloys, magnesium and magnesium alloys, copper and copper alloys and zinc alloys were given detailed consideration. In this work, the relevant American and British standards also had to be considered to ensure the acceptability of Canadian exports to these countries.

Development

The method of coldworking critical sections of mining drill rods by the spiral rolling process devised by the Division has been proved successful by service tests in a number of mines. Field-test results totalling over 2,000,000 feet of drilling showed that the newly developed drill-set decreases the cost of mine drilling by from 1½ cents to 5½ cents a foot. A patent on the process has been applied for, and a commercial arrangement has been entered into for the production of the rolling equipment.

Work was successfully completed on the design and production of an 81 mm. mortar base plate for the Department of National Defence. Two types of base plate were produced, one of hammer-forged aluminum alloy and the other of cast magnesium alloy. The aluminum-alloy plate which has been approved by the Canadian and United States defence services, is about 50 per cent lighter in weight than the standard steel variety, and is about half as expensive to produce. Tests on the magnesium plate also proved successful. This plate is about 60 per cent lighter than the steel plate.

Methods were investigated for making a special component for defence applications, requiring high-dimensional accuracy and very thin sections. Attempts to manufacture this part elsewhere by various means had met with failure. Techniques were devised to manufacture the component, and a number of successful precision castings having the required dimensional tolerances were produced. The information and the special tools with which to produce the component, were made available to commercial manufacturers.

The hardening properties of austenitic manganese steel were investigated. The Canadian mining industry makes extensive use of these steel castings. Austenitic manganese steel hardens to a great extent by shock impact, and the hard layer thus formed is quite wear-resistant. The reason for this great increase in hardness has long been a controversial subject. The investigation showed that the hardened steel contains a few hundredths of a per cent of a ferro-magnetic constituent, tentatively identified as a tempered martensite. It also showed that this new phase was concentrated along grain boundaries and the resultant slip planes, and it was theorized that the great increase in hardness occurred by a mechanism similar to that for age-hardening alloys.

The yield obtained from a wide variety of nodular irons was investigated at various pouring temperatures. Compared with ordinary grey irons, nodular irons are tough and ductile. In the foundry industry, a reservoir of liquid metal must be attached to every metal casting in order to compensate for the shrinkage which occurs when the casting solidifies. The number of sound castings which can be obtained from a given amount of liquid metal is thus very dependent upon the amount of metal which must be used to fill the reservoirs or risers. The yield is the weight of sound castings obtained divided by the weight of the liquid metal poured. The information obtained from this investigation will lead to increased efficiency in the production of nodular-iron castings, since producers will be able to choose pouring temperatures which will result in the highest yield of sound metal.

Continued attention was given to development work on new alloys for Atomic Energy of Canada Limited. After selection, alloys are experimentally fabricated in the Division into shapes suitable for use in reactors. Pilot-plant work was also done on one stage in the commercial manufacture of fuel elements for the NRU reactor under construction at Chalk River, Ontario. Work was continued on fuel-rod fabrication and on sheathing problems for the NRX and

NRU reactors at Chalk River and in particular, for the NPD (power demonstration) reactor to be built by government and private industry at the power station of the Hydro-Electric Power Commission of Ontario near Des Joachims in southeastern Ontario. Three specific rod-sheathing techniques developed by others were adapted to Canadian needs, and work was done on one all-Canadian technique.

An investigation was set under way into the occurrence of hot tears in castings owing to the stresses developed with the cooling of the metal through the freezing range. One objective of the investigation was to develop a hot-tear test of such simplicity that the hot-tearing characteristics of any alloy could be determined rapidly in a foundry by semi-skilled labour. Certain alloys are much more susceptible to hot tearing than others. To obtain a clearer understanding of the phenomenon as it occurs with magnesium alloys, hot-tear tests were developed by which a large number of commercial alloys have been tested. Several test designs were tried but it was found that the hot-tearing characteristics as determined by these tests were strongly affected by the kind of test pattern used. It appears, therefore, that no one test will indicate the hot-tearing characteristics of any alloy under all conditions, and it may be necessary to use two or more tests of different design, each of which would emphasize a different factor.

Research work was continued on the production of titanium alloys and their efficient use in modern Canadian military aircraft. Titanium alloys are being required to an ever increasing degree in the construction of such aircraft, and they form one of the newest groups of alloys being used by industry. However, the knowledge necessary for their production, fabrication, and use is still incomplete. Considerable time and effort were directed toward designing, building and installing the specialized equipment needed to work with titanium and its alloys.

Engineers of the St. Lawrence Seaway Authority continued to consult the Division on the numerous metallurgical problems continually arising during the construction of the project. These problems involve questions of metal compositions, casting design, welding procedures, and formulation of pertinent specifications.

Considerable attention was given to fundamental research on the behaviour of metals. Work is being done on the very wide discrepancy between the theoretical cohesive strength of metals and the strength actually found in tension tests. In other research, basic facts were discovered concerning the formation of the hard brittle compound of iron and carbon to which the strength of steel is mainly attributable. The data obtained are useful in interpreting the process of tempering in steel and in understanding related processes in other metals.

Other Activities

The reports completed and enquiries answered may be classified as follows:

	Research Reports	Invest. Reports	P.M. Test Reports	Enquiries
Industry	2	4	103	
National Defence		9	91	
Other Government Agencies		3	23	
N.R.C. (T.I.S.)				62
Research	6			
National Research Council		1	3	

In addition, 35 lectures were given to technical organizations, and 12 papers were published in technical journals.

MINERAL RESOURCES DIVISION

Major attention was given to the preparation of background material on the principal metals for the Royal Commission on Canada's Economic Prospects. Briefs were prepared on copper, nickel, lead, zinc, iron ore and primary iron and steel, aluminum, titanium, and gold and other precious metals. Special studies were made on petroleum and natural gas, trends in mine finance, and Canadian mining technology, and several comprehensive statistical tables and graphs on Canadian mineral production, exports, and consumption were prepared.

The continued growth of the mining industry, both in volume of production and in expanded exploratory and development activity, resulted in an increased demand for information. More than 1,600 written enquiries were handled, and numerous reports were prepared at the request of government departments. These reports dealt with such subjects as mineral potentialities between Fort Rae and Great Bear Lake; the implications of mineral resources developments on potential traffic through the St. Lawrence seaway; the movement of iron ore via the St. Lawrence seaway; a review of federal assistance in relation to mining and tourist roads; the helium content of natural gases in Canada; markets for fuel along the proposed route of the trans-Canada pipe line in northern Ontario; and metallurgical and chemical possibilities resulting from the development of the base metal deposits in the Bathurst area, New Brunswick.

Technical assistance was furnished to the National Film Board in the preparation of film strips on subjects related to the mineral industry, and to the Exhibition Branch, Department of Trade and Commerce, in the design of the mining exhibit for the Universal and International Exhibition to be held in Brussels, Belgium, in 1958.

In cooperation with other divisions of the Mines Branch and the Geological Survey of Canada, reviews for 1954 were issued covering each of the metals or minerals produced or extensively used in Canada. Revision of the Mining Laws of Canada (Mines Branch Report No. 828, 1951) was begun. Ten articles were written for publication in the technical press, 11 addresses were prepared and delivered, and several information circulars on specific metals were prepared for limited distribution.

Field work included visits to base metal mines and metallurgical plants in Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia; to all active gold mines in Canada; to iron-ore operations in Newfoundland (Labrador), Quebec, and Ontario; to oil and natural gas fields in western Canada; and to titanium developments in Quebec. An officer attended the natural gas hearings of the Federal Power Commission in Washington, D.C., on behalf of the Department of Trade and Commerce, and two officers were granted leave to attend special university courses, one at Gainsville, Florida, in statistical methods, and the other at Pennsylvania State University in petroleum engineering and a Seminar for Industry.

The Division's mineral occurrence index was maintained and this, in conjunction with the Division's resource records, provide industry and government with a valuable source of information on mining properties and deposits.

Two engineers assisted the Director General of Scientific Services in the administration of the Emergency Gold Mining Assistance Act. One was responsible, in cooperation with the Cost Inspection and Audit Division of the

office of the Comptroller of the Treasury, for processing applications under the Act, and the other carried out the annual field inspections required to ensure the observance of the regulations relating to allowable exploration and development expenditures.

In cooperation with the Geological Survey of Canada the Division assisted the Department of National Revenue in the administration of Section 83(5) of the Income Tax Act. Twenty-two submissions were prepared for the information of the Minister of Mines and Technical Surveys relating to applications received for the 3-year tax exemption of new mines. The Division assisted in the processing of eight applications by oil companies for approval of the special tax concessions made available under income tax legislation on proposed deep-test wells. Six of the eight applications were approved. Two companies submitted applications for accelerated depreciation as provided for by legislation respecting oil or natural gas pipe lines.

The Chief of the Division carried out an assignment in Indonesia in February as part of Canada's contribution to the Colombo Plan.

The Division was represented at the meetings of 15 scientific societies and technical committees. During the fiscal year, over 69,500 copies of Mines Branch publications were distributed.

Library

The library of the Mines Branch is administered by the Division. The following acquisitions were recorded.

Publications Received	
Publications of the Canadian government	1,909
Publications of British, U.S. and foreign governments	3,193
Publications of scientific societies	1,815
Periodicals	6,352
Books and pamphlets by purchase	916
	14,185
Other Data	
Loans of books, pamphlets and periodicals, including inter-library loans of 1,188	25,833
Volumes bound	408
Volumes accessioned	795
Periodicals and annuals subscribed to	502
Cards added to general catalogue in main library and P.M.D. branch library	1,354
Reference cards prepared and filed in Research Section	13,549

DOMINION OBSERVATORIES

C. S. Beals,
Dominion Astronomer

THE Observatories carried out a broad program of observation and research in astronomy, geophysics and astrophysics.

The time service of Canada was maintained by nightly astronomical observations, and the Canadian public was supplied with accurate time by means of broadcast and wire services. In anticipation of the approaching sunspot maximum and the International Geophysical Year of 1957-58, daily observations of variations in the sun's radiation and their effect on the earth's upper atmosphere were commenced.

Aerial navigators, surveyors and prospectors were provided with an expanded magnetic and gravity map coverage. At Ottawa the new Geophysics building was completed and is occupied by laboratories of the Observatory's geomagnetism, gravity and solar physics divisions.

At Victoria, B.C., extended studies were made of four giant stars of low temperature having diameters several hundred times that of the sun. As each of these large cool objects has a small hot star rotating around it, the eclipses of the hot star by the cool body offered exceptional opportunities for the study of stellar atmospheric physics.

Members of the public, in increasing numbers, are taking advantage of the public observation facilities of the Observatories at Ottawa and Victoria. Approximately 25,000 visitors were recorded.

Dr. R. L. G. Gilbert of Cambridge, England joined the staff in May.

J. P. Henderson, astrophysicist, retired on superannuation after 37 years of service.

DOMINION OBSERVATORY

Positional Astronomy

The main function of this Division is to make accurate determinations of the positions of stars and to utilize this and other data to maintain the time service of Canada, for the determinations of latitudes and longitudes, and for general astronomical research.

The operation of the Division centres about two telescopes: the meridian telescope used for deriving accurate positions of stars, and the photographic zenith telescope (PZT) whose purpose is time determination. Associated with the telescopes are five precision quartz clocks with associated radio and electronic equipment to record, compare and distribute time impulses.

The meridian telescope was used on 102 nights and 6,054 star observations were secured. The results of observations made during the period 1950 to 1953 (PZT stars for time determination at Ottawa) were checked and are being prepared for publication. Improved proper motions and positions that are expected to prove satisfactory for a standard of references for about 10 years, were derived for these stars. The positions of a corresponding group of stars, observed on an exchange basis for time determination at the Royal Greenwich Observatory, were forwarded in manuscript to the Astronomer Royal.

As the result of conferences held in Evanston, Ill., 1953, Leningrad, U.S.S.R,. 1955, and Brussels, Belgium, 1955, it was proposed to form under the guidance of the International Astronomical Union, a third *Astronomischen Gesellschaft* (A.G.) star catalogue of 180,000 stars. The star positions of this catalogue will be derived mainly from photographic plates of star fields, but positions of the reference stars are fixed by meridian telescope observations. The Observatory was asked to observe 3,754 of the reference stars for this catalogue. The positions of the reference stars will be determined from observations made together with observations of stars from an international catalogue known to astronomers as FK3, thus establishing positions on a uniform system in all countries. Five hundred observations have already been made in the program, which is expected to be completed in 1960.

Considerable progress was made in the design of the new mirror transit telescope to replace the present meridian circle, and contracts have been let for the major parts.

Time Service The photographic zenith telescope was used on 195 nights, 5,536 transits being secured. The resulting clock corrections and latitude variations were computed, and the corresponding variation of longitude was applied to the time determinations. The mean value of latitude used in these calculations was 45°23′38″7.

The performance of the three primary crystal clocks, particularly the recently acquired Essen ring crystal was studied, and extrapolated values of clock corrections provided corrections to the two quartz clocks used as time signal generators. The crystals of the two secondary clocks were shock-mounted from NRC design, and housed in a temperature-controlled room with a resultant improvement in stability.

All five clocks were equipped with coaxial connections to a comparison panel where spot checks on relative frequency were made daily. At first the inter-comparisons were made by means of microdials with phaseable seconds outputs. Later, a cold cathode counter technique of English design was installed, permitting the clocks to be intercompared to 1/10,000th of a second per day, a 100-fold increase in precision.

Daily observations of radio signals from Washington Naval Observatory (NSS), United States Bureau of Standards (WWV), and Rugby, England (GBR), were recorded to the nearest millisecond. Dominion Observatory time was also broadcast continuously on three short-wave frequencies, 3330 kc., 7335 ks. and 14,670 kc. Under good atmospheric conditions these have been received at Washington and in England, and the two-way link provides a valuable inter-observatory check on time.

Discussions were held with representatives of National Research Council, Department of Transport and Defence Research Board, on the pooling of information on the five Essen ring crystals in Ottawa laboratories. Since the Dominion Observatory oscillator is referred to fundamental astronomical time, this group of oscillators serves as a standard of frequency. Discussion pointed to the desirability of broadcasting a Canadian standard of frequency, using the existing CHU frequencies as outlet.

Small but significant improvements were made in the mechanical adjustment of the PZT and the plate-measuring machine. One of these was the replacement of the copper-lined mercury mirror by one electroplated with pure gold, the resulting amalgum being tarnish resistant and hence a better reflector.

The number of clocks in government offices for which the Observatory is responsible has continued to decrease owing to the increased use of 60 cycle a.c. frequency dials.

An interesting moon problem relating to a contentious point in the early history of Quebec city was answered, and tables of times of sunrise, sunset, moonrise and moonset were distributed on request. The Observatory continued its normal services to the CBC, the Canadian Pacific and the Canadian National Railway systems, the Bell Telephone Company, and several government and private groups.

Stellar Physics

Research in Meteor Astronomy An intensive program of meteor photography was continued at Meanook and Newbrook, Alberta. With the aid of the Super-Schmidt cameras, numerous photographs suitable for determining upper atmosphere densities were secured by measuring meteor decelerations. About 40 doubly-photographed trails were copied at Ottawa with the special copying camera, and forwarded for measurement to Harvard University as part of an international program of upper atmospheric research. These studies are partly concerned with the resistance of the atmosphere to high altitude projectiles.

Thirteen meteor spectrographs of medium dispersion were operated at Ottawa, Meanook and Newbrook while four small dispersion instruments were put into operation at Ottawa for the observation of faint meteors. Plans are almost ready for the construction of large dispersion spectrographs at Meanook, which, for the observation of bright meteors, will supersede any now in operation.

In the entire meteor-observing program, 2,231 photographic exposures were made and 1,147 meteors were recorded visually. A single valuable meteor spectrum was photographed.

A search of 200,000 aerial photographs covering the Canadian Shield in Ontario and Quebec revealed five circular features of possible meteorite origin. One of these, of 1·25 miles in diameter at Holleford, about 20 miles northwest of Kingston, Ontario, was found to be filled with palæozoic sediments, and to have points of similarity to the crater at Brent, Ontario.

A paper relating visual observations with radar observations of meteors was published, and another on the topographical features of the New Quebec crater was prepared for publication.

Solar Physics The Lyot type hydrogen alpha filter, in conjunction with an automatic camera, was kept in almost continuous operation on clear days from September, 1955 on. This was done to meet the demand which has arisen in recent years for a continuous record of solar flares and other chromospheric features for use in studies of the correlation of geophysical phenomena with solar activity. The cooperation of a number of observatories distributed in longitude around the world is necessary to carry out the project. Periodic shut-downs were required to conduct tests and to add new equipment, making the operation of the instrument almost completely automatic. Trials were conducted with various photographic materials and film processing techniques in order to obtain satisfactory permanent records and the combination of materials found to be the most satisfactory was accepted as standard for observatories participating in the flare patrol program during the International Geophysical Year.

Studies of the infrared solar spectrum beyond the photographic limit have indicated that, for many problems, higher resolving power is required than is now available. To increase the resolving power of the present solar spectrometer at the Observatory, several improvements in instrumental technique are being applied. The chief difficulty is the inadequate sensitivity of available infrared detectors. This was largely overcome in the near infrared region of the spectrum by operating the lead sulphide photoconductive cells at low temperatures. In the far infrared region, improved lead telluride photoconductive cells are now becoming commercially available, and it is hoped that the increased sensitivity they will afford, combined with a further increase from a new amplifying system under construction, will result in greatly improved resolution in this region of the spectrum.

Using spectral lines of silicon in the photographic infrared region of the solar spectrum, evidence was obtained for the existence of a term dependence of the wavelength shifts of lines in spectra taken at the solar limb when compared with spectra taken at the centre of the disk.

Work was continued on the detailed photometric study of the spectra of the chromosphere obtained during the total eclipse of the sun on June 30, 1954.

Theoretical Astrophysics Work on the formation of craters by meteorite explosions was continued. The quasi-elastic behaviour of the ground for displacements, so strong as to overcome the resistance to transverse stresses, was approximated by a mathematical model in which the displacement was entirely radial. The relation thus obtained between the radius of the crater produced and the work done by the explosion, showed reasonably close agreement with the available data on controlled explosions.

Research into the theory of the radiation field of emission line stars was renewed. A solution of the equation of radiation transfer appropriate to an idealized planetary nebula was obtained, and from it isophotes were computed. Comparison with the observational data was made to obtain values of optical thickness and geometrical thickness of the emitting region and from these values, an attempt is being made to deduce electron temperature and density.

Geomagnetism

Magnetic Survey The magnetic survey of Canada was continued on the ground by three parties. Observations were made for declination, inclination, and intensity at 18 points comprising one repeat and 17 new stations. Of these, 3 were in Nova Scotia, 9 in Quebec, and 6 in Ontario. In addition, 39 vertical intensity stations were established in the Meanook-Athabasca area of Alberta.

The three-component gyro-stabilized airborne magnetometer, developed by the Dominion Observatory, was used on detailed magnetic mapping in Manitoba, Saskatchewan and Alberta. Continuous registration of declination, horizontal and vertical intensity was made on east-west flight lines, 60 miles apart, from the 49th to the 60th parallels of latitude, supplemented by three north-south lines. Before and after the survey the aircraft was swung over St. Rosaire, Quebec, and Meanook magnetic observatory, Alberta, to determine the aircraft coefficients. A total of 30,000 miles was flown, representing 125 flying hours. The North Star aircraft used was supplied and manned by the R.C.A.F.

Magnetic Charts Five magnetic charts of Canada for the epoch 1955·0 were completed and published. These charts depicted lines of equal declination, inclination, vertical intensity, horizontal intensity, and total intensity and lines of equal annual change. The preparation of general magnetic charts of Canada was continued by completing construction of charts of the north and east components of horizontal intensity. A detailed declination chart of Alberta, Saskatchewan, and Manitoba, based on all available data, was almost completed.

Magnetic data for new and revised topographical map sheets, and marine and air-navigation charts were supplied for 1,500 items, comprising 769 for the Surveys and Mapping Branch, 38 for the Geological Survey of Canada, 659 for the Department of National Defence, and 34 for other agencies.

Magnetic Observatories The four magnetic observatories at Agincourt, Ontario; Meanook, Alberta; and at Baker Lake and Resolute in Northwest Territories were in continuous operation. Tabulations of disturbance indices were sent monthly to research centres in the Netherlands, Germany, United States, and Canada. Magnetograms were made available for study to the National Research Council, the University of Toronto, and the Defence Research Board, and commercial agencies continued to be supplied with photostat copies on a routine basis.

The data from Resolute for the last 5 years have been used to determine the main daily, seasonal and annual drift of the North Magnetic Dip Pole. The average daily excursions of the pole owing to atmospheric magnetic effects are of the order of 10 to 15 miles and this may increase to 100 miles during magnetic storms. The drift of the pole owing to changes within the earth's core is at present approximately 4 miles per year in a direction slightly east of north.

An analysis was commenced of the characteristic of magnetic disturbance at the observatories at Resolute and at Baker Lake and several interesting features of magnetic phenomena were discovered. At Resolute, the daily disturbance variation can be well represented by an expansion in amplitude of the quiet day effects with no change in form. However, the daily changes at Baker Lake are much more complex, and the determination of the form of real quiet day effects proved impossible because of residual disturbance on

quiet days. Sudden-commencement storms and geomagnetic bays at both stations were studied to discover possible regularities. It seems probable that certain previously unreported seasonal changes in sign and distribution, which have been discovered from Canadian data, cannot be explained on present theories of transient disturbance, and attempts are being made to improve the theory.

A study of earth-current phenomena was started at Meanook. The installation of electrodes was completed and continuous registration started. Preliminary inspection of records suggested that the Meanook installation, the only one of its kind in operation in the Western Hemisphere, will result in valuable contributions to fundamental research in geomagnetism.

An investigation relating to the cause and effects of the magnetic field in the crust and core of the earth and the particular correlation of long-term changes in the direction and magnitude of the field was continued by a staff member at Cambridge University, England.

Plans were completed for the establishment of two additional magnetic observatories, one at Yellowknife, Northwest Territories, and the other at Victoria, B.C., for International Geophysical Year investigations.

Geomagnetic Laboratory A statistical analysis was made for 5,000 miles of magnetic profiles of declination, horizontal intensity, and vertical intensity obtained during the 1955 airborne magnetic survey. From the auto-correlation functions of these profiles, probable errors of magnetic charts prepared from various distributions of observations were completed. The effect of different methods of interpolation of the probable error was investigated.

The gear trains in the stabilized platform of the airborne magnetometer were rebuilt, and more powerful servo-motors installed. The servo-amplifiers were also redesigned and rebuilt and an experimental model of a new type of servo-amplifier was built and tested. A small analog electronic computer for performing least squares solutions was completed and used in analysing aircraft swings, and a new frequency standard for the airborne magnetometer was designed and built.

A new portable electronic magnetometer for use in field studies was built. Three-component magnetometers of the recording type were adapted for use at Meanook in connection with earth-current studies, and at Ottawa for use with the astatic magnetometer for measuring remanent magnetism in rock samples. A prototype of the electrical recording magnetometer to be used during the International Geophysical Year at all Canadian magnetic, ionosphere, and auroral stations was constructed, and an order placed for building ten such magnetometers.

The construction of an astatic magnetometer for measuring the remanent magnetism of rocks for secular change information was completed, save for final adjustments.

Gravity

Gravimeter Surveys Special emphasis was placed on extending the primary base network within Canada and on improving the connections between the national base station at Ottawa and the world gravity network. One party using three gravimeters and aircraft transportation travelled 30,000 miles to establish a system of 48 primary bases at principal airports throughout southern Canada. The bases are, on the average,

about 150 miles apart, and from a series of six closed nets extending from Vancouver, B.C., to Gander, Newfoundland. Accurate ties were made to previous gravimeter networks and to sites where pendulum measurements, both with the Mendenhall and Cambridge apparatus, had been made. The results of the three gravimeters are consistent to about 0·3 milligals and should provide an accurate datum for adjustment and control of all regional gravity measurements throughout southern Canada.

To resolve some of the uncertainties in previous gravity connections between the fundamental gravity stations in Ottawa and Washington, D.C., a series of measurements between the two sites was carried out. Observations were made at 25 stations to form a series of networks that permitted adjustment for closure. On the basis of instrumental calibrations carried out against Cambridge pendulum values, nine independent sets of measurements between these two important stations give differences in gravity which are consistent within one tenth of a milligal.

An observational program, making use of gravimeters, was also initiated to strengthen the ties between the North American and European gravity networks. In cooperation with the Geophysical Observatory in Trieste, Italy, an accurate tie was successfully completed between Gander Airport, Newfoundland and Orly Field near Paris, France.

Laboratory Projects A laboratory program initiated in 1954 to improve the Mendenhall pendulum apparatus, which the Observatory has had in use for a number of years, was nearing completion. The new arrangement is an attempt to eliminate uncertainties due to temperature, pressure, sway of the case, and inaccuracies in measuring the time of swing. Satisfactory results were indicated in all preliminary tests.

A research program to develop and construct an instrument suitable for measuring gravity on unstable ground or in a submarine at sea, was initiated. A workshop and laboratory were fitted out for this project and some progress was made in designing the new instrument. An elementary bench model was constructed to permit the checking of details.

Other laboratory projects in progress are: certain alterations to the North American gravimeters to improve their performance and to permit making an instantaneous calibration at any time; the reconstruction of the Atlas and Boliden gravimeters for use in recording earth tides during the forthcoming International Geophysical Year.

Other Projects The isostatic reduction work for about 300 gravity stations observed throughout the Cordilleran region of southern British Columbia was completed with a view to the eventual production of an isostatic map of Canada, based upon the Airy hypothesis. A study of the preliminary gravity results for a large area of the Canadian Shield in southern and central Quebec has also been completed, and papers on the results are in press.

In accordance with resolutions adopted by the International Union of Geodesy and Geophysics, gravity data for nearly 8,000 stations were forwarded to the International Gravimetric Bureau, Paris, whose responsibility it is to catalogue all gravity data for geodetic purposes.

76816—7

Seismology

Study of Earthquakes in Canada Ten permanent seismograph stations were maintained across Canada. The instrumentation at Kirkland Lake was improved by the addition of a new vertical seismometer and by the substitution of a crystal clock for the original spring-driven chronometer. Readings from the ten stations are reported in bulletins, and those from Ottawa, Victoria and Resolute are sent by radio to Washington to assist in the rapid location of earthquakes.

A temporary installation at the University of New Brunswick in Fredericton was closed down, after having been in operation for long enough to show that a permanent station in that area would be a useful addition to the eastern network. Other temporary stations have been installed at Banff, Alberta and at Knob Lake in New Quebec-Labrador.

Strata-stress Project The operation of the three portable seismographs, which were loaned to the Mines Branch to record rockbursts in the Cordilleran coalfields, was completed. To facilitate a more detailed study of rockbursts a two-channel radio seismograph receiver was constructed in Ottawa, and operated for some weeks in the vicinity of Coleman, Alta., and Fernie, B.C., in conjunction with two of the Observatory's transmitting seismometers. The results obtained with both sets of equipment are being worked out in Victoria.

A single portable seismograph was set up near Springhill, Nova Scotia to record rockbursts in the coal mines there. The instrument is being maintained by Mines Branch personnel, the records being sent to the Nova Scotia Research Foundation for interpretation.

Explosion Seismology Parties from the Observatory collaborated with the Atlantic Oceanographic Group, the Royal Canadian Navy, and the Nova Scotia Research Foundation, in recording the seismic waves from a pattern of depth charges dropped in the St. Lawrence Gulf and on the Scotian Shelf. Preliminary interpretation of the records indicates the presence of very deep sediments in the vicinity of the Magdalen Islands and Cabot Strait. Short-range observations on Sable Island showed it to be a pure sand bar, the bedrock under it being no higher than at other points on the Scotian Shelf.

Waves from depth charges dropped by the Navy in Juan de Fuca Strait were recorded by a seismograph network based on Victoria. The results of this work are not yet available.

Fault Plane Project Tables of extended distances for pPKP, pPP and PPP have been prepared, and studies have been made of groups of earthquakes in the North Pacific and Mediterranean regions.

Russian, Dutch and Japanese methods of investigating fault plane motions were studied and found to be equivalent to our own. A list of more than 225 fault plane solutions has been compiled from a combination of all available results. The pattern of results is similar to that shown by the Ottawa reductions alone, in that it shows that the faulting in most earthquakes is predominantly strike-slip.

DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.

The telescope was used on 186 nights for a total observing time of 993 hours. This was an improvement over the fiscal year 1954-55, but compared with the 37-year average, it is 14 per cent below in actual hours observed, although only two nights below the average in nights observed.

Stellar Physics

An extensive study was made of the four eclipsing stars of large dimensions, *31 Cygni, Zeta Aurigae,* ε *Aurigae* and H.D. 190967. Special observations with a powerful spectrograph provided data on the chemical composition and extent of the stellar atmospheres. This work will have application in the studies of the interiors and outer layers of stars in general, and will ultimately contribute to an understanding of the sources of stellar energy.

New spectrographic equipment was put into operation on the telescope allowing the study of the ultraviolet part of stellar radiation to the limit of atmospheric transmission. It has already been used to gain new information on ionized titanium, iron and chromium in the atmosphere of *Zeta Aurigae* and on interstellar absorption by ionized titanium and the CH molecules.

Analysis of the photographed light of several hundred high-temperature stars was begun as part of an extensive program designed to explore the galaxy out to distances not heretofore studied in any detail and to increase present knowledge of interstellar matter. The colours and brightnesses of 50 stars were measured with a photoelectric photometer as part of this program.

Stellar Motions

New data for galactic research were obtained from the measurement of the line-of-sight speeds of some 175 stars, the velocities of which were hitherto unknown. Line-of-sight speeds were measured for many stars belonging to the Pleiades and Praesepe star clusters. Six stars were found to be double stars, and the orbits were determined for four of these. Several hundred measures were made of the speed of "vibration" of certain pulsating stars.

Seismology

The four stations of the western Canada network were kept in daily operation. A total of 170 local (Victoria) earthquakes were recorded and located. The depth-charge program in collaboration with the Royal Canadian Navy and the Pacific Naval Laboratory was continued in order to study the crustal structure beneath local waters. A special expedition was sent to the coal mining areas in the Rocky Mountains to investigate a possible relation between earthquakes and outbursts in the mines. Analysis of the records obtained is well advanced.

Equipment

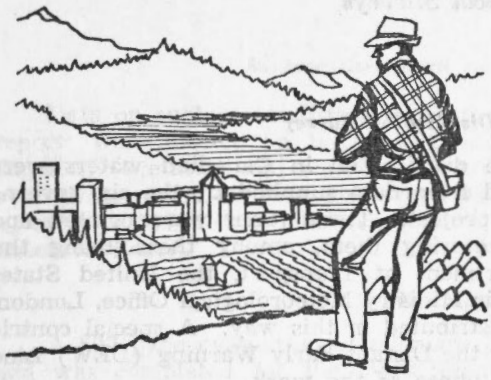
A photoelectric exposure-meter, which has considerably increased the efficiency of spectroscopic work, was completed and mounted on the telescope. A study of the electrical system of the telescope and dome resulted in plans to replace existing obsolescent controls and general requirements were drawn up for the acquisition of a second telescope and for a workshop building.

General

The Observatory was represented at nine scientific congresses at which 22 papers by staff members were read.

An estimated 20,800 persons including 13 special groups visited the Observatory. Staff members gave 23 non-technical lectures before local groups and astronomical societies.

Times of sunrise, sunset, moonrise and moonset were supplied to airport authorities upon request. Eight papers were prepared for printing as Publications and one Contribution was prepared. Seven scientific papers were issued.



GEOGRAPHICAL BRANCH

N. L. Nicholson,
Acting Director

Demand for geographical information on northern Canada remained high particularly in connection with the construction of the Distant Early Warning Line. This is a continuing project as information will be required as well in the supply phase of the line's operation.

Work on the Atlas of Canada progressed, and final production of the English edition was commenced.

The Branch continued to act as the co-ordinating centre for the Canadian Committee of the International Geographical Union, the UNESCO Arid Zone project, and the Geography Commission of the Pan-American Institute of Geography and History. Preliminary plans were made for Canada's participation in the Eighteenth International Geographical Congress to be held in Rio de Janeiro in 1956.

The Branch also provides basic geographical data to government departments, institutions, and individuals. During the fiscal year, it dealt with the following research enquiries (as distinct from research projects):

Department	Major Enquiries	Minor Enquiries
Mines and Technical Surveys	4	29
Trade and Commerce	3	25
External Affairs	2	96
National Defence	2	58
Northern Affairs and National Resources	2	13
Citizenship and Immigration	1	6
National Research Council	..	7
Labour	3	2
Others	14	621
	31	857

76816—8

SYSTEMATIC GEOGRAPHY

Canadian Ice Distribution Survey

Over 4,000 items describing ice distribution in Canadian waters were extracted from books, pamphlets and from data supplied by the six government agencies collaborating in the project. These items were printed and distributed to the organizations requiring them, among these being the Defence Research Board, the Department of Transport, the United States Navy Hydrographic Office, and the Air Ministry Meteorological Office, London, England. Over 25,000 items were distributed in this way. A special contribution of 960 items was prepared for the Distant Early Warning (DEW) Line organization during the construction phase of the work.

A report, with maps, on the physical characteristics of the Ungava Bay area was published, in which are indicated the geographical limits of ice-free water during the critical break-up and freeze-up periods. Interest in the area centres mainly around the iron-ore discoveries on the west side of Ungava Bay. A similar report for the Hudson Bay-Hudson Strait sea route is in press.

Two Branch officers made special aerial ice reconnaissance surveys of the Gulf of St. Lawrence in connection with the operations of HMCS *Labrador*. The work was co-ordinated by the Defence Research Board and carried out with the cooperation of the Royal Canadian Air Force and the Royal Canadian Navy. Certain tentative conclusions were reached with regard to year-round navigation in the Gulf.

A member of the staff of the Scott Polar Research Institute, England, was attached to the Branch for several weeks while carrying out a special project on ice distribution for the Defence Research Board.

Urban Geography

The program of recording the urban physical characteristics of the major cities of Canada, being carried out principally for the Civil Defence Division, Department of National Health and Welfare, was continued. It is anticipated that the results will be of use also in connection with the redevelopment of older sections of major cities. Field work was carried out in Toronto and Quebec city by teams of five geographers in each place. The field data, some of it obtained in previous seasons, for Montreal, Toronto and Winnipeg were compiled, and in the cases of Montreal and Toronto, five maps in full colour on scales of one inch to 1,000 feet and one inch to 800 feet were completed. A detailed report on a survey of Carleton Place, Ontario, carried out in 1951, was prepared for the Civil Defence Division. On several occasions, members of the Branch lectured on civil defence work during staff training courses at the Civil Defence College, Arnprior, Ontario.

The Branch assisted the commission of the Canadian Committee of the International Geographical Union in its work on industrial ports by doing field work on the island of Newfoundland. This included a study of 21 customs ports and a special survey of the port of St. John's. A report on the extent and nature of the hinterlands of Saint John, N.B., was published and proved of special interest to the National Harbours Board.

The Branch was consulted on urban mapping, from time to time, by the staff of the Central Mortgage and Housing Corporation.

Surface Conditions in Northern Canada

Data on surface conditions in northern Canada extracted from published reports were plotted on 1-inch-to-8-mile map sheets. Land forms, surface deposits, vegetation and water features are considered, and during the fiscal year almost 9,000 extracts concerning these were made, together with a bibliography of 547 items. The information is mainly for the use of the Defence Research Board.

Map Appraisal

A 500-page evaluation of all maps published of Canada or parts of Canada was completed for the Department of National Defence. The report, which represents four years of study, deals with 1,076 separate items and includes 10 tables and 21 maps. It was prepared with the cooperation of federal, provincial and private map-producing agencies.

REGIONAL GEOGRAPHY

Arctic and Subarctic Regions

Field surveys were carried out in the areas of Eureka (Ellesmere Island), Mould Bay (Prince Patrick Island), Cambridge Bay (Victoria Island) and in the Mackenzie delta. These surveys were mainly intensive studies of small sample areas to obtain data on the extent and nature of land forms, the degree of drainage, and the chief types of vegetation and their relationship to permafrost phenomena. From this data, ground-photo keys can be prepared by which surface conditions over a wider area can be interpreted fairly rapidly from aerial photographs. Descriptive reports on the geography of the areas involved will also be prepared. A report on terrain conditions in the central Canadian Arctic, arising out of previous field work, was published.

Investigations connected directly with the construction phase of the DEW Line were made. A total of 112 maps, in colour, on a scale of one inch to eight miles, showing a detailed analysis of the terrain elements was prepared from data collected on surface conditions in northern Canada either from published material or from previous field work. Texts were prepared to accompany these maps. Work on this project will be continued to meet the need for such information during the operation of the line.

Prairie Region

As the co-ordinating agency in Canada for the UNESCO Advisory Committee on Arid Zone Research, the Branch investigated the influence of the semi-arid environment in southern Saskatchewan upon occupation and settlement. The committee is concerned with the systematic collection of data, particularly economic and social, on the arid areas of the world.

The Acting Director attended an Arid Lands symposium held in Albuquerque, New Mexico, at the invitation of UNESCO and the American Association for the Advancement of Science, which sponsored the meetings.

Cordilleran Region

A report on the semi-arid areas in southern British Columbia was prepared for publication. Work was commenced on an analysis of the geographical subdivisions of the Canadian Cordillera for the Department of National Defence.

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Gulf of St. Lawrence Region

Field work was carried out on the island of Newfoundland in collaboration with the federal and Newfoundland departments of Fisheries. This completes the field studies made in 1951, 1952 and 1953 in connection with the redevelopment of the province's fishing industry, and comprehensive reports are being prepared for the federal and provincial agencies concerned with this problem.

A report on the New Glasgow region of Nova Scotia, arising out of previous field work, was published.

ADMINISTRATION AND SPECIAL PROJECTS

Atlas of Canada

The purpose of this atlas is to provide the people of Canada with a comprehensive series of authoritative maps, which will show the nature, extent, and use of the physical resources of the country and their effect on economic development and settlement. During the fiscal year, the English edition of the atlas went into production with the printing of three sheets: Population Distribution 1951 (sheet 47); Aboriginal Population (sheet 52); and Rural Population (sheet 57). Press proofs were prepared of two others: Mapping the Coasts, 1492-1874 (sheet 2), and Mapping the Interior, 1630-1870 (sheet 3). Eleven other sheets were sent for final drafting and printing. By the end of the year, about 75 per cent of the basic data for the atlas had been received from the contributing departments and preliminary compilation had been started. Particular attention was paid to maps dealing with types of settlement, land use and functional plans of major cities, and to maps dealing with mineral resources, agricultural regions and air lines.

General

Data on geographical regions of Canada were supplied to the Royal Commission on Canada's Economic Prospects to government departments, commercial institutions and individuals.

Over 1,800 publications were distributed, of which 439 were extracts and reprints.

Drafting

Ninety maps and scientific figure drawings were drafted for reproduction by photolithography or by zinc-cut process for illustrating memoirs and reports. Fifty-three maps were drawn for other government departments, of which 16 were for the Department of External Affairs; 12 for the Department of Citizenship and Immigration, seven for the territorial governments of Yukon and the Northwest Territories and 12 for the Tariff Board. Fourteen sheets consisting of 132 maps and diagrams were drafted for the Atlas of Canada.

Book Library

Accessions brought the total number of volumes in the library up to 16,105 and 11,893 cards were added to the main and periodical index catalogues. Several atlases were acquired, including the "Northern Europe" volume of the new *Times Atlas*; the Russian *Atlas Mira*; and the first sheets of *Atlas de Belgique*.

Other data

No. of requests for information	754
No. of accessions (books and pamphlets)	889
No. of library loans (exclusive of periodicals)	2,513
No. of inter-library loans	478
No. of letters sent out	396
No. of books and pamphlets catalogued	1,077
No. of cards added to main catalogue	8,261
No. of cards added to periodical index catalogue	3,652

Map Library

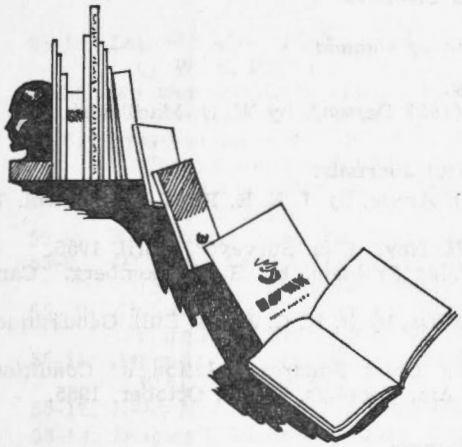
Over 7,000 maps were added to the collection bringing the total number of sheets held to approximately 188,000. Accession lists were prepared every two months, and a shelf list was added to the catalogue. A five-year accumulation of Canada's annual contribution to *Bibliographie Cartographique Internationale* for the years 1949 to 1954 was prepared for publication.

Other data

No. of requests for map information	294
No. of map accessions	7,140
No. of maps loaned	2,482
No. of letters sent out	600
No. of form letters sent out	250
No. of maps catalogued	914
No. of cards added to the catalogue	7,697

Photographs

No. of photograph accessions	2,575
No. of photographs loaned	2,390
No. of cards added to catalogue	6,184
No. of photographs indexed on maps	4,340



PUBLICATIONS

Administrative

Summary of Activities 1955. (Offset).
Report of the Explosives Division (Calendar Year 1953).
Report of the Explosives Division (Calendar Year 1954).
Explosives Division pamphlet, Safety with Explosives.
Report on the Administration of the Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31, 1955.
The Emergency Gold Mining Assistance Act and Regulations, Office Consolidation.
Annual Report for the Fiscal Year ended March 31, 1955.

French Translations

Summary of Activities 1955. (Offset).
Report of the Explosives Division (Calendar Year 1953).
Explosives Division pamphlet, Safety with Explosives.
Report on the Administration of the Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31, 1955.
Annual Report for the Fiscal Year ended March 31, 1955.

Surveys and Mapping Branch

Canadian Hydrographic Service

Sailing Directions, Foxe Basin. (Offset).
St. Lawrence River Pilot—Quebec to Kingston (Second Edition).

1. Tide Tables, 1956. *Atlantic Coast.*
2. Tide Tables, 1956. *St. Lawrence and Saguenay Rivers.*
3. Tide Tables, 1956. *Prince Edward Island and Adjacent Waters.*
4. Tide Tables, 1956. *Nova Scotia, Atlantic Coast.*
5. Tide Tables, 1956. *Bay of Fundy.*
6. Tide Tables, 1956. *Newfoundland, East and South Coasts.*
10. Tide Tables, 1956. *Pacific Coast.*
11. Tide Tables, 1956. *Strait of Georgia.*
12. Tide Tables, 1956. *British Columbia, Northern Waters.*
13. Tide Tables, 1956. *Vancouver Island, Southwest Coast.*

Geodetic Survey of Canada

73. *Geodetic Base Lines,* by J. E. Lilly.
74. *Triangulation in Southern Quebec (1927 Datum),* by W. H. MacTavish.
78. *Geodetic Application of Shoran.*

Articles Published in Scientific and Technical Journals:

Geodetic Investigations in the Canadian Arctic, by J. E. R. Ross. Arctic, vol. 7, Nos. 3 and 4, 1954.

Airborne Target Triangulation, by C. H. Ney. Can. Surveyor, April, 1955.

Coordinate Systems and the Three Point Problem, by H. Klinkenberg. Can. Surveyor, July, 1955.

Azimuth Determination by Equatorial Stars, by R. K. C. Johns. Bull. Géodésique, September, 1955.

A *Modified Equations Method for the Least Squares Solution of Condition Equations,* by L. A. Gale. Trans. Am. Geophys. Union, October, 1955.

Legal Surveys

Report of Commissioners on Ontario-Manitoba Boundary Survey, 1929-1950 (and Atlas.)

Report of Commissioners on Alberta-British Columbia Boundary Survey, Part IV, 1950-53 (and Atlas.)

Regulations, Rules and Instructions of the Board of Examiners for Dominion Land Surveyors, 16th Edition. (Offset).

Canadian Board on Geographical Names

Gazetteer of Canada—Manitoba.

Geological Survey of Canada

Memoirs:

167: *Fort William and Port Arthur and Thunder Cape Map-areas, Thunder Bay District, Ontario,* by T. L. Tanton. (Reprint).

278: *Palæozoic Geology of the Windsor-Sarnia Area, Ontario, (Supplement to Memoir 240),* by B. V. Sanford and W. B. Brady.

Bulletins:

29: *Wall-rock Alteration at Certain Lead-zinc Replacement Deposits in Limestone, Salmo Map-area, British Columbia,* by L. H. Green.

30: *A Decrepitation Study of Quartz from the Campbell and Negus-Rycon Shear zone Systems, Yellowknife, Northwest Territories,* by R. W. Boyle.

31: *Mineralogy of Uranium Deposits, Goldfields, Saskatchewan,* by S. C. Robinson.

35: *Devonian Formations in the Alberta Rocky Mountains between Bow and Athabasca Rivers,* by D. J. McLaren.

Papers:

54-9: *Preliminary Map, Atlin, British Columbia,* by J. D. Aitken.

54-15: *Uranium City, Saskatchewan.* (Map with marginal notes, Sheets 1 and 2), by L. P. Tremblay.

54-16: *Columnar Sections of Wells Across Southern Saskatchewan,* by L. L. Price.

54-19: *Adams Lookout, West Half, Alberta.* (Map with marginal notes), by E. J. W. Irish.

54-20: *Teslin Map-area, Yukon Territory.* (Map and Preliminary account), by Robert Mulligan.

54-21: *Preliminary Map, Lindsay, Victoria, Ontario, Peterborough, and Durham Counties, Ontario, (Glacial Geology),* by C. P. Gravenor.

54-22: *Notes on Columbium Mineralization, Oka District, Two Mountains, Quebec,* by R. B. Rowe.

55-1: *Lac Herodier, New Quebec* (Preliminary map and descriptive notes), by W. H. Fahrig.
55-2: *Manicouagan Lake—Mushalagan Lake Area, Quebec* (Map with marginal notes), by E. R. Rose.
55-3: *Cross-sections through the Devonian System of the Alberta Plains* (Report and five figures), by Helen R. Belyea.
55-4: *Forcie Lake Map-area, Saskatchewan* (Map with marginal notes), by W. E. Hale.
55-8: *Knee Lake, Manitoba* (Map with marginal notes), by H. A. Quinn.
55-9: *O'Connor Lake (West Half), District of Mackenzie, Northwest Territories* (Map with marginal notes), by A. B. Irwin and D. B. Prusti.
55-10: *Abitau Lake, District of Mackenzie, Northwest Territories* (Map with marginal notes), by J. W. Hoadley.
55-11: *Argentia, Newfoundland* (Preliminary map with marginal notes), by W. D. McCartney.
55-12: *Keno Hill, Yukon Territory* (Map with marginal notes), by E. D. Kindle.
55-13: *Dingwall, Victoria County, Cape Breton Island, Nova Scotia* (Map with marginal notes), by E. R. W. Neale.
55-14: *Two Lakes, Alberta* (Map with preliminary report), by H. R. Greiner.
55-15: *Surficial Geology of Edmundston, Madawaska and Temiscouata Counties, New Brunswick and Quebec* (Preliminary report and map), by Hulbert A. Lee.
55-17: *Geological Notes on Central District of Keewatin, Northwest Territories* (Map and preliminary account), by G. M. Wright.
55-18: *Blairmore, Alberta* (Map with marginal notes), by D. K. Norris.
55-21: *Wolf Lake, Yukon Territory* (Preliminary map with marginal notes), by W. H. Poole.

Miscellaneous:

Prospecting for Uranium in Canada. (Reprint.).

French Translation

Prospector's Guide for Uranium and Thorium in Canada.

Mines Branch

846: *The Granite Industry of Canada,* by G. F. Carr.
850: *Supplement No. 1 to Analysis Directory of Canadian Coals,* by E. Swartzman and T. E. Tibbetts.
62 Preliminary Mineral Reviews. (Offset).
List 1-1, *Metallurgical Works in Canada, Part I, Primary Iron and Steel.* (Offset).
List 2-1, *Metal and Industrial Mineral Mines in Canada, July 1955.* (Offset).
List 4-1, *Coal Mines in Canada, January 1955.* (Offset).
List 5-2, *Petroleum Refineries in Canada, January 1955.* (Offset).

Technical Papers:

No. 10: *Electronic Concentration of Low-grade Ores with the Lapointe Picker,* by A. H. Bettens and C. M. Lapointe. (Offset).
11: *Refining of Antimony by Electrodeposition and by Distillation,* by R. R. Rogers and R. A. Campbell. (Offset).
12: *Constitution of Bone China, Part III, High Temperature Phase Equilibrium Sudies in the System Tricalcium Phosphate-anorthite-silica,* by P. D. S. St. Pierre. (Offset).
13: *Developments of the Port Radium Leaching Process for the Recovery of Uranium.* (Offset).
14: *Measurement of Thorium in Ores by the Thorium Emanation Method,* by J. B. Zimmerman and J. A. F. Bouvier. (Offset).

Memorandum Series:

No. 96: *Determination of Uranium in Ores by Field Analysis*, by F. E. Senftle, C. McMahon, and G. G. Eichholz, (1951, Revised 1955). (Offset).

108: *Notes on Antimony Deposits and Occurrences in Canada*, by W. R. McClelland, (1950.) (Reprint). (Offset).

115: *Radioassay of Uranium Ores with the Geiger Type Equilibrium Counter*, by R. D. Wilmot and C. McMahon, (1951). (Reprint). (Offset).

129: *Durability of Aggregates in Concrete Mixes*, by R. Picher. (Offset).

130: *Nickel in Canada*, by W. R. *McClelland*. (Offset).

131: *Gasoline Survey for Summer 1955*, by P. B. Seely, A. Yates, and R. G. Draper. (Offset).

Articles published in scientific and technical journals:

Technical Advances in Milling and Process Metallurgy in Canada During 1955, by L. E. Djingheuzian. Can. Mining J., vol. 77, No. 2, 1956.

Metallurgical Developments in the Recovery of Some of the Less Common Metals in Canada, by L. E. Djingheuzian. *Symposium on the Extraction Metallurgy of Some of the Less Common Metals*, Proc. Inst. Min. Met. (London), March 1956.

The Distillation of Metals, by R. R. Rogers, V. E. Viens, and G. V. Sirianni. Chem. in Can., vol. 8, No. 3, 1956.

Metal Corrosion and Protection, Part I, by R. R. Rogers. Chem. in Can., vol. 7, No. 3, 1955.

Metal Corrosion and Protection, Part II, by R. R. Rogers. Chem. in Can., vol. 7, No. 5, 1955.

The Constitution of Bone China, Part II, Reactions in Bone China Bodies, by P. D. S. St. Pierre. J. Am. Ceram. Soc., vol. 38 (6), 1955.

The Preparation of Dicalcium Phosphate Dihydrate and Calcium Pyrophosphate, by P. D. S. St. Pierre. J. Am. Chem. Soc., vol. 77, No. 8, 1955.

A New Centrifuge Tube for Mineral Separation, by E. H. Nickel. Am. Mineralogist, vol. 5, 1955.

The Distribution of Major and Minor Elements Among Some Co-existing Ferromagnesian Silicates, by E. H. Nickel. Am. Mineralogist, vol. 5, 1955.

Protective Coatings Fight Corrosion, by R. R. Rogers. Design Eng., vol. 1, No. 5, 1955.

Slip Casting Thorium Dioxide, by P. D. S. St. Pierre. Bull. Am. Ceram. Soc., vol. 35, No. 7, 1955.

The Determination of Hydrogen Chloride in Titanium Tetrachloride, by T. R. Ingraham. Can. J. Chem., vol. 33, 1955.

Refining Bismuth by Distillation and Chlorination, by R. R. Rogers and R. A. Campbell. Trans. Can. Inst. Min. Met., vol. 68, 1955.

The Transformation of White to Grey Tin, by R. R. Rogers and J. F. Fydell. Chem. in Can., vol. 7, No. 12, 1955.

Chemists Join Metallurgists in Ore Dressing Research, by K. W. Downes. The Northern Miner, December 8, 1955.

Determination of Uranium in Uranium Concentrates, Use of Ethyl Acetate, by R. J. Guest and J. B. Zimmerman. Anal. Chem., vol. 27, June, 1955.

A Study of Contact Time in Pilot Plant Agitators, Using Radioactive Tracers, by J. C. Turgeon, Trans. Can. Inst. Min. Met., vol. 49, January, 1956.

A Transistorized High-Voltage Power Supply, (Divisional report TR-125/54), reprinted by "Ra-Det" (a restricted technical periodical of the U.S. Atomic Energy Commission), by G. E. Alexander.

A Correlation of Data Obtained from Tests on Refractory Insulating Materials, by J. G. Brady and S. Matthews, Can. Ceram. Soc., February, 1955.

Sampling, Sizing, Preparation and Storage of Coal, by J. Visman. Western Can. Coal Rev., vol. 39, No. 9, 1955.

Burning of Coal—Combustion Characteristics and Combustion Equipment, by E. R. Mitchell. Western Can. Coal Rev., vol. 39, No. 7-8, 1955.

Factors of Variability of the A.S.T.M. D-441-55 Tumbler Test Applied to Coal Briquettes, by R. P. Charbonnier and C. F. J. Rozenhart. Proc. International Briquetting Assoc. (Fourth Biennial Briquetting Conference), September 1-3, 1955, Appendix.

Reliability of Komarek-Greaves Compression Strength Test for Coal Briquettes, by R. P. Charbonnier and C. F. J. Rozenhart. Proc. International Briquetting Assoc. (Fourth Biennial Briquetting Conference), September 1-3, 1955.

The Fuels Division, by D. S. Montgomery. Can. Oil and Gas Ind., vol. 9, No. 1, 1956.

Tests on the Binomial Theory for Heterogeneous Coals, by J. Visman. Symposium on Coal Sampling, 57th Annual Meeting, A.S.T.M. 1954.

Iron Ore in Canada: A Symposium: Smelting of Iron Ore, by S. L. Gertsman. Bull. Can. Inst. Min. Met., vol. 48, No. 516, 1955.

Some Observations on Sparked Craters in Spectrographic Micro-Volume Analysis, by J. K. Hurwitz.* Spectrochim. Acta, vol. 7, 1955.

Calibration of Photographic Emulsions for Quantitative Autoradiography, by J. K. Hurwitz. Rev. Sci. Instr., vol. 26, No. 5, 1955.

An Evaluation of the Recovery Theory of Creep, by H. H. Bleakney.* Can. J. Technol. vol. 33, 1955.

The Effects of Trace Amounts of Tin, Lead and Antimony on the Annealing of Blackheart Malleable Iron, by R. C. Shnay, J. E. Wilson, and J. E. Rehder. Trans. Am. Foundrymen's Soc., vol. 63, 1955.

Ladle Desulphurization of Grey Iron, by D. E. Parsons and S. L. Gertsman. Am. Foundryman, vol. 27, No. 6, 1955.

The Feeding Requirements of Nodular Iron Castings, by R. C. Shnay. Can. Metals, vol. 18, No. 6, 1955.

The Risering of Nodular Iron. Part II; The Effect of Silicon Content on Feeding Distance, by R. C. Shnay and S. L. Gertsman. Trans. Am. Foundrymen's Soc., vol. 63, 1955.

Discussion by F. Weinberg of the paper *"Conditions of Dendritic Growth in Alloys",* by W. Morris, W. A. Tiller, J. W. Rutter and W. C. Winegard. Trans. Am. Soc. Metals, vol. 47, 1955.

Experimental Production of Pig Iron and Steel from Cominco Iron Concentrates, by B. G. Hunt, E. J. Kwasney, W. P. Campbell, and S. L. Gertsman.* Bull. Can. Inst. Min. Met., vol. 48, No. 517, 1955: Trans. Can. Inst. Min. Met., vol. 58, 1955.

Mechanical-Metallurgical Improvements in Drill Steel, by T. W. Wlodek.* Bull. Can. Inst. Min. Met., vol. 48, No. 514, 1955: Trans. Can. Inst. Min. Met., vol. 58, 1955.

Simplification of a Molten Zone Refining Formula, by K. Milliken.* J. Metals, vol. 7, No. 7, 1955.

A Method of Measurement of Stress Changes During Mining Operations, by J. C. Buchanan, F. W. Marsh and R. C. A. Thurston.* Can. Mining J., vol. 76, 1955.

Short-Time Elevated Temperature Properties of Three Copper-Base Casting Alloys, by J. O. Edwards. Trans. Am. Foundrymen's Soc., vol. 63, 1955.

Discussion by R. C. Shnay of the paper *"Slag-Metal-Graphite Reactions and the Activity of Silica in Lime-Alumina-Silica Slags".* J. Metals, vol. 7, 1955.

Major Trends and Developments in the Canadian Steel Foundry Industry in the Past Decade, by S. L. Gertsman. Can. Metals, vol. 18, 1955.

Iron Ore in Canada: A Symposium, Geographic and Economic Aspects, by W. Keith Buck. Bull. Can. Inst. Min. Met., vol. 48, No. 516, 1955.

Zirconium, by R. J. Jones. The Northern Miner, March 3, 1955.

Zinc in Canada, by R. E. Neelands. La Produccion Minero Metalurgica Mundial en el Ano 1954, Madrid, Spain.

Aluminum in Canada, by H. A. Graves. La Produccion Minero Metalurgica Mundial en el Ano 1954, Madrid, Spain.

Iron Ore in Canada, by W. Keith Buck. La Produccion Minero Metalurgica Mundial en el Ano 1954, Madrid, Spain.

A Decade of Canadian Mineral Development, 1945-1954, by W. R. McClelland. La Produccion Minero Metalurgica Mundial en el Ano 1954, Madrid, Spain.

Chemicals Mighty Valuable Mine By-Products, by W. R. McClelland. The Northern Miner, Annual Review Number, December 8, 1955.

Those Billions of Tons of Low Grade Iron, by W. Keith Buck. The Northern Miner, Annual Review Number, December 8, 1955.

Refining in Canada—Pipeline Link, by R. B. Toombs. Can. Oil and Gas Ind., vol. 8, No. 11, 1955.

A Decade of Progress in Canadian Mining (1945-1954), Part II, by H. A. Graves. Trans. Inst. Min. Met. (London), vol. 65, Part 4, 1955-56.

* Reprints available.

French Translations

845 *The Canadian Mineral Industry in 1952.*
62 Preliminary Mineral Reviews.

Dominion Observatories

Dominion Observatory, Ottawa

Vol. XIV, No. 15:

Bibliography of Seismology, January to June, 1954, by W. E. T. Smith.

Vol. XV, No. 4:

The Ottawa Photographic Zenith Telescope; Method and Formulæ Used in PZT Plate Measurement; A Program Machine for Automatic Operation of the Ottawa PZT, by M. M. Thomson, R. W. Tanner and V. E. Hollinsworth.

Vol. XV, No. 5:

A Projection Type Measuring Engine for Photographic Zenith Telescope Plates, by M. M. Thomson.

Vol. XVI, No. 13:

Canadian West Coast Earthquakes, 1953, by W. G. Milne.

Vol. XVI, No. 14:

Charts for Measuring Azimuth and Distance and for Tracing Seismic Rays through the Earth, by P. L. Willmore and J. H. Hodgson.

Vol. XVIII, No. 1:

Gravity Measurements over the Cumberland Basin in Nova Scotia, by G. D. Garland. (Reprint).

Vol. XVIII, No. 2:

Gravity in the Sudbury Basin and Vicinity, by A. H. Miller and M. J. S. Innes.

Vol. XVIII, No. 3:

Canadian West Coast Earthquakes, 1954, by W. G. Milne.

Articles published in scientific and technical journals (Reprints available as Contributions of the Dominion Observatory).

Robert Meldrum Stewart, by M. S. Burland. J. Roy. Astron. Soc. Can. vol XLIX, No. 2, 1955.

General Statistical Hydro-Dynamics in Porous Media, by A. E. Scheidegger. Geofis. pura e appl., vol. 30, pp. 17-26, 1955. (Contribution Vol. 1, No. 15).

A Determination of the Differences in Gravity between the National Physical Laboratory, Teddington, the Dominion Observatory, Ottawa, and the National Bureau of Standards, Washington, by G. D. Garland and A. H. Cook. Proc. Roy. Soc. (London), A, vol. 229, 1955. (Contribution Vol. 1, No. 16).

Direction of Faulting in Pacific Earthquakes, by J. H. Hodgson. Geofis. pura e appl., vol. 32, pp. 31-42, 1955. (Contribution Vol. 1, No. 18).

Heat Flow Measurements in Permafrost at Resolute Bay, N.W.T., by A. D. Misener, P. C. Bremner and J. H. Hodgson. J. Roy. Astron. Soc. Can., vol. L, pp. 14-24, 1956. (Contribution Vol. 1, No. 19).

Gravity Measurements in North America with the Cambridge Pendulum Apparatus, Part II, by G. D. Garland. Proc. Roy. Soc. (London), A, vol. 233, pp. 203-213, 1955. (Contribution Vol. 1, No. 20).

The Physics of Orogenesis in the Light of New Seismological Evidence, by A. E. Scheidegger. Trans. Roy. Soc. Can., vol. XLIX, sec. IV, pp. 65-93, 1955. (Contribution Vol. 1, No. 21).

Meteor Echo Durations and Visual Magnitudes, by P. M. Millman and D. W. R. McKinley. Can. J. Phys. 34:50-61, 1956. (Contribution Vol. 2, No. 20).

Some Heat Measurements in West Indian Soufrières, by G. R. Robson and P. L. Willmore. Bull. Volcanologique, Assoc. Volcan., Internat. Union Geod. Geophys., Ser. II, tome XVII, 1955. (Reprint No. 47)

Astrophysical Observatory, Victoria, B.C.

Vol. X, No. 6:

A Spectrographic Study of Eta Aquilæ and Delta Cephei, by T. S. Jacobsen.

Vol. X, No. 7:

On the Use of the Hydrogen Lines as Absolute Magnitude Criteria in the O Stars, by Anne B. Underhill.

Vol. X, No. 8:

An Investigation of the Strength of the Interstellar Absorption Feature at λ 4430 in the Spectra of O Stars, by Anne B. Underhill.

Vol. X, No. 10:

Spectrographic Orbital Elements for H.D. 110854, by E. H. Richardson and A. McKellar.

Articles published in scientific and technical journals (Reprints available as Contributions of the Dominion Astrophysical Observatory).

On the Development of the FeI Chromospheric Lines during the 1951 Eclipse of 31 Cygni, by Anne B. Underhill. Monthly Notices Roy. Astron. Soc., vol. 114, No. 5, 1954. (Contribution No. 37).

Relative Spectral Gradients of Several Cool Carbon Stars in the Blue and Violet Regions, by A. McKellar and E. H. Richardson. Mem. Soc. Roy. Sci. Liège, 4th Ser., tome XV, pp. 256-275, 1954. (Contribution No. 39).

Pre-Eclipse Observations of ε Aurigae, by K. C. Wright. J. Roy. Astron. Soc. Can., XLIX, pp. 221-230, 1955. (Contribution No. 46).

Geographical Branch

Memoir 3: *Geographical Discovery and Exploration in the Queen Elizabeth Islands,* by Andrew Taylor.

Bibliographical Series No. 14: *Selected Bibliography of Canadian Geography with imprint 1953.* (Offset).

Bibliographical Series No. 15. *Selected Bibliography of Canadian Geography with imprint 1954.* (Offset).

Geographical Bulletin No. 7: (*Terrain Conditions in the Central Canadian Arctic,* by J. Brian Bird. *Physical Characteristics of the Ungava Area,* by R. H. Drinnan and L. Prior. *Rural Settlement and Land Use in the New Glasgow Region,* by N. L. Nicholson. *The Hinterlands of Saint John,* by Marion H. Matheson).