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ANNUAL REPORT 1955

FISCAL YEAR ENDED MARCH 31

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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ANNUAL REPORT

for the

fiscal year

1954-55

DEPARTMENT OF MINES
AND TECHNICAL SURVEYS

OTTAWA

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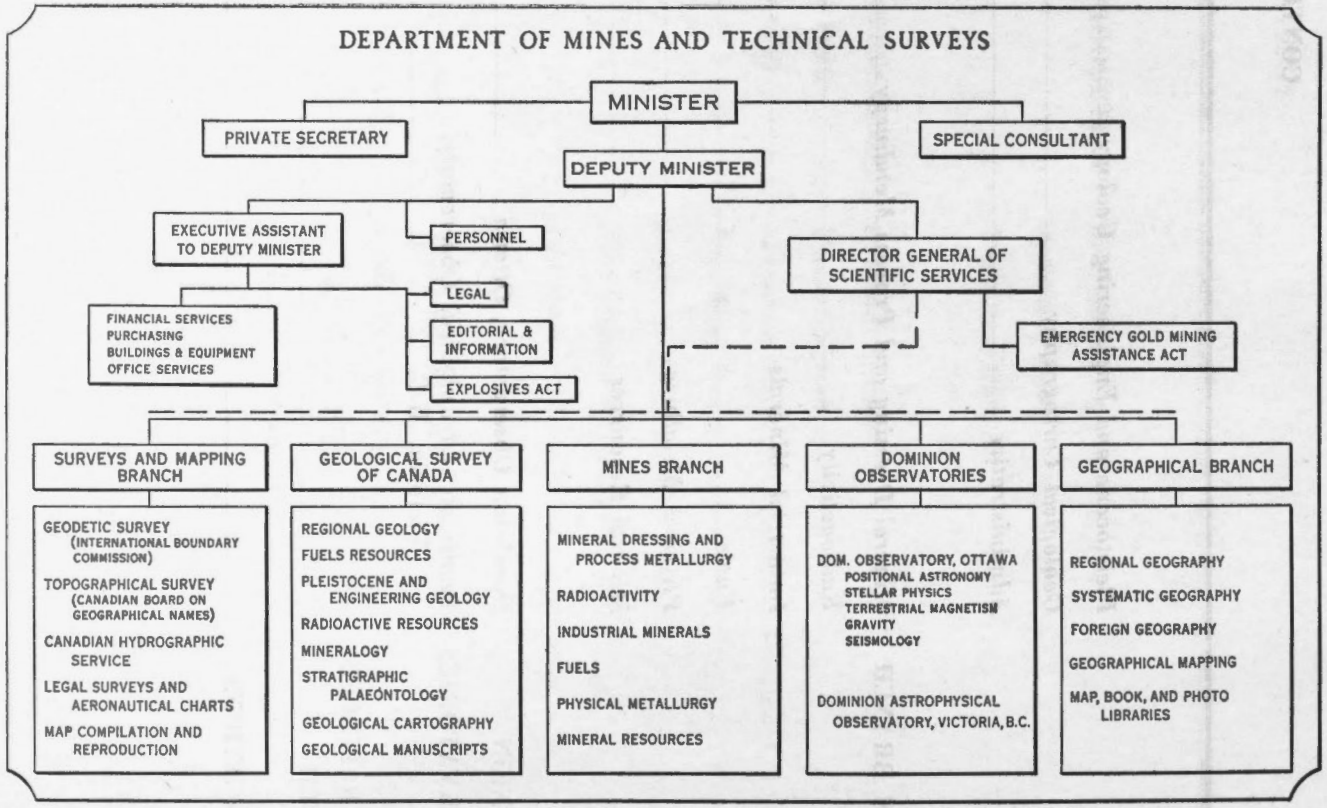
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
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SPECIAL CONSULTANT
DEPUTY MINISTER
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GEOLOGICAL SURVEY OF CANADA
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POSITIONAL ASTRONOMY
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SEISMOLOGY
DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.
REGIONAL GEOGRAPHY
SYSTEMATIC GEOGRAPHY
FOREIGN GEOGRAPHY
GEOGRAPHICAL MAPPING
MAP, BOOK, AND PHOTO LIBRARIES

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, 1955.

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, 1955.

Your obedient servant,

G. S. HUME,
Acting Deputy Minister.

INTRODUCTION

The Mineral Industry

Mineral development activity reached a record level in Canada in 1954, bringing in its wake new highs in volume and value of production and contributing greatly to the outstanding growth under way in the Canadian mineral industry. Of special significance during 1954 were: the marked extension in iron ore and nickel production facilities; the steady development of the uranium industry; the progress realized in proving up additional reserves of crude petroleum in western Canada, and the discovery of several new sources of base metal wealth.

Production in 1954 was valued at $1,454,196,460, a nine per cent increase over 1953 and the tenth consecutive annual peak in the value of mineral output. Each of the mineral groups shared in the gain. Metals advanced from $708,850,758 in 1953 to $763,428,741, fuels from $314,181,168 to $354,756,704, other non-metallics from $126,039,359 to $136,625,426, and structural materials from $187,202,218 to $199,385,593. Crude petroleum recorded the greatest gain, advancing $45,000,000 to $245,995,500. Copper was next with an increase of $23,000,000 followed by nickel at $20,000,000, lead $9,000,000, asbestos $7,000,000 and gold $6,000,000. Zinc and coal, however, each showed a decline of $7,000,000.

All provinces and territories showed increases in value of mineral output. Ontario, the major producing province, recorded an increase of 4·38 per cent over 1953 to $484,992,796. Alberta with an output valued at $281,461,638 moved into second place replacing Quebec at $275,140,830. British Columbia ranked fourth with an output valued at $161,309,312.

Exports of primary metals and minerals increased four per cent in value over 1953 to $803,000,000 and accounted for 21 per cent of Canada's total export sales which were valued at $3,900,000,000 in 1954. The proposed tariffs on Canadian sales of lead and zinc to United States failed to materialize.

Exports of the four principal non-ferrous base metals in all forms, which continued to go mainly to United States, were valued at $416,258,228 compared with $382,807,355 in 1953. Exports of refined copper increased 18 per cent to 156,000 tons; of refined nickel 15 per cent to 91,000 tons; of refined lead 12 per cent to 116,000 tons; and of refined zinc 31 per cent to 206,000 tons. United Kingdom markets absorbed 51 per cent more copper than in 1953, 9 per cent more lead and 87 per cent more refined zinc while United States bought 14 per cent more nickel and 20 per cent more lead but 19 per cent less copper and 3 per cent less zinc.

Base metal prices improved markedly during 1954. Lead rose from 12·75 cents at the beginning of the year to 14·25 cents at the end of the year. Zinc increased from 11·10 cents to 12·85 cents at the end of 1954 but decreased 2·75 cents to 11·50 cents before the end of the fiscal year. Copper remained firm throughout 1954 closing the year at 29·03 cents. However, it underwent three price increases during the first quarter of 1955 and closed the fiscal year at 35·375 cents. Nickel was 57 cents until mid-November 1954 when it was increased to 64·50 cents.

An estimated 136,000 persons were employed in the industry during 1954 at salaries and wages totalling $490,000,000 compared with 130,038 persons in 1953 at salaries and wages totalling $453,065,518.

Events in the crude petroleum industry in 1954 served to emphasize the major problem facing the industry—that of providing markets for a rapidly expanding production potential. For the second consecutive year crude petroleum was Canada's leading mineral in point of value with an output of 95,480,100 barrels valued at $245,995,500. Alberta continued to supply over 90 per cent of the production but Manitoba and Saskatchewan showed significant rates of growth, Manitoba tripling its production of 1953 to 2,090,000 barrels. Saskatchewan doubled its production to 5,000,000 barrels.

Almost $1,000,000 a day was spent on oil exploration and development activity in western Canada but geophysical exploration was below the peak levels of the few years previous. No major field discoveries were made in Canada in 1954. The chief development in Alberta was the establishment of the Pembina field discovered in 1953 as a major producing field. In Saskatchewan, the discovery of the Frobisher field gave the southeastern part of the province its first light gravity oil field.

An outstanding development in crude petroleum during 1954 was the great expansion in Canadian reserves of crude petroleum from 1,845,000,000 barrels in 1953 to an estimated 2,500,000,000 barrels. Much of this great increase came from the extension of existing fields in Alberta but Saskatchewan led the provinces in the amount of reserves found in new areas.

At the end of the year western Canada had over 6,000 producing oil wells with a daily potential production of 413,000 barrels, equivalent to almost three-quarters of the Canadian market demand that year. Actual daily production, on the other hand, averaged 263,200 barrels.

Some progress was realized during the year in providing new market outlets for this production. Trans Mountain Oil Pipe Line Company built a 27-mile spur from the British Columbia-Washington border to Ferndale, Washington, to service a new refinery there, and plans were made to extend this line 36 miles southwestward in 1955 to a refinery under construction at Anacortes. Interprovincial Pipe Line Company spent $51,000,000 on the looping of large sections of its line in Canada and United States. An outlet for the medium gravity crude oil from the Fosterton-Cantuar-Success group of fields in Saskatchewan was provided for in the construction of a 153-mile line from Cantuar to the Interprovincial pipe line at Regina from which the oil will be transhipped to St. Paul, Minnesota.

Natural gas reserves in western Canada rose to 16 trillion cubic feet and indications were that these would increase at an annual rate of from 1½ to 2 trillion cubic feet during the next few years. The problem of providing major market outlets for such quantities of gas was very much to the forefront during 1954.

Provision for the marketing of gas from the Peace River area was brought nearer reality in the signing of an agreement in December 1954 by Westcoast Transmission Company Limited with two United States companies, Pacific Northwest Pipe Line Corporation, and El Paso Natural Gas Company. The agreement provided for the daily delivery of 300,000 M cu. ft. of Peace River gas to Pacific Northwest Pipe Line Corporation at Sumas near the British Columbia-Washington border for redistribution in United States. The resultant gas transmission system is expected to cost some $400,000,000 and will link all major populated areas west of the Rocky Mountains in United States and Canada with the gas-producing areas in the western half of the Continent. Approval for the line has yet to be obtained from the United States Government. The original proposal by Westcoast to export gas into the Pacific

northwest states from the Peace River area was turned down in June 1954 by the Federal Power Commission in Washington in favour of the proposal of the Pacific Northwest Pipe Line Corporation.

Financing arrangements for the proposed 2,250-mile natural gas pipe line of Trans-Canada Pipe Lines Limited from Alberta to Toronto and Montreal were still incomplete at the end of 1954. The Board of Transport Commissioners for Canada and the Alberta Government granted the company an extension first to April 30, 1955 and later to October 31, 1955 on the time limit set in which to complete these arrangements.

The pipe line as planned in 1954 is to start at the Alberta-Saskatchewan border east of the town of Princess, Alberta, pass through or in the vicinity of Moose Jaw, Regina, Brandon and Winnipeg, through northern Ontario and from there south to Toronto and east to Montreal. Cost of construction is estimated at well over $300,000,000.

Notable headway was made by the metal mining industry in 1954. An indication of the high level of activity is seen in the amount of new railway construction that was either set under way or completed. In northwestern Ontario, both Canadian National Railways and the Canadian Pacific Railway Company began the construction of lines into the Manitouwadge base metal area. In northern Quebec, the CNR started to build a line from Beattyville near Barraute into the Chibougamau area, and shortly after the close of the fiscal year, announced plans to start on the construction of a line to link these areas with St. Felicien on Lake St. John. Meanwhile, the 360-mile railway from Seven Islands on the St. Lawrence River into the Iron Ore Company of Canada property at Schefferville in New Quebec-Labrador was completed as was the 48-mile line in British Columbia connecting the new aluminum centre of Kitimat, 400 miles north of Vancouver, to the main line of the CNR.

Developments in uranium mining gave rise to the forecast by the President of Atomic Energy of Canada Limited in a recent address that, by the end of 1957, uranium production in Canada will be more than 12 times as great as at the end of World War 2 and that the annual gross income from the production will then be about $100,000,000.

The disclosure by diamond drilling of very large tonnages of relatively low grade uranium ore in the Blind River district of northern Ontario gained wide prominence during 1954 and plans for large scale production were completed by Pronto Uranium Mines Limited and Algom Uranium Mines Limited, the two major operators in the field. Pronto had reportedly outlined an orebody with a gross value of more than $70,000,000 and had negotiated a contract for the sale of precipitates to the value of $55,000,000. By the end of the fiscal year the company was well on its way to becoming the first uranium producer in the area with production at an initial capacity of 1,000 tons a day to start in September 1955. Algom's two properties, Quirke Lake and Nordic Lake, are said to be valued at $300,000,000. Early in 1955 the company completed financing arrangements and negotiations for the sale of concentrates valued at $206,910,000. It plans to bring each property into production at a daily rate of 3,000 tons, the Quirke Lake in mid-1956 and the Nordic by early 1957. Shaft sinking is under way at both properties, and construction of a permanent mill was started on April 1, 1955 at the Quirke Lake property.

In the Beaverlodge area of northern Saskatchewan, the crown-owned Ace-Fay plant was enlarged to 700 tons daily to handle custom ore which was shipped to it for the first time during 1954. Gunnar Mines Limited was up to

schedule in its preparations for production by October 1955 at a daily rate of 1,250 tons. Further drilling increased the gross estimated value of the deposit to $130,000,000.

Meanwhile, regular production of uranium concentrates was maintained at the Eldorado mine at Port Radium in Northwest Territories and extensive modernization was carried out at the company's refinery at Port Hope in southern Ontario to increase uranium recovery.

Several important events took place in the iron ore industry which, together with developments already under way at the beginning of the year, point to a great expansion in Canada's output of iron ore by 1960. An initial production of 2,000,000 tons was realized during the year from the Iron Ore Company of Canada project in New Quebec-Labrador. This served to offset a decline in output from Ontario and Newfoundland Island, and led to a new high of 7,280,000 tons in the Canadian output of iron ore. Iron Ore Company of Canada hopes to produce 6,000,000 tons of iron ore from its New Quebec-Labrador properties in 1955, 10,000,000 tons by 1957, and eventually to reach the 20,000,000-ton goal upon the completion of the St. Lawrence Seaway.

In eastern Ontario, Marmoraton Mining Company Limited at the end of the fiscal year was on the threshold of production from its orebody near Marmora, from which it had completed stripping the 100-foot capping of limestone. Production which is expected to average 500,000 tons of high grade magnetic pellets annually will be shipped by boat from nearby Picton to the parent company's steel mills near Buffalo. At Bristol, 40 miles northwest of Ottawa, Steel Company of Canada Limited and Pickhands Mather and Company, Cleveland, U.S.A., are planning to spend $10,000,000 to bring an old iron mine into production. Output at the rate of 500,000 tons of high grade iron ore pellets annually is expected to start late in 1956. In northwestern Ontario, Caland Ore Company Limited planned to dredge the northeastern arm of Steep Rock Lake for open pit mining of the orebody beneath. Production is expected to start in about five years' time and will eventually amount to 3,000,000 tons annually. All told, output from the rich Steep Rock area will be some 9,000,000 tons annually by 1960.

Two new sources of iron ore appeared on the mineral scene during 1954. Late in the year, Noranda Mines Limited began the production of high grade iron oxide sinter from pyrite at its new plant at Port Robinson near Welland in southern Ontario. Production is expected to amount to 75,000 tons a year. In northern Ontario, The International Nickel Company of Canada Limited set to work on its plans to produce high grade iron ore from the treatment of pyrrhotite tailings at a new $16,000,000 plant to be constructed near Copper Cliff. Construction of the first unit of the new plant, which is to have an eventual production of 1,000,000 tons of high grade iron ore annually, is well advanced. The company expects to ship its first iron ore to the steel industry before the end of 1955. The first unit will handle 1,000 tons daily.

Canada's output of nickel recorded an all time high of 160,000 tons in 1954. The major development in the industry was the commencement of production from the Lynn Lake property of Sherritt Gordon Mines Limited in northern Manitoba. The first shipment of concentrates was made from the property early in the year to the company's new refinery at Fort Saskatchewan, Alberta, which produced its first nickel in mid-summer. Output from the Lynn Lake property will amount to 8,500 tons of nickel yearly.

In the Sudbury area, International Nickel continued its extensive program of expansion, which during the past decade, has involved an expenditure of $150,000,000. During 1954 the company set aside $30,000,000 for expansion, including $16,000,000 for the new pyrrhotite plant. During 1954,

International Nickel also began its first Canadian production of electrolytic cobalt at its Port Colborne refinery. The cobalt is to be of high purity so important in the manufacture of alloys. The company also announced plans to sink a 1,300-foot shaft at its Mystery Lake property in northern Manitoba, where it has done active exploration for several years.

Falconbridge Nickel Mines Limited made marked progress in carrying out its $55,000,000 expansion program designed to increase the company's production of nickel to 27,500 tons annually by 1960. The program includes the bringing in of six new mines, three of which, the Hardy in Levack township, the East Falconbridge in Falconbridge township and the Mount Nickel in Blezard township, began production in 1954. The company also began the expansion of its refinery facilities in Kristiansand in Norway to a capacity of 22,500 tons of nickel annually.

Canada's copper production rose to 299,900 tons in 1954, the highest since 1942, under the strengthening influence of a steady demand and a firm price for copper. Each of the producing provinces recorded increases in output, the greatest gains being made by Ontario and Quebec. In Ontario, the steady expansion under way in the nickel industry led to a seven per cent increase in copper output over 1953 to 140,000 tons. In Quebec, production reached a new high of 82,500 tons in 1954 despite a work stoppage at Noranda Mines Limited from mid-August 1953 to mid-February 1954. Contributing to the higher output in the province was Opemiska Copper Mines (Quebec) Limited in the Chibougamau area which had its first full year of operation during 1954. Manitoba's output increased 32 per cent over 1953 because of the addition of new production from the Lynn Lake mine of Sherritt Gordon Mines Limited. The company shipped its copper concentrates to Noranda Mines Limited for treatment.

Considerable development activity was carried out during 1954 at several promising copper properties. At the end of the year two companies in Quebec, Gaspé Copper Mines Limited in the Gaspé peninsula and Campbell Chibougamau Mines Limited in the Chibougamau area, neared production. Interest continued high in the copper-zinc discovery of Geco Mines Limited in the Manitouwadge area of northwestern Ontario, which shows every indication of becoming a major copper producer. The company plans to enter production at a rate of over 3,000 tons by the spring of 1957. In New Quebec much interest is being shown in what may prove to be a promising copper belt in the Gerido Lake area in the Ungava Bay district.

The steady improvement in the demand for and the price of lead resulted in 1954 in the production of 221,000 tons, the highest since 1943. Contributing to the greater output was the completion of the extensive modernization of the Trail smelter set under way a few years ago by The Consolidated Mining and Smelting Company of Canada Limited. Production in British Columbia, by far the leading producer, increased 17 per cent over 1953 to 174,000 tons. Elsewhere, in Canada, new output came from New Brunswick where Keymet Mines Limited brought its lead-zinc property, 15 miles north of Bathurst, into production in October 1954.

The lowered rate of steel mill activity and the resultant slackening in the demand for zinc were reflected in a 7 per cent decrease in Canadian output below 1953, to 374,000 tons in 1954. The decrease was mainly in British Columbia where Consolidated Mining and Smelting reduced its output of refined zinc by about 20 per cent. In eastern Canada, Brunswick Mining and Smelting Corporation Limited built a 50-ton pilot mill near its Austin Brook zinc-lead-pyrite deposit, 17 miles southwest of Bathurst, for

the treatment of development ore. Late in the year The American Metal Company Limited announced the discovery of several extensive zinc-lead-copper-pyrite orebodies on its Little River property 30 miles northwest of Newcastle.

Canadian gold production increased five per cent over 1953 to 4,280,000 ounces mainly because of the settlement early in 1954 of strikes which had curtailed production in northern Ontario and Quebec for several months in 1953. No new gold mines were brought into production in 1954. The average Mint price of gold was $34.11 the lowest since 1933, because of the high premium on the Canadian dollar. Early in 1955 the Government announced, that subject to the approval of Parliament, cost-aid payments under the Emergency Gold Mining Assistance Act would be extended at a reduced rate to the end of 1956.

Coal production dropped a million tons to 14,825,000 tons in 1954, the fourth successive decrease since the high of 19,139,000 tons in 1950. Most of the loss in output was in Alberta where production decreased 18 per cent below 1953 to 4,871,000 tons.

Industrial minerals continued in strong demand in 1954 particularly in the construction and chemical industries leading to an increase of $23,000,000 in the value of their production to $336,011,000. Asbestos recorded the most valuable output at $93,080,000. Four new mills came into production: that of Canadian Johns-Manville Company Limited at its Jeffrey mine at Asbestos, Quebec; the 5,000-ton mill of Asbestos Corporation Limited at its new Normandie mine near Vimy, and the 4,000-ton mill of Johnson's Asbestos Company at Black Lake, all in the Eastern Townships of Quebec, and the new 500-ton mill of Cassiar Asbestos Corporation Limited in northern British Columbia. In all $70,000,000 is being spent on the expansion of productive facilities at properties in the Eastern Townships.

With the completion of the St. Lawrence Cement Company's 1,500,000-barrel plant at Villeneuve near Quebec City in 1954, Canada's annual cement productive capacity exceeded the 25,000,000-barrel mark. Production in 1954 amounted to 22,552,000 barrels. Three companies plan to start on the construction of plants during 1955 which will raise overall productive capacity a further 2,375,000 barrels annually. Huge quantities of cement will be needed for the St. Lawrence Seaway project which was set under way during 1954.

Activity in the gypsum industry was at a high level, production in 1954 being a record 3,957,000 tons and several important developments promised a considerable expansion in output in the near future. These included the expenditure of $6,000,000 by National Gypsum Company of Buffalo, N.Y. to develop a large gypsum deposit at Dutch Settlement, north of Halifax in Nova Scotia, for an eventual annual production of 1,000,000 tons. Output is to be exported to the company's plants along the Atlantic coast as far south as Savannah, Georgia.

Important developments took place in several other segments of the industry. Canadian Rock Salt Company Limited neared completion of a 1,100-foot shaft on its property at Ojibway near Windsor, Ontario. Production from the deposit is expected in 1955 on a large scale. The product, pure mined rock salt, is much in demand in central Canada and United States. A promising potash industry continued to take shape in Saskatchewan where one company had sunk a shaft to about 1,000 feet on its property near Unity and two other companies continued the active exploration of their holdings elsewhere in the province. Production of sodium sulphate in Saskatchewan, Canada's only producer, increased $1,000,000 over 1953 in value to $2,548,000 owing mainly to a greater demand for it in the kraft paper and glass industries and for making detergents. Canada's capacity for sulphur production was further

increased during 1954 with the entry into production of Noranda's new plant at Port Robinson, Ontario, with an annual capacity of 18,000 tons of elemental sulphur and 36,000 tons of sulphur in the form of sulphur dioxide. Shell Oil Company extended its sulphur plant at Jumping Pound in Alberta to produce 11,000 tons of sulphur annually over and above its current output of 11,000 tons annually. The new production is to meet the sulphur requirements of Gunnar Mines for use in the treatment of uranium ore from its property in the Beaverlodge area.

Activities of the Department

In view of the mushroom-like growth of the Canadian mineral industry and the rapidity with which areas off the beaten trail are entering the mineral spotlight, the department in 1954 continued to press forward the topographical and geological mapping of Canada's great expanses. Events during the year underlined the fact that many of the slow, laborious methods of surveying and mapping must be replaced to allow the department to continue in its primary role of assisting the industry to develop. On the one hand, for instance, there is the increasing interest in Canada's large northern regions and on the other, the fact that, despite more than a century of effort, about two-thirds of the country's 3·6 million square miles of land area still lacks even reconnaissance geological maps.

To this end the department carried out its second large helicopter-equipped, geological mapping project in Northwest Territories and mapped 67,000 square miles of territory in northern Keewatin district. Plans were made for two similar projects in the 1955 field season: Operation Thelon to be carried out in the Thelon River area of the District of Mackenzie and Operation Franklin in the Queen Elizabeth Islands to the north. With the completion of Operation Thelon, the department will have, within the space of four years, assessed for the industry and the interested public, the prospects for minerals in 191,000 square miles of territory north of the 60th parallel of latitude and between Hudson Bay and Great Slave Lake. Such geological mapping by helicopter on a large scale, by covering in one year what ordinarily would take upwards of 25 years by conventional methods, has made it possible to foresee the completion of the geological reconnaissance of Canada's vast northern areas. Moreover, this method permits satisfactory mapping at a much lower cost per square mile and at much greater pace per geologist employed. Experience gained from the first such operation in 1952 has already led to a considerable reduction in overall costs.

During 1954 the department had 144 mapping parties in the field comprising 87 geological parties, 18 geodetic, 29 topographic and 10 legal surveys. Charting operations were carried out by nine ships and nine launches.

It continued to experiment with marked success with the use of helicopters for geological mapping in almost inaccessible mountainous areas, and it initiated the use of helicopters for such mapping over heavily timbered areas. It also continued to use the helicopter for the topographical mapping of large blocks of territory in the Far North, permitting a single field party to cover many times the work done by older methods.

The department continued to make use of shoran trilateration, the electronic measurement of distance, in establishing survey control for aerial mapping in unmapped areas. This method permits the coverage of large areas in a short time as well as the extension of control into areas, which because of their remoteness and isolation, would not otherwise be covered.

Through the use of shoran trilateration the department has in a few years extended a triangulation net for accurate mapping from known positions in midwestern Canada, north and west to the eastern Yukon boundary, across northern Canada and Baffin Island, south through Labrador, New Quebec and northern Ontario. Several more field seasons will be required to complete this work.

In its charting of coastal and inland waters the department is replacing older techniques with newer sonic methods and has started to fix points by means of electronics rather than by direct shore observations. Developments in the Far North where existing provisional small scale charts covering Arctic waters lack, to a large extent, necessary soundings and tidal and current information, have emphasized the need for a new modern ship specially designed for Arctic work. Construction of this type of vessel has been started. It will cost about $4,000,000 and is expected to be ready for operation in 1956.

The use of the helicopter and of new techniques has brought about a decided increase in the acquisition of data for map compilation and in the near future the department will need to expand its map production facilities.

In line with the high level of activity in uranium, particularly in the Beaverlodge area of northern Saskatchewan and in the Blind River and Bancroft areas in Ontario, the department in 1954 gave special attention to assisting private uranium properties into production. Hitherto, its efforts were directed mainly to aiding Crown-owned Eldorado Mining and Refining Limited to increase production. During 1954 it developed treatment methods for two properties in the Blind River area and before the close of the year commenced similar work for companies developing properties in the Bancroft area.

The remarkable headway made by the Canadian non-ferrous base metal industry was reflected in the large number of shipments of these ores received for testing and investigative work. The department also did extensive work on the treatment of low grade manganese ores from Newfoundland and New Brunswick. North American requirements of manganese come almost wholly from overseas markets.

The department initiated the use of automatic voice announcements in its time service to surveyors, aerial navigators, ships at sea, and persons in remote or isolated areas by short wave broadcast. The needs of the general public continued to be served by the daily CBC broadcast of time signals at one p.m. eastern (or daylight) standard time.

Dr. J. W. Watson resigned as director of the Geographical Branch in September 1954 to accept the position of professor of geography at the University of Edinburgh.

Shortly after the close of the fiscal year, tenders were called for the new Mines Branch building intended to house the Branch's chemical laboratories, Radioactivity Division, and administrative staff. Construction is expected to start on this building during the fall of 1955. Plans are well under way for each of the new Geological Survey of Canada and the departmental administrative buildings. The new geophysical laboratories building of the Dominion Observatory was completed on the grounds of the Central Experimental Farm and officially opened by Mr. Prudham on March 30, 1955. It has been occupied by the Terrestrial Magnetism, Gravity, and Solar Physics divisions of the Observatory.

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	$ 18.11	463,913.79
Explosives Act	6,072.71	94,745.69
Mines Branch	32,563.83	2,974,426.37
Geological Survey of Canada	20,987.06	2,201,499.23
Surveys and Mapping Branch	101,175.11	7,431,680.23
Geographical Branch	510.05	267,628.23
Dominion Observatories	2,133.77	674,164.43
General:—		
To provide for payments under the Emergency Gold Mining Assistance Act	.....	15,485,820.60
Payments to Royal Canadian Air Force and Commercial Companies for Air Photography, and to defray the expenses of and the purchase of equipment by the Inter-departmental Committee on Air Surveys	.....	2,297,538.79
Provincial and Territorial Boundary Surveys	.....	48,359.40
Gratuities to families of deceased employees	.....	3,515.00
	$163,460.64	$31,960,291.76

Explosives Division

A revision of Regulations under the Explosives Act was made during the year in preparation for the second consolidation of statutory orders and regulations. The revision was completed and approved by Order in Council P.C. 1954-1801, November 23, 1954 and became effective on December 8, 1954. Amendments made in the Regulations since the last consolidation are now incorporated in the revised Regulations.

Only Explosives Regulations Part VI, which deals with the transportation of explosives by road and by private railway, was changed materially. By this change the maximum load which any vehicle may carry was increased to 10,000 pounds from 4,000 pounds, with the important provision, however, that transportation of loads exceeding 4,000 pounds requires possession of an explosives transportation permit. The change followed representations made chiefly by the mining industry and shippers in isolated areas and will prove particularly beneficial to resources development in remote areas serviced as yet only by road. In the interest of public safety, the regulations have been tightened up. Vehicles with larger loads than 4,000 pounds must be placarded and have two attendants and mixed loads are not permitted. Holders of permits to transport explosives must comply with provincial and municipal requirements governing the transportation of explosives.

Factories

Seventeen explosives factories and one storage depot were licensed in 1954. Inspectors of the Division made 36 inspections of licensed factories.

The factories produced 122,405,443 pounds of commercial explosives in 1954.

Magazines, Registered and Unlicensed Premises

In all, 472 permanent and 888 temporary licences were in force at the end of 1954 compared with 450 permanent and 1,072 temporary licences at the end of 1953. Registered premises decreased from 115 to 106, some being replaced by magazine licences.

Inspectors and deputy inspectors made 1,515 inspections of magazine and 172 inspections of registered premises. There were also 3,631 inspections of unlicensed premises, which include premises where small quantities of blasting explosives are kept for private use. Following a revision of regulations dealers in small arms ammunition are no longer required to keep records of sales and receipts.

Imports

Importation permits issued totalled 823 and covered fireworks, distress signals, nitrocotton for paint and lacquer manufacture, and seismograph explosives for oil exploration.

Accidents

No fatalities involving explosives occurred during 1954 in the manufacture of commercial explosives. A serious injury occurred in a detonator plant. Ten persons were injured slightly in minor explosions and flashes.

Playing or tampering with explosives resulted in death to 3 persons and injuries to 56 others. Fireworks and home-made bombs were the cause of many of these accidents. With reference to the latter the Division enlisted the help of two provincial pharmaceutical associations and an appeal was made through association publications to member druggists to control, voluntarily, the sale of chemicals from which home-made explosives can be made by juveniles.

	Accidents	*Killed*	*Injured*
Mines and quarries	42	5	43
Elsewhere in industry	28	7	29
Playing with detonators	14	0	20
Playing with other explosives	17	1	27
Miscellaneous	6	2	9
Manufacturing	24	0	11
Keeping	1	0	10
	132	15	149

Laboratory

Explosives submitted for authorization are tested and analyzed in the Division's explosives laboratory. Materials of explosive or suspected explosive properties from other government departments are also examined and tested. In all, 477 samples were received and examined in 1954.

Good progress was made in testing the fume classification of explosives in use in metalliferous mines. The project was extended following a meeting between the Division and the explosives manufacturer. When the planned work is completed all explosives in use in underground mining will have been examined and a comprehensive list prepared. Explosives in common use in metal mines are in the first group of fume classification.

Work was continued on investigation of the hazards attending the storage, shipment and use of explosives.

Prosecutions

Prosecutions for infractions of the Explosives Act and Regulations were instituted in 13 cases. Convictions were obtained in 11 of these and fines were imposed. Two cases are still pending. The offences were: improper storage; illegal sale; failing to provide a red flag on a truck while transporting explosives; and storage of explosives in quantities in excess of the licence limit.

SURVEYS AND MAPPING BRANCH

W. H. Miller, Director

Although the introduction of modern techniques and a greater use of modern equipment has increased the output of the branch without an increase in personnel, the demand for maps, charts and surveys, both for development and defence, has increased at such a rate that only the most urgent needs have been met.

The increase in the demand is accounted for by the expansion of the mineral industry and the increased needs due to expanding development and administration requirements. The urgency for new maps, charts and surveys will continue to increase as the resources of the northern parts of Canada are developed.

Reports from each of the divisions follow.

Geodetic Survey of Canada

The Division had 18 parties in the field compared with 19 in the previous fiscal year, the distribution being as follows:

	1954-55	1953-54
Yukon	0	1
Northwest Territories	1	1
British Columbia	1	3
Alberta	5	2
Saskatchewan	0	1
Manitoba	1	0
Ontario	4	4
Quebec	1	2
New Brunswick	1	2
Newfoundland	4	3
	18	19

Several of these parties crossed provincial boundaries in the course of the season's work. One of the Alberta parties in 1954-55, engaged in base line measurement, spent part of the season in Labrador.

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

	1954-55	1953-54
Triangulation, linear miles of network completed	680	530
Shoran trilateration, new stations established	5	17
Precise levelling, linear miles	1212	1017
Base lines measured	3	3
Precise astronomic azimuth determinations	4	3
Precise astronomic position determinations	4	12
Second-order astronomic position determinations	4	2

Shoran

The calibration of shoran equipment was carried out at Winnipeg before and after the season's operations. Five new stations in Ungava were selected and prepared for operations, and were tied in to the existing network by the shoran measurement of about 25 lines. Most of the season's shoran operation

consisted of cooperation with the Army Survey Establishments on shoran-controlled photography. The Geodetic Survey supervised the necessary computations at Ottawa and maintained one man at Goose Bay to be responsible for the indexing and transmission to Ottawa of the observational data.

Triangulation

The precise triangulation networks in Alberta and Ontario were further extended as were the second-order networks in Quebec and Newfoundland.

In Alberta, three parties operated. One continued to select and prepare stations between Smith and Edmonton. This net is now ready for the final measurement of horizontal and vertical angles. Another party measured angles on the net extending easterly from Dawson Creek. An axial length of 235 miles was completed. The third party worked northerly along the Mackenzie Highway, completing an axial length of 90 miles. Reconnaissance and station preparation were projected a short distance beyond the observing.

In addition to this regular summer work a party operated for part of the winter at Primrose Lake in Alberta on a special project undertaken at the request of the Defence Research Board. As no triangulation or shoran stations exist in the immediate vicinity, the work will be based on a local astronomic datum. It was still in progress at the end of the fiscal year.

In Ontario, a party was engaged in the extension of the main first-order net of southern Canada westerly from Lake Nipigon, roughly following a course parallel to the main line of the C.N.R. The observing program was completed on 10 stations and several additional stations were selected and prepared for observation.

In Quebec, the extension, by the establishment of 20 new stations, of the previously surveyed City of Montreal net was undertaken at the request of the Federal Department of Transport. The purpose is the provision of control for surveys between Longueuil and Lake St. Louis in connection with the St. Lawrence Seaway development.

The Romaine River net in Quebec was extended northerly to the 52nd parallel of latitude, the boundary between Quebec and Labrador. The party then moved easterly to Cheeseman Lake, on the boundary, and extended the Natashquan River net northerly into Labrador.

In Newfoundland, two parties operated in Labrador and one on the south coast of the island of Newfoundland. One of the Labrador parties, working along the Hamilton river valley extended the net an axial distance of 100 miles to Goose Bay. The other, which spent the first part of the season on the Romaine River net in Quebec, extended the Natashquan River net northerly and effected a junction with the Hamilton River net. The party on the south coast of Newfoundland closed the 85-mile gap between the previous year's work on the south coast and the previously established primary triangulation in the vicinity of Cape Ray.

Precise Levelling

Levelling parties operated in British Columbia, Manitoba, Ontario, Quebec and New Brunswick. In all, 1,212 miles of levels were run and 551 new bench marks were established.

In British Columbia, the line of levels over the Hart highway, between Dawson Creek and Prince George, was completed. Progress was also made on the Cariboo Road line, from Prince George towards Clinton.

In Manitoba, three lines were completed, from Winnipeg to Souris, from Elm Creek to Hartney Junction, and from Baldur to Holmfield.

In Ontario, 47 miles of levelling were done in the Port Dalhousie-Port Colborne area and lines were completed from Toronto to Goderich and from Listowel to Collingwood. At the request of the Department of Transport, lines of levels required in connection with the St. Lawrence Seaway project were run from Hawkesbury to Cardinal and from Rivière Beaudette, Que., to Cornwall.

In Quebec, lines were run from Longueuil to Rivière Beaudette and from Matapedia to Rimouski. The former was run in conjunction with the line from Rivière Beaudette to Cornwall as one line. The whole line, from Longueuil to Cornwall, was run at the request of the Department of Transport.

In New Brunswick, a line of levels was run from Bathurst to Matapedia. It was run in conjunction with the line from Matapedia to Rimouski, Que., as one line.

Region	Mileage		Bench Marks Established	
	1954–55	1953–54	1954–55	1953–54
British Columbia	205	61	57	35
Alberta	.....	91	.....	44
Manitoba	299	.....	144	.....
Ontario	429	351	220	154
Quebec	193	81	87	38
New Brunswick	86	159	43	77
Nova Scotia	.....	107	.....	32
Newfoundland	.....	139	.....	.....
New York State, U.S.A.	.....	28	.....	3
Total	1,212	1,017	551	383

(NOTE:—Some of this work, including all that in Newfoundland, was re-levelling, and did not require the establishment of new bench marks.)

Mileage of Levelling in Canadian Net to end of March, 1955.

Region	Precise	Secondary	Public Works	Total
Yukon	1,333	26	.....	1,359·0
British Columbia	5,977	52	.....	6,029·0
Northwest Territories	93	.....	.....	93·01
Alberta	4,585	3,799	.....	8,384·0
Saskatchewan	4,203	5,098	.....	9,301·0
Manitoba	3,262	467·7	113	3,842·7
Ontario	8,022	1,376	2,012	11,410·0
Quebec	5,070	1,428·8	1,750	8,248·8
New Brunswick	1,349	.....	403	1,752·0
Nova Scotia	1,023·7	.....	309	1,332·7
Prince Edward Island	284	.....	.....	284·0
Newfoundland	834·8	.....	.....	834·8
Minnesota, U.S.A.	89	.....	.....	89·0
Vermont, U.S.A.	6	.....	.....	6·0
New York, U.S.A.	43	.....	.....	43·0
Total	36,174·5	12,247·5	4,587	53,009·0

Geodetic Astronomy and Base Lines

Astronomic observations were made on Banks Island, Northwest Territories, in Alberta, and in Labrador. Base lines were also measured in Alberta and Labrador.

On Banks Island, four second-order astronomic determinations of latitude and longitude were made to serve as control for mapping and charting. The

officer who did this work was attached to the joint United States-Canadian Beaufort Sea Expedition.

In Alberta, one Laplace point was established to serve as control of "twist" in the primary triangulation and one base line was measured to serve as length control. The establishment of Laplace point involves the precise determination of astronomic latitude, longitude and azimuth. A precise astronomic control point was also established and a base line was measured to serve as the basis of the local triangulation scheme at Primrose Lake, requested by the Defence Research Board.

In Labrador, two Laplace points were established and a base line was measured, all to serve as control for the triangulation.

Mathematical Adjustments and Computations

The final loop closure adjustment of the precise triangulation along the Alaska Highway was completed. The closing error in this loop was about 117 feet. In the final adjustment the previously determined positions at Prince George and Whitehorse were held fixed and the closing error was distributed over the 925 miles of triangulation between these two points.

In all triangulation adjustment the computations must of necessity lag behind the field work, but in all parts of the country the computations have kept pace, as closely as possible, with the field operations.

The computations connected with the five new shoran stations were completed and this small network has been adjusted into the existing framework. Also, in connection with the shoran-controlled photography operation, the Universal Traverse Mercator coordinates of about 3,500 plumb points were computed and turned over to the Army Survey Establishment.

The results of all levelling operations were fitted into the previously adjusted main framework.

Computations in connection with the astronomic and base line observations were completed, except for the Primrose Lake base line, measured in March 1955.

Scientific Work

In the course of the astronomic work in Alberta some experimental observations were carried out as a test of a new method of observing for longitude and azimuth. This new method would allow precise azimuth determination with the same instrument as is used for precise latitude and longitude observations. The results to date are promising.

Modifications of the present methods of triangulation adjustment were investigated and tested. Two papers on this investigation were prepared. One was published in the January, 1955 number of the Canadian Surveyor, and the other was submitted to the American Geophysical Union for publication.

A study was made of the intensity pattern of shoran signals from ground stations, the results of which will appear as part of a publication "Geodetic Application of Shoran", now in press.

The Dominion Geodesist attended, as a delegate from Canada, the tenth general conference of the International Union of Geodesy and Geophysics. He is serving as President of Special Study Group No. 2, which is engaged in the study of the calculation of shoran networks and of long geodesics.

Topographical Survey Division

Emphasis in the field work during the fiscal year was given to basic control, such as long spirit level lines and second-order triangulation, with a consequent decrease in area controlled for immediate mapping.

Close to 200 topographic map sheets were forwarded for publication, an increase of 61 per cent over the previous year. The stress on topographic mapping and some shortage of technical staff resulted in a curtailment of the planimetric and medium scale mapping program.

Two major contributions were made to mapping in the northern areas by the completion of a sound spirit level line via Mackenzie River, between Hay River and the Arctic Ocean, and by a similar level-line from Great Slave Lake, via Hanbury and Thelon rivers, to Baker Lake. Further vertical control was established during the winter by spirit level lines from Île-à-la-Crosse and Lynn Lake, which joined at Stony Rapids and then continued to Lake Athabasca and to Wholdaia Lake.

A helicopter-equipped party completed about 16,800 square miles of topographical control for mapping on a scale of 1:50,000 around the headwaters of the Hamilton River in Labrador and over 6,900 square miles of vertical control in the Seven Islands area in eastern Quebec. Another covered over 45,000 square miles of vertical control for 1:50,000 mapping in the Mackenzie River basin.

A precise plotting instrument was added to the scientific equipment and progress was made in the development of an electronic measuring device, being made under contract, to specifications laid down by the Division.

In continuation of technical training under the Colombo Plan, two officers of the Survey of Pakistan were attached to the Topographical Survey to acquire experience in computation and plotting techniques.

New mapping completed and forwarded for publication covered areas totalling 21 per cent more than that of the previous year. Advance information prints of this new work were much in demand and over 13,200 copies were distributed to federal and provincial authorities and to others interested.

Field Surveys

The 29 parties assigned to field work carried out original surveys for control of mapping from aerial photographs over areas totalling 109,680 square miles.

Topographical detail was plotted for areas totalling 44,790 square miles.

During the winter of 1954-55, four officers completed spirit level lines from Île-à-la-Crosse, Saskatchewan and Lynn Lake, Manitoba to Lake Athabasca, Saskatchewan, and Wholdaia Lake, Northwest Territories. Another measured a base line on the ice on Lake Athabasca and tied the new base to a shoran control station.

One senior officer carried out special investigations in the Arctic Islands; another was in charge of the Mackenzie River helicopter project; and a third supervised the Quebec-Labrador helicopter operation. Field projects carried out during the year are summarized below.

Province	Number of parties	Type of Work	Publication Scale	Area Controlled Square Miles
Northwest Territories...	1	Astronomic Observations.....	.....	.....
	2	Spirit levels.....	.....	1,110 (linear miles)
	1	Triangulation.....	.....	140 (linear miles)
	1	Topographical control.....	1:50,000	1,216
	1°	Topographical control (helicopter).....	1:50,000	4,509
	1°	Vertical control (helicopter)....	1:50,000	39,647
Yukon.....	2	Photo-topographical control....	1:50,000	5,436

Province	Number of parties	Type of Work	Publication Scale	Area Controlled Square Miles
British Columbia	1	Photo-topographical control	1:50,000	2,057
	1[x]	Photo-topographical control	1:50,000	1,445
	1[x]	Photo-topographical control	1:250,000	1,400
	1	Photo-topographical control	1:250,000	5,500
	1	Topographical control	1:250,000	5,966
Alberta	2	Photo-topographical control	1:50,000	2,782
	1	Vertical control	1:50,000	1,116
Saskatchewan	4	Vertical control	1:50,000	4,959
	1[y]	Vertical control	1:50,000	774
	2	Spirit levels (winter traverse)	.....	938 (linear miles)
	1	Base line measurement (on ice)	.....	.....
Manitoba	1[y]	Vertical control	1:50,000	774
	1	Vertical control	1:50,000	2,210
Ontario	1	Topographical control	1:50,000	3,215
Quebec	1	Topographical control	1:50,000	1,484
	1	Spirit levels	.....	290 (linear miles)
Quebec-Labrador	1[z]	Topographical control (helicopter)	1:50,000	16,792
	1[z]	Vertical control (helicopter)	1:50,000	6,922
	1[z]	Triangulation (helicopter)	.....	120 (linear miles)
Newfoundland	1	Topographical control	1:50,000	1,700

° —same party as the other so marked.
x — " " "
y — " " "
z — " " "

Map Plotting From Aerial Photographs

The plotting of planimetric and topographic maps of areas totalling 92,775 square miles was completed. A summary by provinces follows.

Province	Number of Map Sheets	Scale of Publication	Area in Square Miles
1. *Planimetric*			
Yukon	2	1:250,000	7,337
Northwest Territories	1	1:250,000	4,583
British Columbia	1	1:250,000	5,700
Saskatchewan	21	1:50,000	7,061
Manitoba	20	1:50,000	6,846
New Brunswick	2	1:50,000	240

Province		Compilation Scale	Area in Square Miles
*Special Projects**			
Northwest Territories	1	1:18,000	119
	1	1:75,000	70
	15	1"=2 miles	9,535
Saskatchewan	4	1:40,000	875
Manitoba	4	1:1,200	172
New Brunswick	1	1:31,680	25
Grand total of planimetric mapping			42,563

Province	Number of Map Sheets	Publication Scale	Area in Square Miles
2. *Topographic*			
Northwest Territories	5½	1:50,000	1,342
Yukon	8	1:50,000	1,990
British Columbia	8	1:50,000	3,033
Alberta	10	1:50,000	3,389
Ontario	2	1:50,000	836
Quebec	56	1:50,000	17,763
New Brunswick	14	1:50,000	5,245
Newfoundland	46	1:50,000	15,740
		Compilation Scale	
*Special Projects**			
Northwest Territories	1	1:6,000	4
Yukon	1	1:15,840	6
British Columbia	7	1:20,000	594
	2	1:12,000	80
Saskatchewan	9	1:10,000	190
Grand total of topographic mapping			50,212

Special Projects for Army Survey Establishment, Department of National Defence, in northern Quebec, Manitoba and Alberta: (Compilation scale 1:17,500).

	Area in Square Miles
Multiplex plots contoured	5,550
Multiplex plots photogrammetrically controlled	5,570
Total	11,120
3. *Mosaics*	
Northwest Territories	4,760
Yukon	27,360
Alberta	16,847
Ontario	3,532
Quebec	40,230
Total of mosaic mapping	92,729

* For Canadian Hydrographic Service, Geological Survey of Canada, Topographical Survey, Legal Surveys and Aeronautical Charts Division, Department of Northern Affairs and National Resources, and Department of Public Works.

Map Sheets Forwarded for Publication

	1:50,000	1:250,000	Total	Area in Square Miles
Newfoundland	64	.....	64	21,076
Nova Scotia	2	.....	2	178
New Brunswick	23	.....	23	7,794
Quebec	52	.....	52	17,122
Ontario-Quebec	2	.....	2	830
Ontario	1	.....	1	424
Manitoba	6	.....	6	2,302
Saskatchewan	10	.....	10	3,865
Alberta	11	.....	11	3,697
British Columbia	9	1	10	6,882
Northwest Territories	9	.....	9	1,312
Yukon	8	1	9	5,341
	197	2	199	70,823

Map Sheets Inked or Traced for Advance Information Prints

Newfoundland	1
Nova Scotia	2
New Brunswick	4
Quebec	4
Quebec-Ontario	1
Ontario	1
Manitoba	25
Saskatchewan	23
Alberta	5
British Columbia	11
Yukon Territory	7
Northwest Territories	7
	91

National Air Photographic Library

During the fiscal year 94,054 new photographs were added, bringing the number now on file to 2,524,359. Altogether, 3,467 requisitions involving the purchase of 408,189 prints, enlargements and diapositive slides were forwarded to the Photographic Establishment, R.C.A.F. These prints were for various federal and provincial government departments, mining and industrial companies and others engaged in the development of Canada's resources. Index maps were provided in most cases.

Copies of "Air Photo Coverage Map of Canada", compiled by the Library are available on request.

Advance Information Prints—A total of 13,241 advance information prints were forwarded to federal, provincial and private agencies throughout Canada.

Canadian Board on Geographical Names

During the fiscal year the Board adopted names for 173 new maps, 28 new hydrographic charts, 18 map and chart revisions, and considered a number of new names, name changes, and other items of related business. It continued the preparation of the Gazetteer of Canada series, the third volume (Manitoba) of which is in press and the fourth volume (New Brunswick) is well in hand.

Six provincial members or their representatives attended the February 1955 meeting of the Board at which several items of particular interest to the provinces were discussed.

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
	N. L. Nicholson
	H. S. Bostock
	G. W. Rowley
	S. G. Gamble
Provincial Members:	
British Columbia	W. R. Young (Acting)
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 that cooperates with the Canadian Board on Geographical Names on matters pertaining to the province.

Canadian Hydrographic Service

The Service had 9 ships engaged in coastal charting during the year, two of them being ice-strengthened sealing vessels that were chartered for work in Hudson Strait and Hudson Bay, and three of them large echo-sounding equipped launches. One of the ships and two of the launches were assigned to the Atlantic coast of Nova Scotia, two ships and one launch to Newfoundland waters, and three ships to the Pacific coast. Two large launches were charting in Lake Huron and Georgian Bay, one in Lake Winnipegosis and one in Great Slave Lake. Hydrographers companied the Department of Transport vessels *C. D. Howe* and *d'Iberville* and the H.M.C.S. *Labrador* on their northern cruises.

Atlantic Coast

Nova Scotia, Southeast Coast

The principal operation of the *Kapuskasing* was charting the coast of Cape Breton Island and Chedabucto Bay, from Guyon Island to Guysborough. The cabin-cruiser *Henry Hudson,* working in conjunction with the ship, operated in the inshore waters of the locality. Isaac's Harbour was surveyed at the close of the season at the request of the Department of Public Works. As a result of the season's work two new charts and a new edition of an existing chart will be published.

SUMMARY OF SEASON'S WORK

Kapuskasing		
Ship sounding	3,130	linear nautical miles
Boat sounding	3,200	" " "
Shoals examined	345	
Henry Hudson		
Boat sounding	983	linear nautical miles
Area triangulated	51	square nautical miles
Shoals examined	72	

Cape LaHave, N.S.

The launch *Anderson* continued the survey of the Nova Scotia coast, concentrating on the inshore work between Western Head and Port Joli.

SUMMARY OF SEASON'S WORK

Boat sounding	1,314	linear nautical miles
Coastlining	79	" " "
Shoals examined	71	

Placentia Bay, Nfld. and St. Pierre-Miquelon

The *Fort Frances* carried out charting operations on the western side of Placentia Bay in the St. Pierre-Miquelon area. As a result of the season's work two new charts will be published. In addition, the work for two other new charts is well advanced.

SUMMARY OF SEASON'S WORK

Sounding (ship and boat)	5,008	linear nautical miles
Coastlining	86	" " "
Shoals examined	450	
Oceanographical stations occupied	12	

The launch *Dawson* extended the survey in the inner part of Placentia Bay between Red Island and Swift Current.

SUMMARY OF SEASON'S WORK

Boat sounding	1,322	linear nautical miles
Coastlining	60	" " "
Shoals examined	52	

Cape Bonavista, Nfld.

The *Acadia* surveyed on the east coast of Newfoundland in the Cape Bonavista area and off the Avalon peninsula in the vicinity of Fermeuse. Catalina Harbour and approaches were charted. As a result of the season's work two new charts will be published. Work on two other new charts was well advanced.

SUMMARY OF SEASON'S WORK

Ship sounding	2,916	linear nautical miles
Boat sounding	2,305	" " "
Coastlining	92	" " "
Shoals examined	514	
Oceanographical stations occupied	11	

Shippigan and Lake Melville

The *Cartier* had as its principal operation the resurvey of Lake Melville. The survey of the approaches to Shippigan Harbour, undertaken last season at the request of the Department of Public Works, was completed. In Miramichi Bay the ship channel and adjacent waters in the vicinity of Fox Island were surveyed to determine the extent of shifting shoals. New editions of three existing charts will result from the season's operations.

SUMMARY OF SEASON'S WORK

Ship sounding	638	linear nautical miles
Boat sounding	2,386	" " "
Coastlining	45	" " "
Shoals examined	64	
Oceanographical stations occupied	23	

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 the Payne Bay area where extensive iron ore deposits are in prospect of development. The ship also worked in the approaches to Leaf Bay. As a result of the season's work three new charts will be published.

SUMMARY OF SEASON'S WORK

Ship sounding	1,412	linear nautical miles
Boat sounding	1,491	" " "
Coastlining	264	" " "
Shoals examined	12	
Oceanographical stations occupied	12	

Hopedale, Labrador; Rankin Inlet, Hudson Bay

The *Theron,* a chartered ice-strengthened ship examined the channel into Caribou Harbour, N.S. and then continued the survey of the outer portion of Hopedale. The principal project of this vessel was the charting in Rankin Inlet in connection with a prospective mining development. The uneven nature of the bottom requires most detailed examination and additional work will be necessary before a chart can be issued.

SUMMARY OF SEASON'S WORK

Ship sounding	276	linear nautical miles
Boat sounding	2,809	" " "
Coastlining	49	" " "
Shoals examined	29	
Oceanographical stations occupied	16	

Eastern Arctic

One hydrographer was assigned to each of the Department of Transport vessels *C. D. Howe* and *d'Iberville.* The former vessel visited eighteen ports and the latter four, one of which was Eureka in Slidre Fiord, the most northerly port visited. At each of these ports and en route much useful hydrographic information was obtained for the improvement of existing navigation charts and Sailing Directions.

SUMMARY OF SEASON'S WORK

C. D. Howe

Ship sounding along vessel's track	2,986	linear nautical miles
Boat sounding	330	" " "

d'Iberville

Ship sounding along vessel's track	3,000	linear nautical miles

H.M.C.S. Labrador

Two hydrographers attached to this new naval icebreaker carried out important charting operations during her voyage in and around the northern part of the Continent.

Western Arctic

One hydrographer was assigned to the joint Canadian-United States Beaufort Sea Expedition. The hydrographic data obtained will appear on the provisional charts of that area.

Inland Waters

Georgian Bay

The launch *Bayfield* completed the survey of the approaches to Parry Sound, a new chart of which will be issued.

SUMMARY OF SEASON'S WORK

Boat sounding	1,828	linear nautical miles
Coastlining	50	" " "
Shoals examined	588	

Lake Huron, North Channel

The launch *Boulton* surveyed Bayfield Sound and approaches and the approaches to Southampton Harbour.

SUMMARY OF SEASON'S WORK

Boat sounding	1,700	linear nautical miles
Coastlining	60	" " "
Shoals examined	12	

Lake Winnipegosis

The new launch *Coot* continued the survey of Lake Winnipegosis, undertaken in the interest of the fishing industry. A chart of the southern end of the lake will be issued.

SUMMARY OF SEASON'S WORK

Boat sounding	1,853	linear nautical miles
Coastlining	201	" " "
Shoals examined	9	

Great Slave Lake

The launch *Rae* continued the sounding of Yellowknife Bay and approaches.

SUMMARY OF SEASON'S WORK

Boat sounding	1,559	linear nautical miles
Coastlining	45	" " "
Extension of triangulation net	20	" " "
Shoals examined	12	

Pacific Coast

The *Wm. J. Stewart* surveyed Indian Arm, the northern extension of Burrard Inlet. Charting operations were continued east of Queen Charlotte Sound, including Fife Sound and adjacent waterways. A survey of the area north of Bonilla Island, southeast of Browning Entrance was completed. The charting of the east coast of Queen Charlotte Islands was started in the Selwyn Inlet area.

SUMMARY OF SEASON'S WORK

Ship sounding	481	linear nautical miles
Boat sounding	1,943	" " "
Coastlining	259	" " "
Shoals examined	695	
Oceanographical stations occupied	6	

The *Marabell* completed the charting of the central portion of Johnstone Channel, including Port Harvey and Port Neville. Surveys of Khutzemateen Inlet in northern British Columbia and of Trincomali Channel in Strait of Georgia were also completed. A survey of Burke Channel was started.

SUMMARY OF SEASON'S WORK

Ship sounding	124	linear nautical miles
Boat sounding	1,486	" " "
Coastlining	187	" " "
Shoals examined	188	

The *Parry* engaged in nautical charting and tidal operations in the vicinity of Yuculta Rapids, Vancouver Harbour and between Butedale and Kitimat.

SUMMARY OF SEASON'S WORK

Boat sounding	267	linear nautical miles
Coastlining	63	" " "
Shoals examined	86	
Current stations observed	16	
Slack waters observed	44	
Tide gauge stations established	12	

As a result of the season's work on the Pacific coast, six new charts will be published.

Chart Production

Output was as follows:

Standard charts (first editions)	47
New editions of existing charts	50
Reprints and overprints	11
Arctic charts, first editions	7
New editions	11
Reprints	11
Special charts (plotting and instructional)	29

Pilots and Sailing Directions

The volumes of Pilots and Sailing Directions compiled and issued by the Service supplement the information given on the charts and describe in detail the nature of the coasts and shipping routes of Canada. During the year the following volumes were issued:

British Columbia Pilot, Vol. II, 3rd Edition;
Supplement No. 2 to Gulf of St. Lawrence Pilot;
Supplement No. 1 to St. Lawrence River Pilot (Below Quebec);
Supplement No. 1 to Great Lakes Pilot, Vol. III;
Supplement No. 1 to Newfoundland Pilot.

Precise Water Levels

The Canadian Hydrographic Service is responsible for the continuous and precise recording of water levels along the 1,400 miles of St. Lawrence-Great Lakes Waterway from Quebec to Port Arthur. During 1954 some 13,000 sheets of information were supplied, through regular mailing lists or upon request, to engineering, power and marine interests. Self-registering gauges were maintained at 46 stations. In all, 15,128 days of recordings were obtained.

Hydrologic Projects

The Service takes 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 on water levels resulting from movements of the earth's crust. A report "Crustal Movement in the Lake Ontario-Upper St. Lawrence River Basin" was issued by the Service during the year.

Research is well advanced for a comprehensive report on crustal movement in the entire Great Lakes region. Close cooperation was continued with engineers of the International Joint Commission and the Canadian Seaways 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 kept in continuous operation to provide information for local use and for the tide tables. A larger number of secondary tide stations were also operated.

Two current surveys were made on the Atlantic coast, namely: a comprehensive study of the circulation in the harbour at Saint John, N.B., to provide basic information for an investigation of local silting; and additional current observations at the causeway site in the Strait of Canso.

A thorough investigation was made of the high water levels in the Strait of Canso area reputedly arising from the construction of the causeway, and the results were published in a report.

The pollution of Canadian shores by oil and other wastes dumped at sea was the subject of a study that led to the preparation of a technical report for the guidance of the official government committee.

An extensive preliminary investigation was made on the broad problem of mean sea level and its variations.

Nautical Geodesy

Work in this field included: the adjustment of triangulation nets; the computation of geographical positions; the provision of tables for computation of geodetic positions in northern Canadian waters; the provision of coordinates for regular and special chart projections; supplying charting and mapping control data to the Canadian navy and army, and to various agencies, including United States Hydrographic Office; and the training of hydrographic field assistants. Steps were taken toward the introduction of electronic distance-measuring equipment on the ships of the Service.

Distribution of Hydrographic Publications

The distribution of standard charts for 1954 reached a new peacetime high. The demand for charts of northern and Arctic waters was increased by 26 per cent over 1953 and 104 per cent over 1952. The distribution of hydrographic publications was as follows:

Catalogues of charts, sailing directions and tidal information, with index maps	1,437
Standard navigation charts	63,667
Instructional, special charts, etc.	21,566
Pilots and Sailing Directions	2,002
Supplements to Pilots and Sailing Directions	880
Tide Tables, 10 editions	64,866
Water level bulletins, graphs, etc. (approximately)	13,000

In accordance with recognized international practice, the information contained in Canadian Hydrographic charts and publications is reproduced by other national hydrographic offices for use of their own shipping. Thus total world circulation is greatly in excess of that indicated above.

The importance of Arctic defence installations makes it necessary to have up to date charts for the use and protection of the costly ships now required to navigate these hitherto uncharted waters. To expedite this work a contract was signed for the construction of a hydrographic vessel especially designed for use in Arctic waters. The ship will be equipped with two helicopters and the electronic means of accurate ship-location for offshore sounding purposes.

Legal Surveys and Aeronautical Charts Division

Provincial and Territorial Boundary Surveys

Ontario-Manitoba Boundary

Preparation of final report and map sheets relating thereto, was completed and the report is in press.

Alberta-British Columbia Boundary

Printing of the report on this boundary is in progress and the map sheets to make up the atlas that will accompany the report have been forwarded for binding.

British Columbia-Yukon-Northwest Territories Boundary

No field work was done on this boundary but considerable progress was made in the compiling of manuscripts and drafting of fair copies of map sheets depicting previously completed field surveys.

Alberta-Northwest Territories Boundary

The surveying and monumenting of 65 miles east from Fort Smith, done during the year, completed this north boundary of Alberta. Spot checks were made at various places along the boundary to ensure that proper accuracies were maintained.

Saskatchewan-Northwest Territories Boundary

The field work of monumenting this boundary was begun during the winter of 1954-55. During the season, 64 miles of trial line were surveyed and final monuments were placed to mark 52 miles of the boundary.

Legal Surveys

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

New Brunswick	Richibucto, Restigouche
Quebec	Lorette, Maniwaki, Ouiatchouan
Ontario	Goulais Bay, Mississagi, Rama, Tyendinaga
Manitoba	Dawson Bay, Roseau River, Roseau Rapids, St. Peter's, Valley River
Saskatchewan	Last Mountain Lake
Alberta	Blood Timber Limit A, O'Chiese, Stony
British Columbia	Aiyansh, Alert Bay, Creston, Kamloops, Kincolith, Lachkaltsap, Masset, Sik-e-dakh, Skidegate

Surveys were also made of Oka Indian lands in Quebec and of Indian lands in the township of Kehoe, Ontario.

Yukon

Two survey parties headed by surveyors of the Division operated in Yukon.

One party established and monumented the boundaries of 24 group lots for legal purposes. Twenty-one of these lie along the Alaska Highway between Whitehorse and the Alaska boundary, two lie at Klukshu on the Haines highway and one at Cowley Station on the British Yukon railway. The party also carried out a large scale topographic survey covering about 1¼ square miles to provide essential planning information for a proposed extension to the city of Whitehorse.

The second party established and monumented the legal boundaries of ten mineral claims and of 75·6 miles of the Stewart River Crossing-Dawson Road. It also carried out a topographic survey of the proposed site of a hospital at Mayo; this survey also involved restoration of the property boundaries in the vicinity.

Instructions were issued to private surveyors for surveys of 226 mineral claims principally in the Mayo and Whitehorse mining districts.

Northwest Territories

Three survey parties headed by surveyors of the Division operated in Northwest Territories.

One party carried out a large scale topographic survey of the proposed new townsite of Aklavik and surveyed several miscellaneous parcels at Yellowknife.

The other two parties carried out control surveys following the Dominion Lands Surveys System. One of these parties operated in the Yellowknife district and the other worked in the area east of Hay River. The latter party also made check surveys of the Alberta-Northwest Territories boundary and of the Mackenzie Highway.

Instructions were issued to three private surveyors for surveys of 54 mineral claims in the Yellowknife and Mackenzie mining districts.

Other Surveys

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

Prince Edward Island,
Prince Albert in Saskatchewan,
Waterton Lakes and Banff in Alberta,
Kootenay and Mount Revelstoke in British Columbia.

Historic sites were surveyed at Baddeck, Nova Scotia and at Batoche and Old Fort Pelly in Saskatchewan.

Office

The Division made 127 miscellaneous plans, tracings and Indian location ticket sketches, recorded 210 plans and the respective field notes in the survey records relating to Indian affairs, examined 573 plans of legal surveys and the field notes thereof; dispatched 3,662 "OCE" prints, 1,759 photostat copies of survey records, 84 photographic linen prints and 909 miscellaneous prints; and prepared 329 legal descriptions for use in conveyance of land rights, 60 descriptions of mineral claims and 189 descriptions for petroleum and natural gas permit applications.

Aeronautical Charts

Air Photogrammetry

In all, 194,000 square miles of planimetric detail was plotted from tri-camera photographs for the production of aeronautical chart bases, an increase of 43,000 square miles over the previous year. The areas covered are as follows:

Charts completed (advance prints available at 1·5 miles to 1 inch).

14 S.W.—Nain-Nutak
14 N.W.—Hebron-Territok
23 S.E.—Ashuanipi (southeast quarter)
24 S.E.—Indian House
24 N.E.—George River
57 S. —Rae Strait
57 N. —Boothia
96 N. —Colville Lake
97 S. —Anderson River

Banks Island—This comprises three 1-inch-to-8-mile charts (Banks Island 98 SE & SW, Banks-Victoria 88 SE & SW, and Amundsen Gulf 97 NE & NW). This area is nearing completion.

Victoria Island—This comprises five 1-inch-to-8-mile charts (Hadley Bay 78 SE & SW, Victoria Island East 77 NE & NW, Cambridge Bay 77 SE & SW, Dolphin and Union Strait 87 SE & SW, and Fort Collinson 87 NE & NW). This area is about 80 per cent complete.

King William Island—This area comprises one 1-inch-to-8-mile chart (King William Island 67 SE & SW) and is about 70 per cent complete.

Ellesmere Island South—This area comprises four 1-inch-to-8-mile charts (Devon East 48 NE & NW, Wellington Channel 58 NE & NW, Craig Harbour 49 SE & SW, and Bache Peninsula 49 N½ & 39 N½). It is 30 per cent complete.

In addition to the regular tri-camera program the following special plots were prepared:

1. Craig Harbour.
   A plot of Craig Harbour on Ellesmere Island to scale of 1 to 50,000 was made for the Canadian Hydrographic Service, using the available R.C.A.F. and U.S.A.A.F. trimetrogon photo coverage.
2. Ashuanipi 23 SE.
   A revision of the west half of this sheet was made at the scale of 1 inch to 1 mile.
3. Ellesmere Island.
   At the request of the Defence Research Board a 1-inch-to-1-mile detailed plot was completed covering some 90 miles of the north coast to Ellesmere Island from Cape Nares to Cape Richards.
4. Indian Reserves.
   Several large-scale plots were prepared from vertical photographs, and photographic interpretation studies were carried out to facilitate legal surveys of Indian reserves.

Air Information

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

The new or revised pages and sheets as shown below were issued. (A "page" is considered as one side of a "sheet". Normally there are two aerodromes per sheet except that only one aerodrome is covered on an instrument approach and landing chart. Most sheets are revised more than once a year).

Revisions to:

392 aerodrome pages
104 miscellaneous pages (facility listings, indexes, etc.)
47 Instrument approach and landing charts (in three colours)
21 Instrument landing system charts (7 in three colours)
63 Radio facility charts (in two colours)

First publication of:

5 aerodrome pages
28 Instrument approach and landing charts (in three colours)
1 Instrument landing system chart
Flight information region and sparsely settled areas map
Canadian Air Defence identification zone map.

The new aerodrome pages were for Maple and Peterborough, Ont., St. Felicien, Que., Tisdale, Sask., and Turin, Alberta.

Seventy-two of a total requirement of 89 radio range instrument approach and landing charts to ICAO specifications, are now available and 12 are in various stages of production.

(*b*) *Aeronautical Overprint Information*—1. Eight-mile Aeronautical Charts. Sixteen new air information compilations were prepared to conform to revised topographical information and map sheet format. Ninety sheets were examined for revision, of which 56 were revised and 34 reprinted.

2. World aeronautical chart series, scale of 1:1,000,000. Three new charts were compiled and printed to bring the total number in the series published by Canada to date to 53. Thirty-four sheets were examined for revision, 27 of which were revised and 7 reprinted. The completed series will number 65 charts.

3. Aeronautical Route Charts. Work was completed on five new charts, bringing the total number of published charts in this series to 8.

4. Revisions to the world aeronautical planning chart were undertaken and the drafting of this chart is well advanced.

5. Work on the compilation of a new sheet, Southern Ontario, scale 1:1,000,000 is well advanced. This chart, initially requested by the R.C.A.F., will be issued as a special and will include that portion of southern Ontario which was not taken up by Canada in its 1:1,000,000 coverage.

6. Canadian Polar Plotting Chart. A polar stereographic plotting chart (scale 1:3,000,000) was compiled and drawn to R.C.A.F. requirements. Printing of this chart is nearing completion.

Radar Altimetry

As a result of radar altimetry field operations completed by contract, 8,610 linear miles of ground profile information was obtained for the purpose of plotting spot heights and conjectural 500-feet contours on 9 aeronautical charts of the 1-inch-to-8-mile series. The operation covered approximately 56,000 square miles in northern Ungava and northern Labrador and 63,000 square miles on the southern extremity of Baffin Island.

Extensive field operations for classified mapping purposes were completed by the Division in cooperation with the R.C.A.F.

The Division participated in research and development work on the type of radar altimeter being used in R.C.A.F. operations. Certain circuits of the altimeter were modified and preliminary flight tests indicated improved performance. The other modifications await the completion of flight tests.

Spot height and contour manuscripts were completed for 4 aeronautical charts of the 1-inch-to-8-mile series and 18 similar manuscripts are nearing completion.

Since 1948 when the work began, 78,310 linear miles of profile information have been obtained in areas totalling 1,087,500 square miles for 52 aeronautical charts of the 1-inch-to-8-mile series. Spot height and contour manuscripts have been completed for 16 of these charts and 18 others are nearing completion.

Columbia River Basin Project

Preparation of the detailed topographical plans of the Columbia River basin was continued; to date, 80 of the 89 sheets of this series have been compiled and advance prints made available.

Survey Records and Electoral Maps

Survey Records

Field Books Recorded	305
Plans Recorded	445
Written requests for information	371
Telephone requests for information	2896
Township plans supplied	552
Settlement plans supplied	179
"OCE" prints dispatched	367
Photostatic copies dispatched	216

There is a constant demand from other government departments and outside agencies for information available from the survey records. In part, this information involves computing geographical positions of specified monuments, supplying data relative to base line and meridian control surveys, and providing data on the early surveys.

The hitherto unconfirmed surveys in Alberta, Saskatchewan and Manitoba were investigated and 253 plans of base line and meridian surveys were compiled, prepared for reproduction and confirmed. Thirteen township plans in the former Railway Belt, B.C., were prepared and confirmed.

127 field books containing field notes of surveys in Alberta and 442 containing field notes in the former Railway Belt, B.C. that have been approved and confirmed were transferred to the respective provinces "on loan".

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

Miscellaneous

326 air-line distances were determined and supplied to the Post Office and Transport Departments, Canadian National and Canadian Pacific communications departments, and to certain air-transport companies.

148 requests for technical publications were dealt with.

316 requests for the current editions of the astronomical field tables were received from private surveyors. A stock was also supplied to provincial and federal departments, universities and technical schools.

The geographical co-ordinates of the monuments on the Ontario-Manitoba Boundary were recomputed and adjusted.

Board of Examiners For Dominion Land Surveyors

The Board met on six occasions during the fiscal year, chiefly in connection with the annual qualifying examinations in February. Examinations were held at Ottawa, Saskatoon, Edmonton, Calgary, Victoria, Vancouver and Kitimat. Ninety-three candidates were examined. Twenty-two were successful in the combined categories. Four certificates of preliminary examination and three commissions as Dominion Land Surveyor were issued as provided for in the Act.

Map Compilation and Reproduction Division

The number of maps, charts and plans printed in the fiscal year was 972, an increase of 220 over the previous year. Limited reprintings were made of a large number of maps which were out of print. Most of these are being revised and regular editions of the revised maps will be printed as soon as possible.

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

Compilation

The drawing of base maps for use in the new Atlas of Canada being prepared by the Department was completed with the exception of the series of four maps on the 1:2,500,000 scale and this is well advanced.

The Division completed new compilations on all 1-inch-to-8-mile sheets of the Canadian Arctic which had not been revised recently, and all but one of the 1:1,000,000 sheets in the Arctic. These sheets are available in advance print form, and are in demand by defence services and private firms.

Summary of Compilation

	Scale	*First Edition*	*Revised Edition*
Aeronautical Chart bases	8 mi.	..	33
World Aeronautical Chart	1:1,000,000	9	
Aeronautical Route Chart bases	1:1,000,000	6	..
Navigational Route Chart bases	1:3,000,000	6	..
National Topographic Series	1:250,000	26	..
National Topographic Series	2 mi.	..	1
National Topographic Series	1:50,000	(conversions)	27
Atlas of Canada (in preparation in Geographical Branch)	various	4	..
Miscellaneous	various	15	..

Map Drafting

Progress was made in the conversion from pen-and-ink drafting to engraving on coated plastic, and about 90 per cent of the output is being produced by the new method. Experience indicates that a map sheet can be drawn by this method in about one-third the time formerly required and that draftsmen of relatively limited experience can do excellent work.

The 1-inch-to-20-mile wall map of Canada for the Railway Committee Room of the House of Commons was completed. This map was drawn and coloured entirely by hand on a single sheet of paper measuring 16 by 18 feet.

A projection of major proportions was prepared in connection with the drawing of a map of Canada on a scale of 1:2,000,000. The projection was drawn on a sheet 14 by 18 feet and included all that part of Canada lying east of the central meridian (92°). For the area west of this meridian the projection was reversed.

New and Revised Maps Drawn

	Scale	*Number*
Aeronautical Charts National Topographic series	8 mi.	19
World Aeronautical Charts	1:1,000,000	4
Aeronautical Route Charts	1:1,000,000	2
Atlas of Canada	various	4
National Topographic series	1:250,000 and 2 mi.	41
National Topographic series	1:50,000	112
Columbia River Basin series		6
Map indices		7
Air information		97
Miscellaneous		31

New topographical maps on scales of 1:50,000 and 1:250,000 are drawn, checked and reproduced to the negative stage and then sent to Army Survey Establishment, Department of National Defence for printing.

Photo-Mechanical

Certain facilities were expanded to provide increased production. The plate-making room was renovated and the plate-making units were increased from three to five. The unit handling enlargements, infra-red development, and general photographic work was moved to a new location in the building with new facilities and equipment provided. The Division has also been equipped with a modern diazo type printer of high capacity for the production of blue and black line prints and other types of prints required in map production.

Summary of Photo-Mechanical Production

Photo-Mechanical	
Wet plate negatives (sq. ft.)	100
Film negatives (sq. ft.)	39,528
Lithographic plates	1,308
Ferro Prussiates (metal)	223
Chromeline and plastic blues	11,718
Multilith plates	1,725
Photography	
Infra-red plates processed	299
Roll film processed	107
Enlargements (sq. ft.)	3,852
Contact prints (sq. ft.)	1,527
Sensitized linen (sq. ft.)	7,293
Photostat (sq. ft.)	11,756
Contact and blueprinting	
Blueprints	8,159
Vandykes	27,317
OCE	246,630
Diazo linen	995

Map Printing and Distribution

A new 40 x 48-inch rotary offset press was installed, bringing the number of presses to eight.

Maps Printed

	Maps Published	*Copies*	*Impressions*
New and revised maps	175	607,915	2,634,275
Maps reprinted	385	923,206	4,132,166
Geological maps and figures	57	173,490	848,585
Hydrographic Charts	196	180,882	434,620
Overprints	159	315,000	314,900
	972	2,200,493	8,364,546

Maps Distributed

In all, 554 new and revised maps were received from the presses for distribution. The Division dealt with 29,865 requests, the total distribution being 786,486 maps, a decrease of 14 per cent from the previous year. This was due largely to the transfer in mid-year of aeronautical chart distribution for the armed services to the Department of National Defence, and of Canada Air Pilot distribution to the Legal Surveys and Aeronautical Charts Division. Following is a summary of distribution:

National Topographic Series maps	448,570
Aeronautical and plotting charts	267,135
Sectional maps	9,141
Old geographical series	580
Miscellaneous maps	60,812
Publications	248
	786,486

New or Revised Maps Produced by Map Compilation and Reproduction Division

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(I) Aeronautical Charts—N. T. S.				
Que—Nfld	13 SW	North West River	8 mi.	52°00′–54°00′	60°00′– 64°00′	Prelim. Ed. Rev.
Nfld	13 NE	Hamilton-Hopedale	8 "	54°00′–56°00′	56°00′– 60°00′	Prelim. Ed. Rev.
Quebec	24 SW	Fort McKenzie	8 "	56°00′–58°00′	68°00′– 72°00′	Prelim. Rev.
Quebec	24 NW	Fort Chimo	8 "	58°00′–60°00′	68°00′– 72°00′	Prelim. Rev.
N.W.T	48 NW & NE	Devon East	8 "	74°00′–76°00′	78°00′– 88°00′	Prelim. Ed. Rev.
N.W.T	76 SW & SE	Upper Back River	8 "	64°°00′–66°00′	104°00′–112°00′	Prel. Rev.
N.W.T	76 NW & NE	Bathurst Inlet	8 "	66°00′–68°00′	104°00′–112°00′	Prel. Rev.
N.W.T	78 NW & NE	Byam Channel	8 "	74°00′–76°00′	104°00′–112°00′	Prel. Rev.
N.W.T	79 SW & SE	Hazen Strait	8 "	76°00′–78°00′	104°00′–112°00′	Prel. Rev.
N.W.T	86 SW & SE	Camsell River	8 "	64°00′–66°00′	112°00′–120°00′	Prel. Rev.
N.W.T	89 NE & 79 NW & E	Borden Island	8 "	78°00′–80°00′	104°00′–116°00′	Prel. Rev.
N.W.T	98 NE & 88 NW & E	M'Clure Strait	8 "	74°00′–76°00′	112°00′–125°00′	Prel. Rev.
N.W.T	99 SE & 89 SW & E	Prince Patrick Island	8 "	76°00′–78°00′	112°00′–124°00′	Prel. Rev.
Yukon	105 SE	Wolf Lake-Watson Lake	8 "	60°00′–62°00′	128°00′–132°00′	Stand. Rev.

New or Revised Maps Produced by Map Compilation & Reproduction Division—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(II) Other National Topographical Series Maps				
Ontario	31 D/NE	Bobcaygeon	2 mi.	44°30′–45°00′	78°00′– 79°00′	Revision
Quebec	31 J/NE	L'Ascension	2 "	46°30′–47°00′	74°00′– 75°00′	"
Ontario	31 L/SW	North Bay	2 "	46°00′–46°30′	79°00′– 80°00′	"
Quebec	31 N/SE	Cabonga Reservoir	2 "	47°00′–47°30′	76°00′– 77°00′	"
Quebec	31 N/SW	Grand Lake Victoria South	2 "	47°00′–47°30′	77°00′– 78°00′	"
Quebec	31 N/NW	Grand Lake Victoria North	2 "	47°30′–48°00′	77°00′– 78°00′	"
Ontario	42 A	Timmins	1:250,000	48°00′–49°00′	80°00′– 82°00′	"
B.C.	82 L/NW	Shuswap	2 mi.	50°30′–51°00′	119°00′–120°00′	"
B.C.	93K	Fort Fraser	1:250,000	54°00′–55°00′	124°00′–126°00′	"
Yukon	105A	Watson Lake	1:250,000	60°00′–61°00′	128°00′–130°00′	"
		(III) World Aeronautical Charts				
N.W.T.	2022	Balantyne Strait	1:1,000,000	76°00′–80°00′	112°00′–136°00′	First edition
N.W.T.	2080	Thelon River	1:1,000,000	64°00′–68°00′	96°00′–112°00′	"
N.W.T.	2081	Quoich River	1:1,000,000	64°00′–68°00′	80°00′– 96°00′	"

(IV) Columbia River Basin

B.C.	17 A	Lower Arrow Lake Area	1:31,680	49°52′–50°00′	117°57′–118°09′	First Edition
B.C.	17 B			50°00′–50°08′	118°04′–118°08′	"
B.C.	20A	Upper Arrow Lake Area	1:31,680	50°34′–50°42′	117°43′–118°00′	"
B.C.	20B		1:31,680	50°42′–50°46′	117°56′–118°02′	"
B.C.	26	Big Bend Area	1:31,680	51′20′–51°28′	118°18′–118°35′	"
B.C.	27A	Big Bend Area	1:31,680	51°28′–51°36′	118°21′–118°38′	"
B.C.	27B		1:31,680	51°28′–51°32′	118°11′–118°21′	"
B.C.	31A	Big Bend Area	1:31,680	52°00′–52°10′	118°25′–118°38′	"
B.C.	31B		1-31,680	52′04′–52°07′	118°38′–118°44′	"
B.C.	32A	Big Bend Area	1:31,680	52°04′–52°12′	118°08′–118°25′	"
B.C.	32B			52°12′–52°18′	118°08′–118°12′	"
B.C.	39A	Big Bend Area	1:31,680	51°24′–51°32′	117°12′–117°29′	"
B.C.	39B			51°31′–51°36′	117°04′–117°13′	"
B.C.	47A	Upper Columbia River Area.	1:31,680	50°27′–50°37′	116°08′–116°21′	"
B.C.	47B			50°33′–50°35′	116°21′–116°24′	"
B.C.	75	Canoe River Area	1:31,680	52°10′–52°20′	118°25′–118°38′	"
B.C.	76	Canoe River Area	1:31,680	52°20′–52′28′	118°32′–118°49′	"
B.C.	77	Canoe River Area	1:31,680	52°28′–52°36′	118°41′–118°58′	"
B.C.	78	Canoe River Area	1:31,680	52°36′–52°44′	118°52′–119°09′	"
B.C.	79	Canoe River Area	1:31,680	52°44′–52°52′	119°02′–119°19′	"

New or Revised Maps Produced by Map Compilation & Reproduction Division—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(V) Aeronautical Route Charts				
B.C. to Alberta	1	Vancouver-Medicine Hat	1:1,000,000			First edition
Man. to Ontario	3	Winnipeg-Kapuskasing	1:1,000,000			"
N.S. to Nfld	6	Yarmouth-Gander	1:1,000,000			"
Ontario	9	Port Arthur-Trenton	1:1,000,000			"
		(VI) Miscellaneous				
Saskatchewan		Saskatchewan South				New—Prov. of Sask.
Saskatchewan		Saskatchewan North				New—Prov. of Sask.
Saskatchewan		Wheat classification				New rev—Dept. of Agriculture
Quebec		New Quebec Crater				New—Dominion Observatory
Ontario		Gravity Map—Ottawa				Revised—Dom. Ob.
Alberta-B.C.		3 Maps of National Parks				Rev—Northern Affairs & Nat. Resources
Alberta-B.C.		9 Maps of the boundary				New—Surveyor Gen.
Manitoba-Ontario		13 Maps of the boundary				New—Surveyor Gen.
World		Map of the World				Revised—Trade and Commerce

List of New Maps Produced by Surveys and Mapping Branch and Printed at the Army Survey Establishment, Fiscal Year 1954-55

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Newfoundland	1K/11	Trepassey	1:50,000	46°30′–46′45°	53°00′– 53°30′	First edition
Newfoundland	1K/12E ½	St. Shotts	1:50,000	46°30′–46°45′	53°30′– 53°45′	"
Newfoundland	1K/13	St. Mary's	1:50,000	46°45′–47°00′	53°30′– 54°00′	"
Newfoundland	1K/15W ½	Renews	1:50,000	46°45′–47°00′	52°45′– 53°00′	"
Newfoundland	1L/16E ½	St. Bride's	1:50,000	46°45′–47°00′	54°00′– 54°15′	"
Newfoundland	1M/1 E ½	Ship Cove	1:50,000	47°00′–47°15′	54°00′– 54°15′	"
Newfoundland	1N/4	St. Catherines	1:50,000	47°00′–47°15′	53°00′– 53°30′	"
Newfoundland	1N/5	Argentia	1:50,000	47°15′–47°30′	53°30′– 54°00′	"
Newfoundland	1N/11	Harbour Grace	1:50,000	47°30′–47°45′	53°00′– 53°30′	"
Newfoundland	1N/12	Dildo	1:50,000	47°30′–47°45′	53°30′– 54°00′	"
Newfoundland	2C/2 W ½	Bay de Verde	1:50,000	48°00′–48°15′	52°45′– 53°00′	"
Newfoundland	2C/3	Old Perlican	1:50,000	48°00′–48°15′	53°00′– 53°30″	"
Newfoundland	2E/7	Comfort Cove	1:50,000	49°15′–49°30′	54°30′– 55°00′	"
Newfoundland	2E/8	Carmanville	1:50,000	49°15′–49°30′	54°00′– 54°30′	"
Newfoundland	2E/9	Fogo	1:50,000	49°30′–49°45′	54°00′– 54°30′	"
Newfoundland	2E/10	Twillingate	1:50,000	49°30′–49°45′	54°30′– 55°00′	"
Newfoundland	2 E/11	Exploits	1:50,000	49°30′–49°45′	55°00′– 55°30′	"
Newfoundland	2 E/14W ½	Cape St. John	1:50,000	49°45′–50°00′	55°15′– 55°30′	"
Newfoundland	2 F/4	Wesleyville	1:50,000	49°00′–49°15′	53°30′– 54°00′	"

List of New Maps Produced by Surveys and Mapping Branch and Printed at the Army Survey Establishment, Fiscal Year 1954-55—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Newfoundland	2 F/5	Musgrave Harbour	1:50,000	49°15′–49°30′	53°30′– 54°00′	First edition
Newfoundland	2 L/4	Horse Islands	1:50,000	50°00′–50°15′	55°30′– 56°00′	"
Newfoundland	2 M/11 W½	Quirpon	1:50,000	51°30′–51°45′	55°15′– 55°30′	"
Newfoundland	2 M/14 W½	Belle Isle	1:50,000	51°45′–52°00′	55°15′– 55°30′	"
Nova Scotia	11 D/10 W½	Owls Head	1:50,000	44°30′–44°45′	62°45′– 63°00′	Second edition
Nova Scotia	11 D/16	Ecum Secum	1:50,000	44°45′–45°00′	62°00′– 62°30′	"
Nova Scotia	11 E/1	Liscomb	1:50,000	45°00′–45°15′	62°00′– 62°30′	"
Nova Scotia	11 E/2	Upper Musquodoboit	1:50,000	45°00′–45°15′	62°30′– 63°00′	"
Nova Scotia	11 E/7	Hopewell	1:50,000	45°15′–45°30′	62°30′– 63°00′	"
Nova Scotia	11 E/8	Lochaber	1:50,000	45°15′–45°30′	62°00′– 62°30′	"
Nova Scotia	11 F/3	Larrys River	1:50,000	45°00′–45°15′	61°00′– 61°30′	First edition
Nova Scotia	11 F/7W ½	Cape Canso	1:50,000	45°15′–45°30′	60°45′– 61°00′	"
Nova Scotia	11 F/10	St. Peters	1:50,000	45°30′–45°45′	60°30′– 61°00′	"
Nova Scotia	11 J/4	Glace Bay	1:50,000	46°00′–46°15′	59°30′– 60°00′	Second edition
Nova Scotia	11 K/8	Bras d'Or	1:50,000	46°15′–46°30′	60°00′– 60°30′	"
Nova Scotia	11 K/9W ½	Ingonish	1:50,000	46°30′–46°45′	60°15′– 60°30′	First edition
Nova Scotia	11 K/10	Cheticamp River	1:50,000	46°30′–46°45′	60°30′– 61°00′	"
Nova Scotia	11 K/11E ½	Cheticamp	1:50,000	46°30′–46°45′	61°00′– 61°15′	"
Nova Scotia	11 N/1	Cape North	1:50,000	47°00′–47°15′	60°00′– 60°30′	"

Nova Scotia	11 N/2 E ½	Cape St. Lawrence	1:50,000	47°00′–47°15′	60°30′– 60°45′	"
Newfoundland	12 G/9 E ½	Skinner Cove	1:50,000	49°30′–49°45′	58°00′– 58°15′	"
Newfoundland	12 I/1	Fleur de Lys	1:50,000	50°00′–50°15′	56°00′– 56°30′	"
Quebec	12 L/1 E ½	Aguanish	1:50,000	50°00′–50°15′	62°00′– 62°15′	"
Quebec	12 L/7	Baie-Johan-Beetz	1:50,000	50°15′–50°′30	62°30′– 63°00′	"
Quebec	12 L/8	Pashashibu Bay	1:50,000	50°15′–50°30′	62°00′– 62°30′	"
Quebec	12 L/9	Lac Michaud	1:50,000	50°30′–50°45′	62°00′– 62°30′	"
Quebec	12 L/10	Lac de la Robe-Noire	1:50,000	50°30′–50°45′	62°30′– 63°00′	"
Newfoundland	12 P/3 E ½	Ferolle Point	1:50,000	51°00′–51°15′	57°00′– 57°15′	"
Newfoundland	13 K	Snegamook Lake	1:250,000	54°00′–55°00′	60°00′– 62°00′	"
Nova Scotia	20 P/6 W ½	Baccaro	1:50,000	43°15′–43°30′	65°15′– 65°30′	"
Nova Scotia	20 P/11	Lockeport	1:50,000	43°30′–43°45′	65°00′– 65°30′	"
Nova Scotia	20 P/12	Pubnico	1:50,000	43°30′–43°45′	65°30′– 66°00′	"
Nova Scotia	20 P/13	Tusket	1:50,000	43°45′–44°00′	65°30′– 66°00′	"
Nova Scotia	21 A/1 W ½	La Have Islands	1:50,000	44°00′–44°15′	64°15′– 64°30′	"
Nova Scotia	21 A/2	Liverpool	1:50,000	44°00′–44°15′	64°30′– 65°00′	"
Nova Scotia	21 A/3	Lake Rossignol	1:50,000	44°00′–44°15′	65°00′– 65°30′	"
Nova Scotia	21 A/4	Wentworth Lake	1:50,000	44°00′–44°15′	65°30′– 66°00′	"
Nova Scotia	21 A/6	Kejimkujik Lake	1:50,000	44°15′–44°30′	65°00′– 65°30′	"
Nova Scotia	21 A/8	Lunenburg	1:50,000	44°15′–44°30′	64°00′– 64°30′	"
Nova Scotia	21 B/1	Meteghan	1:50,000	44°00′–44°15′	66°00′– 66°30′	"
New Brunswick	21 B/14 E ½	Fairhaven	1:50,000	40°45′–45°00′	67°00′— 67°15′	"
New Brunswick	21 B/15	Campobello	1:50,000	44°45′–45°00′	66°30′– 67°00′	Second edition

List of New Maps Produced by Surveys and Mapping Branch and Printed at the Army Survey Establishment, Fiscal Year 1954-55—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
New Brunswick	21 G/3	St. Stephen	1:50,000	45°00′–45°15′	67°00′– 67°30′	Second edition
New Brunswick	21 I/2	Moncton	1:50,000	46°00′–46°15′	64°30′– 65°00′	"
New Brunswick	21 J/3	Millville	1:50,000	46°00′–46°15′	67°00′– 67°30′	First edition
New Brunswick	21 J/4	Woodstock	1:50,000	46°00′–46°15′	67°30′– 68°00′	"
New Brunswick	21 J/5	Florenceville	1:50,000	46°15′–46°30′	67°30′– 68°00′	"
New Brunswick	21 J/7	McDougall Lake	1:50,000	45°15′–45°30′	66°30′– 67°00′	"
New Brunswick	21 J/12	Andover	1:50,000	46°30′–46°45′	67°30′– 68°00′	Second edition
Quebec	21 M/3	Tewkesbury	1:50,000	47°00′–47°15′	71°00′– 71°30′	First edition
Quebec	21 M/4	Rivière Tourilli	1:50,000	47°00′–47°15′	71°30′– 72°00′	"
Quebec	21 N/13	Rivière-du-Loup	1:50,000	47°45′–48°00′	69°30′– 70°00′	"
New Brunswick	21 O/5	Grand River	1:50,000	47°15′–47°30′	67°30′– 68°00′	Second edition
New Brunswick	21 O/16	Charlo	1:50,000	47°45′–48°00′	66°00′– 66°30′	First edition
New Brunswick	21 P/2 W ½	Point Escuminac	1:50,000	47°00′–47°15′	64°45′– 65°00′	Second edition
Quebec	22 A/2	Port Daniel	1:50,000	48°00′–48°15′	64°30′– 65°00′	First edition
Quebec	22 A/4	New Richmond	1:50,000	48°00′–48°15′	65°30′– 66°00′	"
Quebec	22 A/7	Chandler	1:50,000	48°15′–48°30′	64°30′– 65°00′	"
Quebec	22 A/8	Cap d'Espoir	1:50,000	48°15′–48′30°	64°00′– 64°30′	"
Quebec	22 A/13	Lac Madeleine	1:50,000	48°45′–49°00′	65°30′– 66°00′	"
Quebec	22 B/3	Milnikek	1:50,000	48°00′–48°15′	67°00′– 67°30′	"

Quebec	22 B/6	Causapscal	1:50,000	48°15′–48°30′	67°00′– 67°30′	"
Quebec	22 C/4	Tadoussac	1:50,000	48°00′–48°15′	69°30′– 70°00′	"
Quebec	22 H/1 W ½	Petit-Cap	1:50,000	49°00′–49°15′	64°15′– 64°30′	"
Newfoundland	23 H	Ossokmanuan Lake	1:250,000	53°00′–54°00′	64°00′– 66°00′	"
Quebec	23 I/13	Marion Lake	1:50,000	54°45′–55°00′	65°30′– 66°00′	"
Quebec-Newfoundland	23 J/16	Hollinger Lake	1:50,000	54°45′–55°00′	66°00′– 66°30′	"
Quebec-Newfoundland	23 O/1	Willbob Lake	1:50,000	55°00′–55°15′	66°00′– 66°30′	"
Quebec-Newfoundland	23 O/2	Tait Lake	1:50,000	55°00′–55°15′	66°30′– 67°00′	"
Quebec-Newfoundland	23 O/3	Boundary Lake	1:50,000	55°00′–55°15′	67°00′– 67°30′	"
Quebec	23 O/6	Lac le Fer	1:50,000	55°15′–55°30′	67°00′– 67°30′	"
Quebec	23 O/7	Bacchus Lake	1:50,000	55°15′–55°30′	66°30′– 67°00′	"
Quebec	23 O/8	Thompson Lake	1:50,000	55°15′–55°30′	66°00′– 66°30′	"
Quebec	23 O/10	Ahr Lake	1:50,000	55°30′–55°45′	66°30′– 67°00′	"
Quebec	23 O/11	Lac Mussett	1:50,000	55°30′–55°45′	67°00′– 67°30′	"
Quebec	23 P/5	Deborah Lake	1:50,000	55°15′–55°30′	65°30′– 66°00′	"
Ontario	31 D/11	Orillia	1:50,000	44°30′–44°45′	79°00′– 79°30′	Second edition
Quebec	31 I/6	St. Gabriel-de-Brandon	1:50,000	46°15′–46°30′	73°00′– 73°30′	First edition
Ontario	41 A/16 E ½	Christian Island	1:50,000	44°45′–45°00′	80°00′– 80°15′	"
Ontario	41 K/16 W ½	Stokely Creek	1:50,000	46°45′–47°00′	84°15′– 84°30′	First edition Provisional
Saskatchewan	62 E	Weyburn	1:250,000	49°00′–50°00′	102°00′–104°00′	First edition
Saskatchewan	62 E/3	Hitchcock	1:50,000	49°00′–49°15′	103°00′–103°30′	"
Saskatchewan	62 E/5	Goodwater	1:50,000	49°15′–49°30′	103°30′–104°00′	"

List of New Maps Produced by Surveys and Mapping Branch and Printed at the Army Survey Establishment, Fiscal Year 1954-55—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Manitoba	62 H/3	Emerson	1:50,000	49°00′–49°15′	97°00′– 97°30′	First edition
Manitoba	62 H/6	Morris	1:50,000	49°15′–49°30′	97°00′– 97°30′	"
Manitoba	62 H/11	St. Adolphe	1:50,000	49°30′–49°45′	97°00′– 97°30′	"
Manitoba	62 H/14	Winnipeg	1:50,000	49°45′–50°00′	97°00′– 97°30′	"
Manitoba	62 I	Selkirk	1:250,000	50°00′–51°00′	96°00′– 98°00′	Fourth edition
Manitoba	62 I/3	Stonewall	1:50,000	50°00′–50°15′	96°30′– 97°00′	First edition
Manitoba-Saskatchewan	63 C/12	Armit Lake	1:50,000	52°30′–52°45′	101°30′–102°00′	"
Manitoba-Saskatchewan	62 K	Riding Mountain	1:250,000	50°00′–51°00′	100°00′–102°00′	"
Manitoba	63 C/15	Nason Point	1:50,000	52°45′–53°00′	100°30′–101°00′	"
Saskatchewan	63 E	Pasquia Hills	1:250,000	53°00′–54°00′	102°00′–104°00′	"
Manitoba	63 J/7	Hill Lake	1:50,000	54°15′–54°30′	98°30′– 99°00′	"
Manitoba	63 J/8	Metchanais Rapids	1:50,000	54°15′–54°30′	98°00′– 98°30′	"
Manitoba	63 J/10	Muhigan Lake	1:50,000	54°30′–54°45′	98°30′– 99°00′	"
Manitoba	63 K/13 E½	Flin Flon	1:50,000	54°45′–55°00′	101°30′–101°45′	First edition-Provisional
Saskatchewan	72 H/9	Trossachs	1:50,000	49°30′–49°45′	104°00′–104°30′	First edition
Saskatchewan	72 I/5	Moose Jaw	1:50,000	50°15′–50°30′	107°45′–108°00′	"
Saskatchewan	72 I/8	Davin	1:50,000	50°15′–50°30′	104°00′–104°30′	"
Saskatchewan	72 I/10	Lumsden	1:50,000	50°30′–50°45′	104°30′–105°00′	"
Saskatchewan	72 I/11	Bethume	1:50,000	50°30′–50°45′	105°00′–105°30′	"

Saskatchewan	72 I/12	Marquis	1:50,000	50°30′–50°45′	105°30′–106°00′	"
Alberta	72 M	Oyen	1:250,000	51°00′–52°00′	110°00′–112°00′	"
Alberta	73 L/3	Vincent Lake	1:50,000	54°00′–54°15′	111°00′–111°30′	"
Alberta	73 L/11	Pinehurst Lake	1:50,000	54°30′–54°45′	111°00′–111°30′	"
Alberta	74 E	Bitumount	1:250,000	57°00′–58°00′	110°00′–112°00′	"
Saskatchewan	74 N/5	Maurice Bay	1:50,000	59°15′–59°30′	109°30°–110°00′	"
Saskatchewan	74 N/7	Crackingstone	1:50,000	59°15′–59°30′	108°30′–109°00′	First edition-Provisional
Saskatchewan	74 N/8	Goldfields	1:50,000	59°15′–59°30′	108°00′–108°30′	"
N.W.T.	75 B	Abitau Lake	1:250,000	60°00′–61°00′	106°00′–108°00′	"
N.W.T.	75 P	Hanbury	1:250,000	63°00′–64°00′	104°00′–106°00′	"
British Columbia	82 G/13	Skookumchuck	1:50,000	49°45′–50°00′	115°30′–116°00′	First edition
British Columbia	82 J/4	Canal Flats	1:50,000	50°00′–50°15′	115°30′–116°00′	"
Alberta	82 J/7 E ½	Mount Head	1:50,000	50°15′–50°30′	114°30′–114°45′	First edition-Provisional
Alberta	82 J/8 E ½	Stimson Creek	1:50,000	50°15′–50°30′	114°00′–114°15′	"
Alberta	82 J/9	Turner Valley	1:50,000	50°30′–50°45′	114°00′–114°30′	"
Alberta-B.C.	82 J/14 E ½	Evans-Thomas Creek	1:50,000	50°45′–51°00′	115°00′–115°15′	"
Alberta	83 B/3 W ½	Tay River	1:50,000	52°00′–52°15′	115°00′–115°30′	First edition-Provisional
Alberta	83 B/4	Cripple Creek	1:50,000	52°00′–52°15′	115°30′–116°00′	"
Alberta	83 B/5 W ½	Saunders	1:50,000	52°15′–52°30′	115°30′–116°00′	"
Alberta	83 C/6	Sunwapta	1:50,000	52°15′–52°30′	117°00′–117°30′	"
Alberta	83 C/11	Southesk	1:50,000	52°30′–52°45′	117°00′–117°30′	"
Alberta	83 C/14	Mountain Park	1:50,000	52°45′–53°00′	117°00–117°30	"

List of New Maps Produced by Surveys and Mapping Branch and Printed at the Army Survey Establishment, Fiscal Year 1954-55—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Alberta	83 F/11	Dalehurst	1:50,000	53°30′–53°45′	117°00′–117°30′	First edition-Provisional
Alberta	83 G/12	Cranbrook	1:50,000	49°30′–49°45′	116°00′–116°30′	"
Alberta	83 I/5	Dapp	1:50,000	54°15′–54°30′	113°30′–114°00′	First edition
Alberta	83 I/14	Sawdy	1:50,000	54°45′–55°00′	113°00′–113°30′	"
Alberta	83 J/9	Flatbush	1:50,000	54°30′–54°45′	114°00′–114°30′	"
Alberta	83 L/12	Nose Creek	1:50,000	54°30′–54°45′	119°30′–120°00′	First edition-Provisional
Alberta	83 M	Grande Prairie	1:250,000	55°00′–56°00′	118°00′–120°00′	First edition
Alberta	83 O	Lesser Slave Lake	1:250,000	55°00′–56°00′	114°00′–116°00′	"
Alberta	83 P	Pelican	1:250,000	55°00′–56°00′	112°00′–114°00′	"
Alberta	84 H	Namur Lake	1:250,000	57°00′–58°00′	112°00′–114°00′	"
N.W.T.	85 A/14	Long Island	1:50,000	60°45′–61°00′	113°00′–113°30′	"
N.W.T.	85 B/10	Buffalo River	1:50,000	60°30′–60°45′	114°30′–115°00′	"
N.W.T.	85 J/9	Prosperous Lake	1:50,000	62°30′–62°45′	114°00′–114°30′	First edition-Provisional
N.W.T.	85 J/16	Quyta Lake	1:50,000	62°45′–63°00′	114°00′–114°30′	"
N.W.T.	86 B	Indin Lake	1:250,000	64°00′–65°00′	114°00′–116°00′	"
British Columbia	93 O/16 E ½	Portage Mountain	1:50,000	55°45′–56°00′	122°00′–122°15′	"
British Columbia	104 A/9	Damdochax Lake	1:50,000	56°30′–56°45′	128°00′–128°30′	First edition

British Columbia.......	104 N	Atlin....................	1:250,000	59°00′–60°00′	132°00′–134°00′	"
Yukon...............	105 N	Lansing.................	1:250,000	63°00′–64°00′	132°00′–134°00′	"
Yukon...............	106 E	Wind River..............	1:250,000	65°00′–66°00′	134°00′–136°00′	"
N.W.T...............	106 K	Arctic Red River South....	1:250,000	66°00′–67°00′	132°00′–134°00′	First edition-Provisional
Yukon...............	116 A	Larsen Creek............	1:250,000	64°00′–65°00′	136°00′–138°00′	First edition
Yukon...............	116 H	Hart River..............	1:250,000	65°00′–66°00′	136°00′–138°00′	"

International Boundary Commission

Inspections

The Commisisoners, with the United States engineer, inspected the work being done on the 45th parallel in the vicinity of Rouses Point, N.Y. The work of reclearing the boundary vista was advancing rapidly as clearing on farms adjacent to the boundary lessened the amount of heavy cutting. The ornamental markers 649A and 649B between the customs houses immediately west of Rouses Point and those north of Champlain, 653A and 653B, were in excellent condition. A number of the monuments established in 1845 and renewed in 1902 were also inspected and were in excellent condition.

The work of the Canadian engineer was then inspected in the vicinity south of St. Armand, Pinnacle Mountain, Que. Progress here was good.

The work of the Canadian engineer below Armstrong, Que., was inspected. This section is heavily wooded and the boundary follows the height of land. Access to the boundary is mostly by way of bush roads which are at times quite distant from the line. Satisfactory progress was being made in vista reclearance. The ornamental markers 353A and 353B between the customs houses at Armstrong, Que. and Jackman, Maine were in good condition.

The problem of boundary markers along the Saint John River north of Van Buren, Maine, was discussed with the United States engineer. On this section, the building and widening of roads, the increasing use of machinery in farming and the expansion of villages and inter-village construction have made necessary the continual revision of the boundary marks. To preserve a strong system of reference monuments various methods were considered, among them the possibility of establishing by triangulation a system of reference marks at a greater distance from the Saint John River.

Maintenance on the International Boundary

On the Quebec-Maine highlands boundary, 30 miles of the line were inspected and the vista was recleared to a width of 20 feet. Inspection was made of 44 of the large and 685 intermediate monuments which mark this height-of-land boundary and repairs were made to one large and to 22 intermediate monuments.

On the 45th parallel Quebec-Vermont and Quebec-New York boundary 50 miles of boundary were inspected. Vista was recleared to a width of 20 feet for 39 miles on the section from Highwater, Que. to Lake Champlain and 11 miles in the Covey Hill region. Inspection was made of 158 monuments and repairs were made to 6 of these; 2 were completely rebuilt and one reference mark was set.

Chemical control of vegetation on a 17-mile section of the British Columbia-Washington boundary which is adjacent to roads and was thus possible to treat from mobile spraying equipment was continued for the third season. The operation consisted of spot spraying to kill scattered re-growth of bushes. Results to date of this project have been very satisfactory.

Also on the British Columbia-Washington section the lights on four towers which range the International boundary across Boundary Bay were changed from white to flashing green in response to a request from fisheries protection officers who depend upon these lights in their patrolling.

Reports of the Commission

The annual joint report of the Commissioners for 1952 was completed and bound, and that for 1953 is being bound. This 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 plats and tables certified by the Commissioners giving the geodetic positions of the above-mentioned boundary markers.

Preparation was continued of a special report on maintenance on the Saint John River and North Line sections of the boundary subsequent to 1925 and field reports covering the 1954 operations were completed.

The re-computation was continued of geographic positions of triangulation stations, reference monuments and boundary turning points on the St. Francis River section, on the 1927 North American datum. As originally published by the Commission the geographic positions were based on the old North American datum.

GEOLOGICAL SURVEY OF CANADA

G. Hanson, Director

The Survey placed 87 geological parties in the field in 1954, and the area of projects completed was about 113,000 square miles, excluding exploratory surveys in the Arctic Islands, airborne geophysical surveys, and various special projects not confined to regular map-areas. Twenty-seven parties did 4-mile reconnaissance or exploratory mapping; 24 did 1-mile mapping; and 36 were occupied in other field work, including geophysics, mineral deposits studies, stratigraphy, palæontology, water supply, fuels, and detailed mapping. The parties were distributed as follows: Northwest Territories, 9; Yukon, 6; Yukon and British Columbia, 1; British Columbia, 14; Alberta and British Columbia, 2; Alberta, 8; Saskatchewan, 5; Saskatchewan and Manitoba, 1; Manitoba, 2; Ontario, 8; Ontario and Quebec, 4; Quebec, 3; New Quebec and Labrador, 5; New Brunswick, 5; Nova Scotia, 5; Prince Edward Island, 1; island of Newfoundland, 5; and general, 3.

Top priority was given to reconnaissance mapping and to the development of more rapid reconnaissance methods, the object being to provide, as soon as practicable, geological maps of all land areas of Canada at scales of 1 inch to 4, 8, or about 16 miles. This policy was put into effect in various field activities during 1954 as follows:

a 67,000-square-mile portion of the District of Keewatin, N.W.T., was geologically mapped by helicopters in what is known as Operation Baker, the second such operation to be undertaken within the past few years;

plans were made and a cache was established for a third operation of this kind in 1955;

the experimental use of a helicopter in an otherwise almost inaccessible mountain area was continued;

a helicopter was also used in Nova Scotia affording operational experience in the use of these machines in timbered areas;

field caches were established and much painstaking vital planning completed for a projected 1955 reconnaissance, by freight-type helicopters, of the Queen Elizabeth Islands of the Arctic archipelago.

Much geological assistance was afforded other Federal Government agencies. This included: the loan of a geologist throughout the year to the Department of Northern Affairs and National Resources to investigate geological matters affecting potential damsites and other features of the Columbia River project; loan of a geologist as advisor to the St. Lawrence Seaway Authority; an investigation of a damsite of the South Saskatchewan River project at the request of the federal Department of Agriculture; geological advice by the resident geologists at Whitehorse and Yellowknife to the Department of Northern Affairs and National Resources pertaining to the administration of mineral lands; an airborne survey to provide special data required by the Defence Research Board, Department of National Defence; and geological advice to the Department of National Revenue affecting tax benefits for deep test oil wells.

Fourteen research grants-in-aid totalling $24,935 were awarded to eight Canadian universities from funds provided for this purpose by Parliament. These were awarded on the basis of recommendations of the National Advisory Committee on Research in the Geological Sciences. Twenty-eight research projects in nine universities are being supported at present and twelve other projects have been completed. Each year the number of applications and the aggregate amount applied for have increased, the total amount applied for in 1954 being $45,000. The grants-in-aid are achieving their purpose of stimulating research in Canadian universities and are producing results of interest and value to the mineral industry and the science of geology.

Late in 1954, C. S. Lord was appointed Chief Geologist to succeed G. Hanson who became Director of the Geological Survey of Canada in October 1953.

T. L. Tanton, a senior geologist whose attention was given chiefly to iron ore deposits, retired on superannuation after more than 40 years of service.

The loss of four young lives in two canoe accidents in Labrador is recorded with deep regret. On July 17, 1954, D. E. Crowley and A. T. McIntyre, student assistants, were drowned when their canoe upset in Petitsikapau Lake, and on September 10, J. E. Howell, a newly appointed member of the Survey's staff, and W. Zoloski, student assistant, met a similar fate in Angus Lake.

Regional Geology Division

Fifty-four of the 87 parties the Survey had in the field in 1954 were on regional geology work. Such work provides the data for most of the maps and reports published by the Survey. The data gathered by these parties form the basis of much of the Survey's office and laboratory research and are made use of in replies to many enquiries received annually concerning Canadian geology and mineral resources.

Field Work

Nineteen parties mapped the geology of potential fuel and mineral areas on the scale of 1 inch to 1 mile and seventeen mapped for publication on a scale of 1 inch to 4 miles. Reconnaissance surveys were completed of three large areas in the Arctic Islands and of a large area in central District of Keewatin. Eleven parties made detailed studies related mainly to the occurrence and development of iron, uranium, columbium-tantalum, lithium, nickel, copper, lead, and zinc deposits; others made airborne or ground geophysical surveys.

Northwest Territories

R. G. Blackadar explored geologically much of the coast of Admiralty Inlet, centered about Arctic Bay, on the northwest part of Baffin Island. He gained important information on the youngest Precambrian and oldest Palæozoic rocks. Deposits of pyrite, pyrrhotite, and galena were noted in the Precambrain rocks, but none is known to be of commercial value.

R. L. Christie explored geologically the north coast of Ellesmere Island between longitudes 72°15′ and 93°00′. He found a complex succession of igneous and sedimentary rocks ranging in age from Precambrian to Recent.

W. L. Davison explored geologically the area about Pond Inlet and the shores of Eclipse Sound on the north part of Baffin Island. He examined the low-rank coal deposits of Pond Inlet, long used as a local source of fuel.

J. W. Hoadley completed geological mapping of the Abitau Lake area (longitude 106° to 108°; latitude 60° to 61°) where granitic rocks were found to be the bedrock of all but a small part of the area.

R. Mulligan completed geological mapping of the Hill Island Lake area, west half (longitude 109° to 110°; latitude 60° to 61°); to extend geological knowledge northward from the Beaverlodge uranium area north of Lake Athabasca, Saskatchewan.

F. C. Taylor completed geological mapping of the Hill Island Lake area, east half (longitude 108° to 109°; latitude 60° to 61°), which is immediately north of the Beaverlodge uranium area.

G. M. Wright, accompanied by C. H. Smith, J. A. Fraser, R. C. Shields, and J. G. Fyles, completed an aerial geological reconnaissance of about 67,000 square miles of central District of Keewatin. This project, known as Operation Baker, was a northerly continuation of Operation Keewatin of 1952, and as in it, helicopters were used. However, the area covered in a season was increased by about 18 per cent and the cost per square mile was reduced by approximately 40 per cent to about $2.20 a square mile. The survey outlined several areas of promising prospecting ground underlain by sedimentary and volcanic rocks of Precambrian age and derived schists and gneisses. The percentage of such favourable ground is less, however, than in southern District of Keewatin.

Yellowknife Office—Local investigations were made for the compilation of data on the mineral industry of the District of Mackenzie. Geological advice was given the Department of Northern Affairs and National Resources on matters concerning administration of mineral explorations and assistance was given to the Canadian Institute of Mining and Metallurgy in its courses for prospectors.

The facilities of Yellowknife office, under J. C. McGlynn are made available to prospectors of the area.

Yukon

R. W. Boyle continued a detailed study of the silver-lead-zinc ores of the Mayo mining area. The results are expected to provide important data on the nature of the metal-bearing solutions and on the factors controlling the deposition of ore. The feasibility of locating drift-covered mineral deposits in some permafrost areas by sampling stream and spring waters was demonstrated and areas were found where metal-bearing waters suggested undiscovered deposits.

R. B. Campbell continued geological mapping of the Glenlyon area (longitude 134° to 136°, latitude 62° to 63°). The area contains a complex of granitic and metamorphic rocks in which metallic mineral deposits may occur.

L. H. Green completed geological mapping of the Mayo Lake area (longitude 134°30′ to 135°00′, latitude 63°45′ to 64°00′) which adjoins the Keno Hill area on the east. He extended the study into the Scougale Creek area (longitude 134°30′ to 135°00′, latitude 64°00′ to 64°15′) that adjoins the Mayo Lake area on the north. The results of the study of the complex geology of these areas should aid in the search for and development of orebodies.

E. D. Kindle continued geological mapping of the Keno Hill area (longitude 135°00′ to 135°30′, latitude 63°45′ to 64°00′), the only source of silver-lead-zinc ore production in Yukon.

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.

J. O. Wheeler continued geological mapping of the Kaskawulsh area (longitude 138° to 139°, latitude 60°30′ to 61°00′). The area is adjacent to the Alaska Highway, contains gypsum, placer gold, and coal deposits, and affords the best exposures for the study of the rocks of the Kluane Ranges in which recently discovered nickel-copper deposits are being explored.

Whitehorse Office—R. B. Campbell was appointed resident geologist at Whitehorse where he opened a permanent branch in the new Federal Building in December. His main duties are to aid those concerned with the exploration and development of Yukon and adjacent areas by all practicable geological means short of encroaching on the legitimate duties of non-government geologists. Geological advice was afforded the Department of Northern Affairs and National Resources on administrative matters concerning mineral exploration, and instructional lectures were given to prospectors.

Yukon and British Columbia

H. S. Bostock investigated recent developments in mining and prospecting in Yukon and adjoining parts of British Columbia.

British Columbia

J. D. Aitken continued geological mapping of the Atlin area (longitude 132° to 134°, latitude 59° to 60°). The area contains the old placer gold camp of Atlin which is still an important producer, and covers much of the region in which the engineering works connected with proposed hydro-electric developments will be located.

S. Duffell continued geological mapping of the Terrace area (longitude 128° to 129°, latitude 54° to 55°), which is crossed by the Prince Rupert line of the Canadian National Railways. The east flank of the Coast Range batholith with which mineral deposits are associated lies in the area. Some of the many mineral deposits in the area are being developed.

H. Gabrielse completed geological mapping of the McDame area (longitude 128° to 130°, latitude 59° to 60°), including a study of the Cassiar asbestos deposits and other mineral occurrences. The area contains placer gold deposits and lode gold and base metal prospects.

H. W. Little continued geological mapping of the Kettle River area, east half (longitude 118° to 119°, latitude 49° to 50°), which includes the Lightning Peak mining camp and several precious and base metal prospects.

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.

J. A. Roddick continued geological mapping of the Coquitlam area (longitude 122° to 123°, latitude 49° to 50°). This extremely rugged area contains a complex of igneous rocks favourable for mineral deposition. Although it is close to transportation and is bounded by areas containing important mines, it has received little prospecting attention. A helicopter was used for part of the season to determine whether geological mapping in rugged areas in the Cordillera can be facilitated and expedited by use of these aircraft. Despite exceptionally unfavourable weather the party in one season accomplished what would have taken five seasons to do by the slower ground methods and at about half the cost.

J. Souther completed his study of the granitic rocks of the Terrace area (longitude 128° to 129°, latitude 54° to 55°), which should result in establishing their relationships to the various types of mineral deposits and serve as a guide to further prospecting.

H. W. Tipper commenced geological mapping of the Anahim Lake area (longitude 125° to 126°, latitude 52° to 53°). This area covers part of the east flank of the Coast Range batholith with which mineral deposits are associated. It is traversed by the road route from Williams Lake on the Pacific Great Eastern Railway to Bella Coola on the coast. The road, when completed, will provide easy access to the area from the coast.

British Columbia Office—The Geological Survey's office at Vancouver under the direction of W. E. Cockfield, gave local assistance in connection with ground water supplies, engineering geology, and occurrences of metallic and industrial minerals and construction materials. Determinations were made of many rock and mineral specimens, and reports and maps were issued in response to requests from the public.

Alberta

R. J. W. Douglas completed the revision of the geology of a group of map-areas in the central Foothills (longitude 116°30′ to 117°, latitude 53° to 53°15′; longitude 116°30′ to 117°, latitude 52°45′ to 53°; longitude 116° to 116°45′, latitude 52°30′ to 52°45′; and longitude 116° to 116°30′, latitude 52°15′ to 52°30′). Structural features favouring the accumulation of oil and gas were mapped and undeveloped coal deposits examined.

J. K. Eccles commenced geological mapping of the east half of the Adams Lookout area (longitude 118°30′ to 118°45′, latitude 53°30′ to 53°45′). The area contains coal deposits, but the main object of the mapping is to obtain stratigraphic and structural information that will assist exploration for oil and gas in nearby parts of western Alberta.

H. R. Greiner commenced geological mapping of the Two Lakes area (longitude 119°30′ to 120°, latitude 54°15′ to 54°30′). Coal seams up to 5 feet or more in thickness were noted. Data obtained relative to the change in character of formations from southeast to northwest (along the strike) will be of value to those concerned with exploration for oil and gas.

E. J. W. Irish completed mapping the geology of the west half of Adams Lookout area (longitude 118°45′ to 119°, latitude 53°30′ to 53°45′). Coal seams occur in the northeast part of the area, and new stratigraphic information was obtained that will assist in the search for oil and gas elsewhere.

D. K. Norris completed the geological investigation of the Blairmore area (longitude 114°15′ to 114°30′, latitude 49°30′ to 49°45′). Precise structural data obtained are expected to aid in obtaining the lowest practicable mining costs. Detailed studies of Turtle Mountain, site of the disastrous Frank slide of 1903, indicate that another similar slide is unlikely. Cooperation with the Mines Branch was continued on the effect of mining practice and geological structure on the occurrence of violent stress relief in coal mines.

Saskatchewan

C. K. Bell commenced detailed geological investigations of the Milliken Lake area (longitude 108°30′ to 109°, 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. Some indications of relations between structure and the localization of ore are already becoming apparent.

W. E. Hale commenced and completed geological mapping of the Forcie Lake area (longitude 109°15′ to 109°30′, latitude 59°30′ to 59°45′). Several structures were found that merit prospecting for deposits of radioactive minerals.

L. P. Tremblay continued detailed geological mapping in the Beaverlodge Lake area in which the Ace-Fay mine of the Crown-owned Eldorado Mining and Refining Limited is located. Results of the study so far completed strongly suggest a relationship between certain structures and the distribution of deposits of uranium minerals.

Manitoba

W. W. Heywood commenced detailed geological mapping of the Schist Lake area (longitude 101°47′ to 101°53′, latitude 54°37′ to 54°43′) in which are deposits of copper and zinc. This is a southerly extension of previous similarly detailed geological investigations of the Flin Flon copper-zinc area.

H. A. Quinn commenced and completed geological mapping of the Knee Lake area (longitude 94° to 96°, latitude 55° to 56°) where small amounts of gold and copper occur in greenstone bands. Ultrabasic rocks favourable for base metal deposition were noted.

Ontario

E. R. Rose completed a mineralogical and petrological investigation of iron deposits in Grenville rocks of eastern Ontario. Certain relationships between iron deposits and associated rocks were established that should aid in prospecting for iron in this region.

Ontario and Quebec

R. B. Rowe examined the radioactive columbium deposits at Lake Nipissing, Ontario, and near Oka, Quebec, as part of a continuing assignment to study the columbium deposits of Canada. Data obtained on the probable genesis of these ore deposits may prove a useful guide to the search for columbium elsewhere in Canada.

Information on the lithium deposits of the Preissac-Lacorne area of Quebec was brought up to date.

Quebec

W. R. A. Baragar commenced geological mapping of Ahr Lake area (longitude 66°30′ to 67°, latitude 55°30′ to 55°45′). The area contains the northward extension, along the strike of certain of the sedimentary rocks of the group that, in turn, contain the iron formation at Schefferville. Large bodies of basic rocks accompanied by copper-bearing sulphide deposits also occur in the area.

W. F. Fahrig mapped the Lac Herodier area, east half (longitude 68° to 69°, latitude 57° to 58°) which straddles the Labrador Trough and contains deposits of non-ferrous metals. As a result of this work it is now thought that the granitic rocks east of the Trough are younger than the Trough rocks.

W. G. Johnston continued the geological revision of the Opasatika Lake area (longitude 79° to 79°30′, latitude 48° to 48°15′). This is a continuation of the systematic study of the Quebec gold and copper belt.

E. R. Rose made a reconnaissance examination of the circular structure outlined by Manicouagan and Mushalagan Lakes (centred at about longitude 68°45′, latitude 51°20′). These preliminary investigations suggest that the structure is a result of ancient volcanic activity.

Quebec-Labrador

M. J. Frarey commenced and completed geological mapping of the Menihek Lake area, east half (longitude 66° to 67°, latitude 54° to 55°). This was largely a compilation and revision of information supplied by private companies and provides new data on the relationship of iron ore to the stratigraphy and structure of the Labrador Trough.

J. E. Howell completed detailed mapping of a strip through Knob Lake and Burnt Creek across the Labrador Trough. Important information was obtained on the stratigraphy, structure, and economic geology of areas within the Trough.

New Brunswick

F. D. Anderson continued geological mapping of the Coldstream area (longitude 67° to 67°30′, latitude 46°15′ to 46°30′) which lies near the southwest end of the province's central mineral belt where large deposits of base metals occur.

I. C. Brown commenced a detailed geological study of the mineral deposits of the central mineral belt of New Brunswick. This is a northeasterly trending belt in which important base metal deposits occur in highly deformed volcanic and sedimentary rocks cut by granite. His investigations were concentrated in the Bathurst-Newcastle area (longitude 65° to 67°, latitude 47° to 48°) where large zinc-lead-copper deposits are being developed.

R. Skinner completed geological mapping of the Tetagouche Lake area (longitude 66° to 66°30′, latitude 47°30′ to 47°45′) near the northeast end of the central mineral belt. This area is being actively prospected for base metals as a result of discoveries in the Bathurst district.

Nova Scotia

D. G. Kelley completed geological mapping of the Baddeck area (longitude 60°30′ to 61°, latitude 46° to 46°15′). Deposits of gypsum in this area are of economic importance because of their proximity to water transportation.

A. S. MacLaren and E. R. W. Neale commenced geological mapping of the Cape Breton Highlands area north of latitude 46°30′, which includes Cape Breton Highland national park and St. Paul Island. The purpose of this helicopter-assisted survey was to assess the economic potential of the area, from which occurrences of zinc, lead, and copper have been reported.

I. M. Stevenson completed geological mapping of the Shubenacadie area (longitude 63° to 63°30′, latitude 45° to 45°15′), where large gypsum deposits are being developed. Limestone, barite, and gold deposits also occur in the area.

Newfoundland

W. D. McCartney completed geological mapping of the Argentia area (longitude 53°30′ to 54°, latitude 47°15′ to 47°30′) and commenced mapping of the Dildo area (longitude 53°30′ to 54°, latitude 47°30′ to 47°45′) as part of the systematic mapping of the Avalon peninsula. Silver-lead deposits occur in the area. Considerable attention is being given to the extensive but low grade manganese-bearing beds near Dildo.

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

G. C. Riley commenced geological mapping of the Victoria Lake area (longitude 57° to 58°, latitude 48° to 49°) as part of a projected program of systematic mapping of a strip across Newfoundland between latitudes 48° and 49°. This will add to the knowledge of the structure and rock sequence of this part of the Appalachian belt and aid in the interpretation of aeromagnetic data and the search for new mineral deposits.

B. L. Smith commenced and completed geological mapping of the Rencontre East area, Fortune Bay (longitude 55° to 55°30′, latitude 47°30′ to 47°45′) in which molybdenite and fluorspar occur.

Geophysics

The demand for aeromagnetic maps is increasing yearly as their usefulness becomes established in interpreting geology under large areas of overburden, in outlining anomalies that may indicate the presence of deposits of magnetic minerals, and for other related purposes. To help meet this demand, work was continued toward improving the airborne magnetometer used in making the field surveys, and on constructing a semi-automatic device for compiling, in the office, aeromagnetic maps from the data of the surveys. Construction of a special magnetometer for measuring the strength and direction of magnetization in rock samples was completed and this instrument will supply valuable data in research concerned with structural geology and in the interpretation of aeromagnetic maps. Preliminary experiments were made toward designing a directional airborne scintillation counter to detect satisfactorily the presence of radioactive minerals, when flown at a height of 500 feet above the terrain.

Field Work

Northwest Territories

F. P. DuVernet conducted an aeromagnetic survey of about 18,600 square miles of District of Mackenzie (longitude 102° to 106°, latitude 60° to 62°) to provide aeromagnetic maps that will be used to facilitate and expedite geological mapping by helicopter and ground methods. A remarkable magnetic anomaly was detected near Atzinging Lake.

British Columbia and Alberta

An exploratory aeromagnetic survey was made of a strip 12 miles wide bordering the 49th parallel between Lethbridge, Alberta and the Pacific Ocean. The results, when compiled, should enable an assessment of the value of aeromagnetic work in mountainous terrain, and are expected to aid in interpreting the complex geology of the Cordillera.

Saskatchewan

Lake Athabasca and its immediate mainland was surveyed with the airborne magnetometer from Goldfields westerly nearly to the Alberta boundary. When compiled, interpretation of the magnetic data may assist in determining the possible occurrence of uranium-bearing formations beneath the lake and the drift- and sandstone-covered south shore.

Ontario and Quebec

R. Mitra investigated rocks causing negative magnetic anomalies found with the airborne magnetometer in the Minden area (longitude 78°30′ to 79°, latitude 44°45′ to 45°) and the Granby area (longitude 72°30′ to 73°, latitude 45°15′ to 45°30′). By analogy with results of aeromagnetic surveys over the

titanium orebodies of Allard Lake it was expected that the rocks investigated might likewise contain titanium. This was found not to be the case and laboratory studies of the rocks from the Minden and Granby areas are in progress in an effort to explain the cause of the negative polarization.

Fuels Resources Division

The Division received 151,507 samples from wells drilled for oil and natural gas, bringing the total available for study and reference at Ottawa to 1,792,519. Samples received represented 773 wells, of which 217 were drilled in Ontario, 554 in Alberta, and 2 in Quebec. In all, 137,881 samples were prepared for microscopic examination.

Acknowledgment 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, British Columbia, 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 maps showing areas of drilling, and for samples of wells drilled in Alberta; Department of Mineral Resources, Regina, Saskatchewan, for monthly reports on drilling activity and production, for maps showing areas under exploration permit and lease, and for drilling samples; Department of Mines and Natural Resources, Winnipeg, Manitoba, for drilling samples and for monthly 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; Paul Payette for samples of wells drilled in the Gaspé region of Quebec; I. W. Jones, Chief, Geological Surveys Branch, Department of Mines, Quebec, Que., for descriptive logs of wells drilled in Quebec; W. A. Roliff, Imperial Oil Limited, Toronto, and C. S. Evans, Union Gas Company of Canada, Limited, Chatham, Ontario, for information regarding wells drilled by their respective companies in Ontario; and officials of numerous oil companies for much useful information on oil and gas activities in many parts of Canada. Appreciation is also expressed to H. C. Hobson, General Manager, Canadian Salt Company, Montreal, for making available samples of rock penetrated by the company's shaft at Ojibway, Ontario.

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

Western Oil and Natural Gas Office, Calgary

This office conducts regional subsurface geological studies of the sedimentary formations of western Canada, maintains drill samples, laboratory facilities, and a geological library, and makes these available to the oil industry for study and reference. Geological Survey reports and maps are distributed as a service to the industry.

During the year this office acquired 268,183 drill samples, comprising 146,000 from wells drilled in Alberta, 82,363 from wells drilled in Saskatchewan, 22,473 from wells drilled in Manitoba, 15,182 from wells drilled in British Columbia, and 2,165 from wells drilled in Northwest Territories.

The technical staff continued to study the detailed stratigraphy and problems of correlation of subsurface formations in the plains region of western Canada. Progress was made in the study and correlation of oil-

and-gas-bearing formations of Devonian age in central and southwestern Alberta and a summary account of this work was forwarded for publication. A study was commenced of formations of Lower Cretaceous age in Saskatchewan, as was one of late Palæozoic and early Mesozoic formations in wells from northeastern British Columbia.

The Calgary office is also cooperating with the Department of Northern Affairs and National Resources in the preparation of a schedule of wells drilled in Northwest Territories.

Coal Section

The work included: the collection of available data on coal mines, coal prospects, and coal occurrences for use in estimating the coal reserves of Canada; the collection of about 100 coal samples from various coal seams in western Canada to determine the germanium content; assistance in solving geological problems associated with mining in some coalfields; and continuation of an investigation into the possible use of electric logs in the identification and correlation of coal seams penetrated by wells drilled for oil and gas in the plains of Alberta.

Sydney Office, Nova Scotia—This office, maintained by the Geological Survey of Canada in cooperation with the Nova Scotia Department of Mines and the Nova Scotia Research Foundation, conducts research in coal petrography and micropalaeobotany as an aid in solving problems relating to the stratigraphy, structure, correlation, and constitution of the coal seams and associated coal measures. Work proceeded on the following projects, each of which involved the microscopic examination of coals:

(*a*) correlation of coal seams penetrated by bore holes in the Mabou coal area;

(*b*) studies related to spontaneous combustion of coal;

(*c*) in cooperation with the Mines Branch, petrographic examination of coal from western Canada as part of a study of rock pressure and gas outbursts in coal mines;

(*d*) spore analysis of a sample of coal from the Nahanni river area, Mackenzie Mountains, collected by John Patton and submitted by J. D. Campbell, palæobotanist, Research Council for Alberta. The coal is the first of Lower Carboniferous age to be recognized in western Canada. The spore assemblage is remarkably similar to one reported from Lower Carboniferous coals in northern Russia.

Field Work

British Columbia and Alberta

B. A. Latour continued to collect data from coal mines, prospects and occurrences for use in estimating the coal reserves.

Alberta

W. B. Brady commenced a detailed stratigraphic study of the Carboniferous formations of the foothills between Nordegg and Banff with the object of evaluating these rocks as potential sources of petroleum and natural gas and as reservoirs for these fuels.

Ontario

B. V. Sanford continued to locate the wells drilled for natural gas and oil in southwestern Ontario and to establish their elevations. These data are for use in compiling maps showing bedrock surface contours and thicknesses of overburden in this region.

B. A. Liberty commenced geological study and mapping the bedrock formations of Manitoulin Island to obtain information that will be useful in appraising the oil and gas potentialities of the area.

Nova Scotia

M. J. Copeland made a detailed stratigraphic and palæontological examination of Pennsylvania strata in order to establish the stratigraphic ranges of arthropods. This work should provide data that will assist in the precise correlation of coal-bearing strata and their contained coal seams, particularly where fossil plants are not available for this purpose.

Stratigraphic Palæontology Division

The Division continued the systematic study of Canadian stratigraphy based on fossil collections submitted by officers of the Geological Survey of Canada, by oil and mining companies and others.

It received 392 boxes containing thousands of individual specimens and prepared 123 reports on fossil collections, 8 of which were for oil companies in western Canada, 89 for the Geological Survey, and the remainder for other government branches and for private individuals.

Field Work

Northwest Territories

E. T. Tozer commenced and completed a palæontological and stratigraphic reconnaissance of parts of Prince Patrick, Eglington, and western Melville Islands. The data will aid in evaluating the oil and gas potentialities of the Arctic archipelago. Thin coal seams were found in Devonian, Jurassic, and Cretaceous rocks.

British Columbia

T. E. Bolton commenced a stratigraphic and palæontological study of the Cambrian, Ordovician, and Silurian strata of the western flank of the Rocky Mountains between Canal Flats and Golden.

H. Frebold studied the Jurassic formations and their faunal content in the Pine Pass area of the Rocky Mountains. Results of this work will aid in clarifying the complex palæogeography of the Jurassic period in this region and will therefore aid in the search for oil and gas by facilitating subsurface studies in the adjacent plains and foothills.

W. L. Fry commenced a study of the Tertiary palæobotany and stratigraphy of the Fraser River delta and made a similar examination of Lower Jurassic formations on the northern part of the west coast of Vancouver Island.

J. A. Jeletzky completed a palæontological and stratigraphic study of the Mesozoic and Tertiary formations of the west coast of Vancouver Island between Kyuquot Sound and Quatsino Sound. This project will assist geological mapping in this and other parts of British Columbia by clarifying the stratigraphy of the sedimentary and volcanic rocks and by defining the age and character of tectonic movements.

Alberta

P. Harker completed a detailed faunal and stratigraphic study of the Mississippian formations between the foothills and main ranges of the Rocky Mountains in the vicinity of the upper North Saskatchewan River. The data will aid the search for oil and gas in the deeply buried petroliferous Mississippian rocks to the east.

Ontario and Quebec

Miss F. J E. Wagner continued examination of the Pleistocene deposits and fauna of the Champlain Sea in the Ottawa-Montreal area. This study should determine the extent of that former sea and thus aid the search for deposits of sand and gravel suitable for construction purposes.

New Brunswick and Newfoundland

L. M. Cumming studied the palæontology and stratigraphy of the Silurian strata of southwestern New Brunswick and northeastern Newfoundland. Lower Palæozoic formations contain base metal deposits in both provinces and the results of this project are expected to aid in the correlation of the strata.

General

D. J. McLaren made a brief study of modern coral reefs of Florida and their environment. The knowledge gained will aid in a better understanding of similar oil-bearing structures and deposits of Devonian age in western Canada.

Radioactive Resources Division

The great interest in prospecting and mining for uranium in many parts of Canada caused much demand for the services of this Division. As agent for the Atomic Energy Control Board, the Geological Survey of Canada, through this division, receives and compiles reports of radioactive discoveries and reports of work done on properties operating under exploration or mining permits issued by the Board. By the end of the fiscal year 331 exploration permits were in force. This information, results of field and laboratory studies, and other related data are compiled in a confidential inventory that is revised annually.

Radiometric assays were made on 1,140 samples, and 141 mineral identifications were made.

To aid in research the Division made 947 mineral identifications by X-ray powder patterns, and continued work on a comprehensive collection of standard X-ray patterns. It made 145 X-ray fluorescence analyses, 96 chemical and 427 spectrographic analyses. A special laboratory for making age determinations on radioactive minerals and rocks by means of a mass spectrometer was placed in operation and 117 age determinations were made on 90 samples.

Field Work

Saskatchewan

D. D. Hogarth examined uranium deposits in northern Saskatchewan and in adjacent parts of Alberta to obtain information for the confidential inventory of Canadian deposits of uranium and thorium.

Ontario

S. C. Robinson commenced a mineralogical study of uranium deposits in the Haliburton-Bancroft region.

S. M. Roscoe began a comprehensive study of the origin, distribution, mineralogy and other factors that may affect the discovery and development of uranium deposits in the Blind River and adjacent regions of Ontario.

Ontario and Quebec

G. B. Leech studied uranium deposits in and near the Ottawa and Gatineau valleys.

General

A. H. Lang examined uranium deposits in Ontario.

Mineralogy Division

The new chemical laboratory was put into operation to meet the growing demand by the Geological Survey for analytical work required for research projects.

About 8,000 specimens of minerals, rocks, soils, water, etc. submitted by prospectors, mine operators, educational institutions, farmers and others were examined free of charge and reported on as to their nature, uses and possible commercial value. In about 3 per cent of the cases, the properties or exposures from which the specimens were derived warrant closer examination by those who sent them in. More than 225 reports or letters were sent in answer to enquiries dealing with mineral localities, especially from United States citizens who planned motor and collecting trips in Canada. About 1,120 visitors were furnished with information regarding specimens or mineral occurrences.

In all, 99,554 specimens of rocks and minerals were prepared and arranged in 2,842 collections, which were sold to the public at nominal cost.

The specimens and collections sold were distributed as follows:

	Specimens	*Collections*
Ontario	43,168	1,255
Quebec	6,629	180
Alberta	21,970	613
British Columbia	5,047	164
Newfoundland	4,248	114
Saskatchewan	4,091	114
Manitoba	3,153	88
Nova Scotia	1,247	32
New Brunswick	721	22
Ottawa	9,280	260

Twenty tons of rocks and minerals from 38 localities in Ontario and Quebec were collected to maintain this service.

Acknowledgment is made to the following for specimens of museum quality donated to the Geological Survey collections: Mr. Adams, Portage du Fort, Que. (tourmaline crystal); Mr. E. J. B. Steele, Lyndhurst, Ont. (quartz crystals); Mr. E. Wallingford, Perkins, Que. (coloured wilsonite); Mr. Alfred Duquette, Mont Laurier, Que. (sphene crystal).

Laboratory work on rocks and minerals included: 7 complete analyses of rocks from O'Connor Lake, Northwest Territories; 4 complete analyses of serpentinites from the property of Cassiar Asbestos Corporation, British Columbia; 10 complete and 22 partial analyses of rocks from the Yellowknife area, Northwest Territories; and 15 partial analyses of magnetite-ilmenite from the Granby area, Quebec.

Pleistocene and Engineering Geology Division

Field Work

Northwest Territories

J. G. Fyles, as a member of the aerial geological reconnaissance project known as Operation Baker, made a reconnaissance survey of the surficial geology of about 67,000 square miles of central District of Keewatin. The results of this work will do much to clarify knowledge of the glacial history of this area, especially with respect to the controversial Keewatin ice centre and the waning stages of the last glaciation.

British Columbia

J. E. Armstrong continued the geological study and mapping of the Tertiary, Pleistocene, and Recent sedimentary deposits of the Canadian portion of the Lower Fraser valley (Flood to Gulf of Georgia). The results of this work are proving of great assistance to groundwater studies, to soils studies for agricultural purposes, and to those planning industrial zoning and development or seeking supplies of sand, gravel, and clay.

E. C. Halstead commenced a study of the groundwater supply of a part of Lower Fraser valley and completed this work within Langley municipality (longitude 122°30′ to 122°40′; latitude 49° to 49°15′) and part of Matsqui municipality (longitude 122°15′ to 122°30′; latitude 49° to 49°15′). Despite a high annual precipitation there is a great demand for well water suitable for private and industrial use and irrigation. As a result of the survey the limits of numerous aquifers already in use have been outlined, and new aquifers found. It was also established that some former artesian wells now require pumping because waters from the same aquifers are being wasted by allowing other wells to flow continuously.

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

Alberta

A. M. Stalker completed mapping the surficial geology of the Beiseker area (longitude 113° to 114°; latitude 51° to 52°) and commenced similar work in the adjacent High River area (longitude 113° to 114°; latitude 50° to 51°). Particular attention was paid to buried valleys since these promise to be important sources of gravel, sand and groundwater.

Saskatchewan

B. G. Craig completed mapping the surficial geology of the Battleford area (longitude 108° to 109°; latitude 52° to 53°). In addition, at the request of the Federal Department of Agriculture a study was made of Damsite No. 10, South Saskatchewan River project, to obtain geological data likely to bear on engineering problems of this project.

Saskatchewan and Manitoba

J. A. Elson continued mapping the surficial geology of the Virden area (longitude 100° to 102°; latitude 49° to 50°). The work outlined areas of gravel and demonstrated that the main ice-movement was southeast and not southwest as was formerly believed.

Ontario

O. L. Hughes mapped the surficial geology of the Smooth Rock Falls area (longitude 81° to 82°; latitude 49° to 49°30′). Gravel deposits, which are of great importance to the pulp and paper companies in this region, were given special attention. Information of scientific interest was gained on the 'Cochrane' ice advance and relevant late-Wisconsin geological history.

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

E. I. K. Pollitt commenced and completed a revision of data concerning the groundwater resources of the Lake Simcoe area (longitude 79° to 79°45′; latitude 44°15′ to 44°45′).

Quebec

N. R. Gadd completed mapping the surficial deposits of the Aston area (longitude 72° to 72°30′; latitude 46° to 46°15′), commenced and completed mapping the surficial deposits of the Yamaska and Three Rivers areas (longitude 72°30′ to 73°; latitude 46° to 46°30′), and commenced similar work in the Upton area (longitude 72°30′ to 73°; latitude 45°45′ to 46°). The data obtained relative to the sequence of glacial events and the resulting deposits will permit a better understanding of the factors governing groundwater supply in the district.

New Quebec-Labrador

E. P. Henderson completed the geological study and mapping of the Pleistocene and Recent features of the Labrador centre of glaciation, particularly within the Dyke Lake area (longitude 64° to 68°; latitude 54° to 56°). A reconnaissance of the Pleistocene and Recent features of the Koksoak and Kaniapiskau River valleys to the north afforded data on the marine overlap and on a hitherto unknown major ice advance.

New Brunswick

H. A. Lee completed mapping the surficial deposits of the Fredericton area (longitude 66°30′ to 67°; latitude 45°45′ to 46°). This investigation outlined large deposits of sand and gravel for construction purposes and of clay suitable for brickmaking.

Prince Edward Island

V. K. Prest continued the geological study and mapping of the bedrock and surficial deposits of Prince Edward Island and an inventory of such mineral resources as may exist. The work has resulted in a new interpretation of the glacial history of the island, and is expected to prove helpful in the search for much-needed gravel deposits.

Geological Cartography Division

Maps Published from April 1, 1954 to March 31, 1955

Publication number	Title	Remarks
	Canada	
900A	Canada, Mining Areas and Principal Producing Mines (fourth edition); scale, 1 inch to 120 miles	For separate distribution.
	Yukon Territory	
54-12	Glenlyon; scale 1 inch to 4 miles	Preliminary geological map. Paper 54-12.
54-18	Geochemical Investigation, Keno Hill-Galena Hill Area; scale 1 inch to 1 mile	Preliminary geological map. Paper 54-18.
	Yukon-Northwest Territories	
1034A	Lower Mackenzie River Area (Sheet 3); scale, 1 inch to 8 miles	Geology. For Memoir 273 and separate distribution.
53-7	Northern Selwyn Mountains; scale 1 inch to 4 miles	Preliminary geological map. Paper 53-7.
	Northwest Territories	
1024A	Matthews Lake, District of Mackenzie; scale, 1 inch to 2,000 feet	Geology. For Memoir and separate distribution.
1025A	Courageous Lake; District of Mackenzie; scale, 1 inch to 2,000 feet	Geology. For Memoir and separate distribution.
1031A	Aylmer Lake; District of Mackenzie; scale, 1 inch to 4 miles	Geology. For separate distribution.
1032A	Lower Mackenzie River Area (Sheet 1); District of Mackenzie; scale 1 inch to 8 miles	Geology. For Memoir 273 and separate distribution.
1033A	Lower Mackenzie River Area (Sheet 2); District of Mackenzie; scale, 1 inch to 8 miles	Geology. For Memoir 273 and separate distribution.
53-10	North Coast of Ellesmere Island; District of Franklin; scale, 1 inch to 8 miles	Preliminary Geological map. Paper 53-10.
218G	Magnetic Anomaly East of Atzinging Lake; District of Mackenzie; (advance edition) scale, 1 inch to ½ mile	Preliminary aeromagnetic map.
	British Columbia	
1027A	Zeballos; Vancouver Island; scale, 1 inch to 1 mile	Geology. For Memoir 272 and separate distribution.

Maps Published from April 1, 1954 to March 31, 1955—Continued

Publication number	Title	Remarks
	British Columbia—Concluded	
1028A	Woss Lake; Vancouver Island; scale, 1 inch to 1 mile	Geology. For Memoir 272 and separate distribution.
1029A	Nimpkish; Vancouver Island; scale, 1 inch to 1 mile	Geology. For Memoir 272 and separate distribution.
1030A	Aiken Lake; Cassiar District; scale, 1 inch to 4 miles	Geology. For Memoir 274 and separate distribution.
53-17	Hesquiat-Nootka; Vancouver Island (2 maps); scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-17.
53-34	Findlay Creek; Kootenay District; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-34.
54-7	Canal Flats; Kootenay District; scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-7.
54-10	McDame; Cassiar District; scale, 1 inch to 4 miles	Preliminary geological map. Paper 54-10.
54-11	Nechako River; Coast District; scale, 1 inch to 4 miles	Preliminary geological map.
	Alberta	
1039A	Alberta Oil and Gas Fields; scale, 1 inch to 20 miles	For separate distribution.
1041A	Copton Creek; West of Sixth Meridian; scale, 1 inch to 1 mile	Geology. For separate distribution.
54-2	Kvass Flats, West of Sixth Meridian; scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-2.
	Saskatchewan	
1044A	Saskatchewan Oil and Gas Fields; scale, 1 inch to 20 miles	For separate distribution.
54-6	Gulo Lake; scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-6.
54-8	Crackingstone; scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-8.
	Manitoba	
54-13	Nelson House; scale, 1 inch to 4 miles	Preliminary geological map. Paper 54-13.

Maps Published from April 1, 1954 to March 31, 1955—Continued

Publication number	Title	Remarks
	Manitoba—Concluded	
54-14A	Heming Lake, West of Principal Meridian; scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-14.
54-14B	Elbow Lake, West of Principal Meridian; scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-14.
	Ontario	
828A	Windsor-Sarnia; Essex, Kent, and Lambton Counties (second edition); scale, 1 inch to 4 miles	Geology. For Memoir 278 and separate distribution.
1042A	Windsor-Sarnia; Essex, Kent, and Lambton Counties (Structure contours); scale, 1 inch to 2 miles	For Memoir 278 and separate distribution.
1970	Blind River; Algoma District (reprint); scale, 1 inch to 2 miles	Geology. For separate distribution.
1902	Thunder Cape; Lake Superior (reprint); scale, 1 inch to 3,000 feet	Geology. For Memoir 167.
2282	Thunder Bay Silver Area; Thunder Bay District (reprint); scale, 1 inch to 4 miles	Geology. For Memoir 167.
53-27A	Burleigh Falls; Peterborough County; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-27.
53-27B	Peterborough; Peterborough, Victoria, Durham, and Northumberland Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-27.
53-30	Haldimand County and Parts of Brant, Wentworth and Lincoln Counties (2 maps); scale, 1 inch to 2 miles	Preliminary geological maps. Paper 53-30.
53-31	Norfolk County (2 maps); scale, 1 inch to 2 miles.	Preliminary geological maps. Paper 53-31.
54-17	Campbellford; Hastings, Northumberland, and Peterborough Counties; scale, 1 inch to 1 mile.	Preliminary geological map. Paper 54-17.
174G	Winchester; Dundas, Stormont, Carleton, and Russell Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
181G	Russell; Russell, Prescott, Carleton, and Stormont Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1954 to March 31, 1955—Continued

Publication number	Title	Remarks
	Quebec-Ontario	
197G	Thurso; Papineau, Russell and Prescott Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
221G	Quyon; Pontiac, Gatineau, Carleton and, Renfrew Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	Quebec	
53-8	Northeast Dasserat Township; Temiscamingue County; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 53-8.
161G	Arthabaska; Arthabaska, Megantic, and Wolfe Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
162G	Warwick; Wolfe, Arthabaska, and Richmond Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
163G	Dudswell; Richmond, Wolfe, and Compton Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
164G	Aston; Nicolet, Arthabaska, and Drummond Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
165G	Drummondville; Drummond, Arthabaska, Richmond, Yamaska, and Nicolet Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
167G	Richmond; Richmond, Shefford, Drummond, and Bagot Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
168G	Woburn; Frontenac County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
169G	Sherbrooke; Sherbrooke, Compton, Richmond, Stanstead Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
170G	Malvina; Compton County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
171G	Granby; Shefford, Brome, Rouville, Bagot, St. Hyacinthe, and Missisquoi Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
172G	La Patrie; Compton and Frontenac Counties; 1 inch to 1 mile scale	Preliminary aeromagnetic map.
173G	Orford; Shefford, Sherbrooke, Brome, Richmond, and Stanstead Counties; scale, 1 inch to 1 mile.	Preliminary aeromagnetic map.
175G	Coaticook; Stanstead, Compton and, Sherbrooke Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
182G	Memphremagog; Stanstead and Brome Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
183G	Sutton; Missisquoi and Brome Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
196G	Wakefield; Gatineau and Papineau Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1954 to March 31, 1955—Continued

Publication number	Title	Remarks
	Quebec—Concluded	
215G	Low; Gatineau, Papineau, and Labelle Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
220G	Usborne Lake; Pontiac County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
223G	Danford Lake; Pontiac and Gatineau Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	New Brunswick	
53-32	Millville; York and Carleton Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-52.
53-33	Woodstock; Carleton County; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-33.
22G	Pointe Verte; Restigouche and Gloucester Counties (revised edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	Nova Scotia	
1026A	Southeastern Cape Breton Island; scale, 1 inch to 2 miles	Geology. For Memoir 277 and separate distribution.
1037A	Framboise; Richmond and Cape Breton Counties; scale, 1 inch to 1 mile	Geology. For separate distribution.
228G	Glace Bay; Cape Breton County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
230G	Cape George; Antigonish and Inverness Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	Newfoundland	
1035A	Harbour Grace; scale, 1 inch to 1 mile	Geology. For Memoir 275 and separate distribution.
1036A	La Poile-Cinq Cerf; scale, 1 inch to 1 mile	Geology. For Memoir 276 and separate distribution.
54-3	Holyrood; scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-3.
54-4	Gull Pond (second map); scale, 1 inch to 1 mile	Preliminary geological map. Paper 54-4.
184G	West Gander River (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
185G	Dead Wolf Pond (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1954 to March 31, 1955—Continued

Publication number	Title	Remarks
	Newfoundland—Continued	
186G	Miguels Lake (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
187G	Lake Ambrose (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
188G	Noel Pauls Brook (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
189G	St. Brendans; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
190G	Gambo; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
191G	Great Gull Lake (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
192G	Kepenkeck Lake (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
193G	Snowshoe Pond (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
194G	Burnt Hill (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
195G	Great Burnt Lake (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
198G	Bonavista; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
199G	Eastport; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
200G	Glovertown; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
201G	Pudops Lake (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
202G	Mt. Sylvester (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
203G	Meta Pond (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
204G	Twillick Brook (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
205G	Burnt Pond (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
206G	Feeder Lake (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
207G	King George IV Lake (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
208G	Cold Spring Pond (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
209G	Old Perlican; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1954 to March 31, 1955—Concluded

Publication number	Title	Remarks
	Newfoundland—Concluded	
210G	Bay de Verde; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
211G	Tug Pond; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
212G	Random Island; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
213G	Trinity; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
214G	Sweet Bay; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
229G	Port Blandford; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

One hundred and eighteen maps and scientific figure drawings were draughted for reproduction by photolithography or by zinc-cut process for illustrating memoirs, reports, articles, and papers.

Two maps were at the Printing Bureau for lithographing at the end of the fiscal year. One map and thirteen map figures were at the Surveys and Mapping Branch for printing. Work was in progress on seven standard geological sheets, eleven preliminary geological maps and twenty-six preliminary aeromagnetic maps.

Administrative

Geological Information and Distribution

In all, 262 reports and maps were made available for distribution, of which 101 were reprints. New editions included 6 memoirs, 25 preliminary papers, 57 geophysics papers (maps), and 19 geological maps. The number of publications distributed was 132,070, of which 53,061 were maps.

Library

Acquisitions:

Books acquired by purchase	565
Books (complete unbound volumes by purchase)	452
Books by transfer, gift, and exchange	587
Canadian periodicals	1,836
Canadian government publications	5,858
British and foreign government publications	4,316
Proceedings, transactions, and bulletins of societies	3,267
British and foreign periodicals	8,156
Total	25,037

Other data:

Recorded loans of books, pamphlets, periodicals	28,661
Inter-library and occasional loans	2,752
Books borrowed from other libraries	463
Maps and charts added to the library	2,737
Maps and charts borrowed from the library	582
Lantern slides borrowed	274
Lantern slides added to the library	50
Cards added to lantern slide catalogue	112
Photographs loaned (exclusive of albums)	404
Volumes bound	520
Volumes accessioned	1,168
Cards added to general catalogue	17,707
Cards added to map catalogue	800
Letters and cards received	3,447
Letters and cards sent	5,136
New serials received and catalogued	162

Photography

The major items of production included:

Contact prints, up to 11" x 14"	20,364
Dry-plate negatives	2,075
Lantern slides	368
Photographs dry mounted	2,032
Bromide enlargements, up to 24" x 30"	5,041
Auto-radiographs	128
Magnetometer film developed	5,885 ft.
Magnetometer film printed	9,521 ft.
Exposures developed, field work	4,546
Kodalith negatives	1,298
Vinyl positives	235
Vandyke prints	2,271

Reproduction Processes

Blueprints	215,842 sq. ft.
OCE prints	20,163 sq. ft.
Photostats (18" x 22")	10,882 sheets
Mimeograph	708,864 impressions

Lapidary

Mineral and rock specimens prepared for scientific study:

Thin sections	4,343
Polished sections	633

MINES BRANCH

John Convey, Director

The mineral industry continued to make heavy demands upon the Branch's services and facilities to solve the many problems associated with its present high rate of growth. Foremost amongst these were requests for work on the processing of complex ores, including radioactive ores. In addition, defence requirements and those of Atomic Energy of Canada, Limited, covered a wide field.

Aside from the very extensive work in developing processes for treating uranium-bearing ores, most of the tests and research on metal-bearing ores were on non-ferrous base metal ores, many of which came from new discoveries. An appreciable amount of technical effort was expended in the processing of ferrous ores.

Research on industrial minerals was related to deposits in all 10 provinces including the newly discovered deposit of witherite and fluorite at Lower Liard Crossing on the Alaska Highway in northern British Columbia. Witherite is important to industry as a source of barium compounds. A study of the possibility of producing sand suitable for concrete work from freshly quarried rock showed that such sand may be made from deposits of limestone within economic reach in the St. Lawrence Seaway area.

Fuel investigations centred about the various problems confronting the coal industry and on research into refining methods applicable to bitumen and low grade crude oils. The research on bitumen is directed toward the utilization of the great resources of bitumen in western Canada.

In the field of physical metallurgy the Branch carried out approximately 300 investigations for industry, Atomic Energy of Canada, and for the defence services. A treatment for drill rods developed by the Branch reacted favourably to tests in several Canadian mines, and indicated a marked extension in the life of these rods.

Numerous economic studies were made of specific phases of Canadian mineral resources and development.

A special section with staff and services continued work for the Royal Canadian Navy. The section was engaged in producing new types of underwater sound equipment and in repairing anti-submarine devices. It continued the processing of quartz for radio-frequency control units for the armed services and carried out further research on the use of piezo-electric ceramics. All quartz for Government use was inspected and graded by the section.

The Branch lost the valued services of two of its Division chiefs: R. E. Gilmore, who had been chief of the Fuels Division since February 1947, and R. J. Traill, chief of the Mineral Dressing and Process Metallurgy Division since June 1946. Mr. Gilmore was succeeded by A. Ignatieff and Mr. Traill by K. W. Downes.

Mineral Dressing and Process Metallurgy Division

Complete ore dressing investigations on 37 shipments of ores and concentrates formed a substantial part of the work of the Division. The nature and origins of the samples received are shown below.

Nature of Samples	Yukon	N.W.T.	B.C.	Alta.	Sask.	Ont.	Que.	N.B.	N.S.	Nfld.	Total
Copper-lead-zinc	1						1	2	1		5
Copper-cobalt-nickel					1						1
Iron		2		2		3	2			1	10
Iron-nickel							1				1
Iron-gold						1					1
Manganese							1		2		3
Tungsten		1									1
Gold			1			3					4
Titanium							4				4
Niobium-tantalum		1				2					3
Beryllium-lithium		1									1
Rare earths						1					1
Zirconium						1					1
Uranium						1					1
Total	1	5	1	2	1	12	9	2	3	1	37

Base metals comprised most of the shipments, and the receipt of ores containing manganese, niobium, tantalum and rare earths indicated the growing diversity of the mineral deposits being developed in Canada.

Aside from the above, 22 mining companies, working in association with the Division made use of the ore dressing facilities to conduct their own investigations, the amounts of ore varying from one to 115 tons.

At the request of industry, a set of master sieves was established in the Division, all carefully standardized, against which mill operators may calibrate their own sieves. This setting up of a national standard will enable operators to estimate the sizing of their products from a common basis, and thus to make more accurate comparisons of their grinding efficiencies.

Also at the request of industry extensive work was done on the beneficiation and treatment of ilmenite (iron-titanium) ore from Quebec. This ore is a source of titanium dioxide pigment and is a potential source of titanium metal. Tests to determine the best methods for sulphur elimination and for beneficiation indicated that magnetic separation gave the best overall results, and over 70 tons of ore were treated by this method.

A large scale smelting investigation, involving over 100 tons of ilmenite ore, was conducted using the 250 KVA electric furnace. Engineers from a Canadian company working in association with the Division produced a pig iron and a high grade titanium slag. The effect of different types of furnace charge and various smelting methods on the efficiency of the operation were determined. The slag produced was good raw material for the production of titanium dioxide pigment.

Research on the production of synthetic rutile, containing 94 per cent titanium dioxide, was completed to the satisfaction of the Canadian company concerned, whose consultants recommended that the process be tested on a pilot plant scale. The synthetic rutile produced was shown to be an excellent source of titanium tetrachloride, from which titanium metal is produced. It is also soluble in acid and hence can be used as a source of titanium dioxide pigment if desired. It appears that this material would be competitive with natural rutile, most of which is imported from overseas.

Studies of the high-temperature chemistry and constitution of high-titanium slags were continued, to provide basic data of use to producers in attaining maximum efficiency.

Further research on the production and refining of metallic titanium has shown that metal of high purity may be obtained from crude titanium. By conducting the reaction in a molten salt bath it has been possible to eliminate some major difficulties that arise when the same reaction is conducted in the vapour phase. Ductile metal of 99·7 per cent purity was obtained on a laboratory scale. A modification of the process makes it possible to produce an adherent protective coating of titanium metal on some metallic and ceramic articles.

At the request of several mining companies, work on the treatment of low grade manganese ores was continued. A marketable concentrate with good recovery was obtained from a large deposit containing very finely disseminated pyrolusite (manganese dioxide). Two other deposits of more complex nature have proved more refractory and so far only low grade concentrates have been obtained. Such concentrates can be smelted, however, and tests in the Division's 50 KVA electric furnace have shown that a pig iron and a low-carbon ferro-manganese can be produced by a two-stage process. This procedure will be tested in the 250 KVA electric furnace.

A possible new use for electric smelting was found in the treatment of asbestos tailings, present in large tonnages in Quebec. Besides magnesium, they contain small amounts of iron, nickel and chromium and it was shown that they can be smelted to produce ferro-nickel, and a high magnesia slag. The preliminary results from this work have led the company concerned to plan tests in the Division's 250 KVA furnace.

A method for recovering the niobium which may be present in by-product ferrophosphorus obtained during electric smelting, was investigated on a laboratory scale, and was found to be technically feasible. The phosphorus content of the ferrophosphorus may be recovered at the same time. This investigation was initiated because of the present wide interest in niobium. Discoveries of deposits of niobium ores in Canada have made necessary an investigation of their treatment. In some cases the niobium is associated with minerals that are impossible to concentrate by simple means and leaching has had to be employed. Good recoveries are obtainable by this method, but further work is required to decrease the treatment costs.

The Division continued to advise industry, and particularly the Department of National Defence, on problems involving corrosion. Samples submitted included airframe and aero-engine parts, signal equipment, and various types of armament, and in each case the cause of corrosion was determined and a remedy suggested. The Division also dealt with a wide variety of problems connected with the production and quality of protective coatings.

Some further work was done at the request of industry on the process for recovering elemental sulphur from pyrrhotite. Developed by the Division, its simplicity and effectiveness have been amply confirmed. The process was extended to include the treatment of a complex base metal ore containing a large proportion of pyrite, which was difficult to treat by ordinary ore dressing methods. It was shown that if the pyrite was first thermally decomposed to form an artificial pyrrhotite, this pyrrhotite could then be treated to yield elemental sulphur. Preliminary results indicated that the base metals which had been associated with the pyrite could be separated by chemical means, following the recovery of the sulphur.

The Division is continually improving its facilities for mineragraphic examinations. Thus an examination of abrasives used in preparing polished

sections of ores for study under the microscope lead to the development of a very effective technique using fine diamond powders in lieu of the commonly used abrasives. In addition, a new method, which can be used for mineral identification and for studying mineral association, was adopted, in which thin sections of ores are interposed between a photographic film and a source of X-rays. The varying absorptive power of the different minerals in the thin section causes images of the minerals to appear on the photographic film. This technique was used effectively in studying the complex manganese and niobium ores. Improvements were made in an electronic instrument which is under development for determining the temperatures at which hydrothermal minerals in an orebody were deposited. It is hoped that such information will eventually aid mine operators in working out the geological history of ore deposits.

Using these and other techniques, 54 complete microscopic studies of ores were made during the fiscal year, involving the preparation of 625 polished sections and 176 thin sections. In addition, 150 prospectors samples were examined and reported on.

Many relatively minor tests were made for various Canadian industries. The Division made a study of the desirable characteristics of bonding clays which are used in foundry sands and developed a slip-casting technique for making thorium oxide crucibles which are used in melting special alloys. In its spectrographic laboratory it completed development of an electronic device for the simultaneous scanning of standard and unknown samples, and brought it into routine use. The device improves the speed and the accuracy of spectrographic analysis. In all, 20,052 spectrographic determinations were made in this laboratory during the fiscal year.

In its chemical analysis laboratory the Division made 21,556 determinations on 5,694 samples. There was a large increase in the number of samples submitted for assay for the rare elements such as niobium, tantalum and lithium. The facilities of the laboratory were made available to analysts who were carrying out pilot plant work for their companies in the Division. The Division participated in collaborative studies on methods of analysis with two Canadian universities and several Canadian mining and metallurgical companies. These studies dealt with alkali metal, base metal and precious metal determinations.

The program of developing rapid optical and electronic methods of analysis was continued. The determination of magnesium in nodular cast iron and of aluminum in steel and in brasses and bronzes was adapted to the flame photometer. A potentiometric method for zinc was developed, which required no separations for many ores. In the field of spectro-photometry a precise colorimetric method for determining low gold values was worked out, which is superior to the conventional method of weighing small beads on an assay balance. The accurate colorimetric method for the determination of tungsten was extended to include concentrates containing up to 50 per cent tungsten oxide.

The Division was represented at 32 meetings of scientific societies and technical committees including the Canadian Government Specifications Board. It issued 108 formal reports of investigation and dealt with 1,401 letters concerning its activities. Its officers presented or published 17 technical papers during the fiscal year.

Radioactivity Division

The Division continued its investigational work on radioactive ores, with a major part of the effort devoted to application of metallurgical treatment methods for uranium recovery from specific ores. The recent rapid develop-

ment of commercial orebodies in several privately owned properties resulted in a continuing demand for extensive pilot plant programs to work out detailed processing methods for these ores and to provide data required for full-scale plant design. The Division has the only pilot plant facilities available in Canada for much of this work.

Close contact was continued with the Crown-owned Eldorado Mining and Refining Limited, several members of whose research and development staff worked on Eldorado projects in the Division's laboratory. The Division worked with the Eldorado staff on common problems in the laboratory and on pilot plant operations in the field.

During the fiscal year Eldorado began operation of a new extraction plant at Beaverlodge in northern Saskatchewan, using the atmospheric pressure carbonate leach originally developed by the Division. Private companies also had staff in the Division's laboratory participating in pilot plant work or being trained on various phases of process operations, analysis etc. This extra staff, including that of Eldorado, usually averaged about thirty, compared with the normal 65 of the Division's staff.

The Division issued 72 classified and 46 unclassified reports, 88 of which covered work done for 24 companies.

Ore Treatment Work

Three companies obtained extensive pilot plant testing of their ore. With the present space and staff only one major pilot plant operation can be carried on at a time. Laboratory scale investigations of their ore were made for a number of other companies.

The pilot leach plant programs extended over an eight-month period and included comprehensive testing of ore from the above three companies, two with ore deposits in the Blind River area, and one with a property in the Bancroft area, both in Ontario.

All of these investigations required complete mineralogical examination and preliminary laboratory physical and chemical testing programs before the pilot plant work could be planned and started. All the pilot plant leaching was done using the acid leach process developed by the Division in 1948-49 and modified as necessary for the ore being tested. Complete testing for means of recovering the uranium from the leach liquors was done as part of the pilot plant program and included extensive operation of a continuous ion exchange system. The results of this work were used by the companies in the design of three full-scale plants, one of which is scheduled to begin operation in 1955 and another in 1956.

Another pilot plant for investigating a new process for the recovery of uranium from alkaline leach liquors was installed and operated under the direction of the Division at the Eldorado operation in the Beaverlodge area.

Further research was done on the atmospheric pressure carbonate leach process. This work consisted of a two-month program of large-scale batch leaches in a tall tower to determine optimum aeration rates for the process. In this program the Division worked closely with Eldorado's Research and Development Division. During the year, Eldorado built and put into operation a full-scale atmospheric pressure alkaline leach plant incorporating the basic principles of the process as developed originally by the Radioactivity Division.

In its services to private companies and individuals the Division tested 29 samples from 25 sources, with work on four of the samples still in progress at the close of the fiscal year. The testing was in addition to the samples

investigated by pilot plant study and laboratory work in conjunction with the pilot plant. Ore dressing and extractive metallurgy investigations were carried out on several samples received from Eldorado properties.

Analytical Chemistry

Over 13,000 samples were handled, requiring approximately 19,000 assays. Considerable development work was done to adapt analytical methods to the increasing variety of products being handled, and an increased number of the more difficult analyses was required.

Increased attention was given to more accurate methods of determining uranium at higher grades and to improvement of methods for various other assays required on radioactive ores and products. Arrangements were made for the Division to act as assay umpire, when necessary, between Eldorado Mining and Refining Limited the official uranium purchasing agent, and the private uranium mining companies.

The Division continued to train analytical staff for the mining companies, the number trained during the fiscal year being eight. It assisted four companies in setting up laboratories for fluorimetric analysis. Visits were made to the analytical laboratories of Eldorado Mining and Refining Limited at Port Hope, Ontario, Beaverlodge, Saskatchewan, and Port Radium, Northwest Territories in connection with analytical problems.

Mineralogy

Mineralogical examinations were made on 20 samples from new occurrences. This work included detailed studies of new ore types submitted in preparation for physical and concentration test work, and reconnaissance examinations on other samples in order to compare them with ores previously studied or to provide preliminary information to help in evaluating new showings. Similar work was done in a number of instances for Eldorado, and technical assistance and mineralogical laboratory facilities were made available to its staff.

Physics and Electronics

This phase of the Division's activities included research, test work and radiometric analyses. There was a large increase in the number of radiometric analyses.

Standard uranium and thorium samples were supplied to industrial users in Canada and abroad. Personnel from many outside organizations were introduced to and trained in the use of radiometric analytical procedures.

The main work on applications of electronic methods to ore dressing has centred on the re-design and testing of the Lapointe picker belt for the concentration of low grade uranium ores.

The use of transistors in circuits was studied carefully, and a number of useful circuits were developed that should greatly simplify the operation and maintenance of electronic units employed in the detection and analysis of uranium in ores.

Work was done on the design of compact portable counters for survey work. Such counters will use transistor circuits, which, it is hoped, will greatly extend the useful life of the instruments. Design of a variety of the counters is still in progress.

Many enquiries were again received concerning prospecting instruments and methods of analysis. Cooperation is maintained with other organizations on questions of health hazards, in uranium mines.

A study was made to apply radioactive tracers to a determination of flow conditions in agitation of mineral pulps. Radioactive isotopes are being applied to the solution of problems in analytical chemistry and several experiments on the use of metallurgical projects are in progress.

Industrial Minerals Division

The demand for industrial minerals was again at record levels, resulting in an increased need for technical information on resources of these minerals throughout Canada. Field work was done in nine of the ten provinces and samples from all ten provinces were processed in the Division's laboratories. In all, 639 samples of industrial minerals ranging in size from a few pounds to over 50 tons were investigated in the laboratory. Their regional origins are shown below.

Samples	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Totals
Andalusite			1								1
Anhydrite			4	1						1	6
Apatite					3	3					6
Asbestos					3	2				3	8
Barite					2	1					3
Bentonite									6	4	10
Corundum						1					1
Diatomite					1					1	2
Diopside					1						1
Dolomite						6					6
Fluorspar						1				4	5
Garnet						1		1			2
Graphite					1				1		2
Gypsum			6							1	7
Kyanite						2				2	4
Limestone				3	3	33					39
Magnesia					2						2
Magnesite	18									2	20
Marble					3						3
Mica					3					2	5
Nepheline Syenite						4					4
Pyrophyllite							1				1
Rare Element Minerals					1					5	6
Roofing Granules					2	1				1	4
Shale				1							1
Silica			1	1	4	10					16
Sillimanite							1				1
Sodium Sulphate							1				1
Talc							1				1
Vermiculite						1					1
Witherite										3	3
Cement Materials			2		5	7					14
Ceramic Clays and Shales	1	3	135	5		37	5	3	27	33	249
Concrete Aggregate	1			1	10	78					90
Lightweight Aggregate:											
(a) Clay and Shale	2		1	8	3	8	10	1	7	7	47
(b) Perlite										12	12
Manufactured Sand						6					6
Sand and Gravel		1		1	16	26	5				49
Totals	22	4	150	21	63	228	24	5	41	81	639

In addition to the above over 800 samples of rocks and minerals submitted for identification and evaluation were examined and reported on, and 824 samples of industrial waters were analysed, involving nearly 1,800 determinations.

The results of the Division's work are made available to the public and to industry by means of reports, interviews, and correspondence. During the year the Division issued 308 reports, those of more than limited interest being listed under "Publications" page 114. Also, replies were sent to approximately 1,600 written enquiries for technical information on industrial minerals and their products.

Following an investigation it made several years ago, which disclosed a scarcity of suitable sand for concrete work in the area of the St. Lawrence Seaway and power development, the Division undertook research into the possibilities of producing a sand at suitable cost from the rocks of the area. This research was continued on a large scale during the fiscal year in cooperation with The Hydro-Electric Power Commission of Ontario, the Federal Department of Transport, and the St. Lawrence Seaway Authority. Samples of various types of limestone from the area up to 50 tons in weight were processed into sand in the Division's laboratories and the type best suited for use in concrete was determined.

The investigation into the production of lightweight aggregates from clays, shales and perlites was continued. The purpose of the test work has been to produce the highest quality aggregate, namely the "coated" type, at the lowest cost by using the raw materials in their natural state. Work has been done on materials collected from all parts of Canada and preliminary reports on most of the work are now available. The reports provide information on the locations of clays and shales which appear most suitable for lightweight aggregate production. Using this information, three plants have been built and a fourth is in prospect.

An investigation was undertaken into the best means of producing heavy concrete for use as a shield against radioactivity. Various heavy minerals were used as aggregates and the object was to size the aggregate in such a way as to obtain a concrete of maximum weight per cubic foot. The samples are now under test.

The survey of the quality of the resources of industrial waters in Canada was continued. Sampling of the waters of Western Canada has been completed and sampling of those of the Maritime Provinces is in progress, with 43 stations in operation. The mobile water-analysis laboratory made on-the-spot analyses of water samples in these provinces as a check on the analyses of the same samples made later in Ottawa. Samples from all municipal water supplies in the Maritimes were taken by the operator of the mobile laboratory.

Work on the analytical control of boiler waters at 13 army camps in Canada was undertaken for the Department of National Defence.

Research on special problems concerning water was done for other government departments and for industry, and special research was done on analytical methods for various scientific societies which in turn provide the Division with the latest information on improvements in methods of water analysis.

The Division continued to assist the ceramic industry by investigating new sources of raw materials and by examining and testing products being made by the various companies. Research on methods of recovering kyanite in pure form from Canadian occurrences yielded a very high-grade product by two methods, one of which involved the recovery of marketable by-products and the other the recovery of kyanite only. Research on the utilization of the

kyanite for the production of super duty refractories resulted in the solving of many problems encountered in attempts to use Canadian kyanite. This coupled with the favourable results of the research on the recovery of the kyanite may lead to the development of one or more of the deposits.

Research is under way on the separation of witherite (barium carbonate) from a newly discovered deposit of this mineral in northern British Columbia. This is the first known large occurrence of witherite on the continent. Purpose of the research is to find an economic means of separating the witherite from its associated minerals and thus pave the way for the operation of the deposit.

The preliminary field survey of the resources of industrial minerals in Newfoundland was completed and a report has been prepared for publication.

A bibliography of published and unpublished laboratory reports on the treatment of Canadian industrial minerals will go to press shortly and a report on the Canadian granite industry is now in the press.

In cooperation with the Royal Canadian Navy and the Canadian Government Specifications Board the complete testing of all types of refractory materials used in marine and stationary boiler furnaces was continued. Sixty-five refractory products of various types were thus tested. The results are of particular value to manufacturers in showing where their products can be improved; they also provide a basis for revision of specifications.

Research in cooperation with the Naval Research Establishment, Defence Research Board on the development of piezo-electric ceramics for ultrasonic use was continued. An improved method of processing was developed which has made possible the production of large numbers of identical specimens for testing.

A detailed investigation into the fireclay and semi-fireclay deposits near Shubenacadie, Nova Scotia yielded very satisfactory results. Products made in the laboratory were of such quality that the working of the deposits is expected to follow shortly.

Work on improving the quality of Canadian ceramic products was continued, particularly in relation to the development of improved bonds for refractory cements, plastics and castables.

Evaluation tests were made on 249 samples of ceramic clays and shales from various parts of Canada.

Research was resumed on the problem of obtaining a silica sand from Canadian sandstone deposits sufficiently low in iron to constitute a raw material for glass plants. Samples from four provinces were processed.

In addition to the above major investigations, the Division did research on: utilization of anhydrite; the wet grinding of mica; the beneficiation of talc; the uses of magnesia; the preparation of pure sodium sulphate from impure deposits; the properties of asbestos fibres; the activation of bentonite; the production of roofing granules from Canadian sources; the properties of slag cements; and the causes of efflorescence on stone and masonry.

Fuels Division

The major objective of the Division is investigation of improvement of methods in producing and utilizing Canada's fuel resources. To do this, research in coal has been directed toward (a) study of stress phenomena in mining (b) improvement in preparation techniques and (c) study of problems relating to combustion and power.

Research on petroleum is being done on the improvement of the quality of low grade oil of which Canada has an abundant supply in the bituminous sands of northern Alberta and in several producing fields. Aid is being given to small

refineries treating these oils. Chemical investigations are being done also in relation to the origin of oil as a means of clarification of certain geological theories.

Bitumen and Petroleum

The research on the improvement of Canada's low-grade oil reserves consisted of experiments designed to remove the sulphur and ash from the petroleum. This was done by a flash distillation procedure followed by the hydrogenation of this distillate. Although the sulphur and ash were removed the refined product would not meet the current gasoline and diesel oil specifications. This indicated that more rigid refining treatment is necessary. To this end a pilot plant is being constructed for operation at much higher hydrogen pressures. Preliminary testing of the unit may be undertaken shortly.

To aid the aforementioned refineries that treat low-grade oils, a project was undertaken to develop a simple refining technique for producing a distillate and a very hard pitch suitable for use in the fibre board industry and road building. The preliminary results were encouraging.

As the future economic development of low-grade crude oils depends upon a much better understanding of their chemical constitution, efforts were made to improve the techniques for the characterization of their chemical constituents. This required the construction of an absorption spectroscopy laboratory. A report was prepared showing the application of absorption spectroscopy to the classification of oils and bitumens. The developments in this field were applied to the clarification of certain geological theories as to the origin of oil. It has been shown that the Devonian origin of Athabasca bitumen is most unlikely. This has consequently indicated that conditions for oil formation existed in the lower Cretaceous period and that this formation should be more thoroughly explored.

Deep Mining Project

Investigations were continued into the occurrence and characteristics of phenomena resulting from excessive strata stresses associated with the extraction of minerals with particular attention to "bumps" and "outbursts" of gas and coal in certain coal mines of eastern and western Canada. These cause mining at depth to become hazardous and costly and it is hoped that the study will provide the answers to the problem. The project is being conducted jointly with industry, provincial governments, the Geological Survey of Canada and other divisions of the Mines Branch.

In the work on the project during the fiscal year observations were continued at a selected group of mines in Alberta and Nova Scotia as were laboratory work on the development of apparatus for field use and determinations of the physical characteristics of the rocks and coals from the mines. The underground observations included the measurement of stress by dynamometers, and the determinations of strata movements by recording and indicating convergence instruments. Stress measurements were made in the solid strata by means of specially devised load cells and in the open workings by more conventional dynamometers. The outbursts of gas in coal were observed by an electrical resistivity method with apparatus designed at the Mines Branch. A method of inducing outbursts by shatter blasting was studied in the mines of France and Belgium and the information has been used to good effect in Canadian mines. The possible relationship between seismic activity in western Canada and the occurrence of "bumps" in underground workings was examined by means of seismometer stations in the coal-producing centres of the Crowsnest Pass.

An investigation was commenced on the submarine iron ore deposits at Wabana, Newfoundland, into the relationship existing between the pattern and magnitude of the stresses existing in the ore and enclosing strata and the system of mining now employed. The work is being done at the request of Dominion Wabana Ore Limited and the provincial government, the purpose being to determine the feasibility of a higher degree of extraction.

Electrical Equipment Certification

A certification officer was appointed in August 1954. He visited the provincial departments interested in the Federal Government's service of certifying electrical equipment for coal mines and also a number of coal mines to study operating conditions. A memorandum was prepared as a guide to manufacturers and others interested in the procedures connected with the testing and certification of electrical equipment. The laboratory for testing electrical equipment is being set up and should be available for use in 1955.

Testing Mine Airs

The Division cooperates with the provincial mining inspectors in the periodic testing of mine airs to ensure adequate ventilation in the workings. Fifty-one samples received from British Columbia were analyzed and reported.

Physical and Chemical Survey of Canadian Coals

This work is part of the study of the basic properties and characteristics of Canadian coals including their suitability to cleaning. Large scale samples from five mines in Nova Scotia and one mine in Alberta were examined and reports were issued for use of the interested parties.

Commercial Coal Surveys

This survey was done in cooperation with the Dominion Coal Board and the provincial mines departments to obtain information on the quality of coal offered for sale by the coal operators. It is part of the general survey of Canadian commercial coals to obtain data for the Analysis Directory of Canadian Coals issued by the Mines Branch.

Coal Beneficiation

Investigations were continued on the problem of finding uses for the finer sizes of western Canadian bituminous coals which are particularly friable. Considerable attention was paid to the evaluation of factors influencing the production of briquettes to meet market requirements. A nozzle for the improved dispersal of asphaltic binder used in briquetting was developed and tested in commercial plants in western Canada, and the results were encouraging and further experimental work is continuing.

Briquetting of Ores and Concentrates with Coal

In an effort to further the use of friable coals in the metallurgical industries, a study of agglomeration techniques was undertaken in cooperation with Quebec Iron and Titanium Corporation. Forty tons of briquettes of ilmenite coal and coke blends were prepared for processing in the Branch's experimental electro-melt furnace. In addition, an investigation was carried out on the preparation of briquettes made of titanium slag blended with coking coal or coke, which would be suitable for further processing for the production

of metallic titanium. This processing involves reduction, leaching with sulphuric acid, and chlorination. The briquettes must be strong enough to retain a coarse granular structure after all the above treatments.

Combustion Engineering

Tests were made in two types of domestic automatic coal-fired furnaces on Canadian and United States bituminous coals. For purposes of comparison a domestic high pressure gun type oil burner was installed in one of the laboratory test boilers and tests were carried out to simulate normal operating conditions. This series of tests showed the preference for oil for domestic heating on the basis of cleanliness and convenience. However, the use of a coal suitable for automatic stoker equipment can result in a saving of approximately 25 per cent in annual heating costs.

Work was continued on the preparation of briquettes for use in automatic ash disposal stoker unit developed by the Nova Scotia Research Foundation. Although the briquettes tended to break down in the screw feed of the stoker, the results were encouraging.

Cyclone Smelting

This research project is a sequel to 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 small experimental unit for producing pig iron with the use of coal was dismantled and a large unit was constructed with which it is hoped to gain information on the economics of this process. If successful, this technique would permit the use of coal in place of expensive coke in the manufacture of pig iron. Such a development would become increasingly important as the reserves of coking coals diminish.

Coal-Fired Gas Turbine

This equipment, which is installed at the Gas Dynamics Laboratory of McGill University at St. Anne de Bellevue, was operated for about 300 hours during the year. Some difficulties were experienced with slag formation and corrosion of the tubes in the hot heat exchangers. The causes of these troubles and methods for their prevention are being investigated.

Thermal Power Investigation

The power investigation, being conducted in collaboration with the Dominion Coal Board, was continued. A survey of steam-electric generating plants in the Prairie provinces was undertaken, similar to that conducted in 1953 in the Maritime provinces. The main conclusion of these surveys was that more thermal capacity will be required to satisfy the rapidly increasing demands for power in certain parts of Canada in view of the inadequacy of economic hydro-electric power in these areas.

Committee and Conference Work

The Division cooperates in the work of a number of technical committees and conferences, among them being: the Dominion Provincial Conference on Coal Research; the Committee on Fuel Research of the British Commonwealth Scientific Official Conference; the Canadian Government Specifications Board; the Interdepartmental Fuel Committee; the Thermal Committee of the Cana-

dian Electrical Association; the International Conference on Briquetting; the Research and Mining Methods Committee of the Coal Division; Canadian Institute of Mining and Metallurgy; the International Peat Symposium, Dublin, Ireland; and the Coal and Coke Committee of the American Society for Testing Materials.

Physical Metallurgy Division

The work of the Division may be divided into three main categories.

1. Investigations into the causes of failure or unsatisfactory service of metal parts and into metallurgical production problems in the melting, shaping or heat treating of metals.
2. Applied research on the production of new alloys, the improvement of existing alloys, the development of new metallurgical methods and the improvement of existing methods.
3. Fundamental research aimed at exploring some of the laws governing the behaviour of metals, such as the mechanism of deformation and fracture of metals, and the effect of time and temperature on metallic microstructures and lattice structures.

The time devoted to these is about 50, 40, and 10 per cent respectively.

Investigations

At the request of The Consolidated Mining and Smelting Company of Canada Limited an investigation was carried out which showed that pig iron electrically smelted from roasted pyrrhotite tailings from the company's operations at Kimberley, B.C., can be used for steel making. The steel made compares favourably with a good commercial grade of structural steel in mechanical properties, hot working, and welding characteristics. The tonnage of high grade iron oxide continuously available from the concentrator could serve as raw material for a small steel industry. Faulty spot welding on tail fins on projectiles to be used in anti-submarine missile throwers was investigated, the reasons for the faulty welds were established, repair procedures devised, and the units already produced were salvaged.

Owing to the shortage of certain alloying metals the Division has been carrying out research on the use of boron as a substitute in the production of high strength steels. Conventional boron steels must be quenched and tempered to develop high tensile strengths, but excellent tensile properties were obtained in normalized and drawn castings of a low-alloy, low-carbon boron steel produced by the Division in sections up to 5 inches. Impact properties were poor, however, at both room temperature and —40°F., and rare earth metal additions were tried as a corrective measure. These raised the impact strength appreciably at room temperature, but only slightly at —40°F.

A series of experiments was carried out to determine the most efficient methods of desulphurizing grey cast iron. Soda ash, caustic soda, lime, calcium carbide and calcium cyanamide were investigated. They were added to the stream during pouring of metals produced in a 500-pound acid-lined direct-arc electric furnace. Nitrogen determinations, before and after ladle treatment, were made on heats treated with cyanamide additions of 15 to 40 pounds per ton, and on heats desulphurized with 40 pounds per ton of the five compounds.

Sulphur reduction varied from 4 per cent to 80 per cent, depending on the type of compound, quantity, and method of introduction. Calcium cyanamide increased the nitrogen content of the iron, thereby affecting the strength

of the iron. The value of rice hulls as an anti-piping material was investigated. Anti-piping materials delay the formation of a skin of solid metal at the metal-air interface of a casting until solidification is complete. In the absence of such a skin, atmospheric pressure promotes feeding of the casting and thus helps to ensure soundness. The work showed that, on a cost per pound basis, rice hulls are an exceptionally efficient anti-piping material.

An investigation was made on foundry clay properties to obtain information that would be of use to small foundries not provided with mullers and which, therefore, must mix the sand and clay by hand. Most published data on the properties obtained with foundry clays deal with mulled sand and are not applicable to foundries using natural sand systems. Mulled sand is sand treated in a special mixer, which smears the clay binder more intimately over the sand grains than hand mixing can do.

Five samples of commercial foundry clays were used as sand binders, and the properties of mulled and unmulled mixtures were measured. Western bentonite was found to have the best combination of durability, green strength and dry strength when the sand was mulled. Illite, because it was least sensitive to the degree of mulling, appears to be superior to the other clays for hand mixing methods. For the small foundry, therefore, this type of clay would give the best results.

An investigation was initiated to determine the risering requirements of nodular iron, a relatively new engineering material, a number of factors covering the production of which are unknown. Data obtained from this study will help the practical foundry man to produce nodular iron castings with a maximum yield of sound metal.

Applied Research

The method of cold working critical areas of mining drill rods by the newly devised process of spiral rolling, which gave such promising results in the Division's laboratory tests last fiscal year, is being tested in a number of mines. Interim reports from the mines indicate that use of the method increases the footage drilled from two to three times before breakage of the rods.

A crack depth indicator, designed and produced in the division during the past year, should be particularly useful in the detection and prevention of fatigue of metals. Eighty per cent or more of metal failures are attributable to fatigue, in which a minute crack forms at the most highly stressed point and thence progresses through the metal part. Fatigue failures usually originate at pre-existing cracks. The indicator will enable the operator to follow the progress of fatigue cracks, to distinguish between surface marks and cracks and to determine whether or not individual cracks in unfinished products may subsequently be removed in the final machining process. No such instrument is commercially available and its economic advantages, particularly in the inspection of ordnance, are obvious.

Load cells developed by the Division for the measurement of strata pressures in coal mines were used to record the changes in stress magnitude and direction in certain coal pillars during the normal process of coal extraction. This project ties in with a study the Department has been making of rock pressures in mines in eastern and western Canada in order to acquire information that may help solve the problem and thus make mining at depth

economical and safe. A further type of load cell was developed and thoroughly checked in the laboratory and is undergoing extensive field tests. A specially designed resistivity apparatus was used in an attempt to foretell the incidence of outbursts in the mines and so reduce the accompanying hazards.

A vacuum electric arc furnace was devised, primarily for the production of titanium alloys, but also capable of melting zirconium and other highly reactive metals. Titanium studies in the Division are designed to provide fundamental "know-how" for use of industry in establishing the production of titanium metal in Canada. Although the furnace capacity is small its operation shows that the design is sound and may be used as a basis for the construction of larger capacity units.

A greater understanding of such subjects as the phase relations existing in alloy systems, precipitation processes, and the texture of fabricated metals is needed to achieve closer control of metallic properties. A magnetic susceptibility balance designed and built in the Division during 1954 has made such studies much more practicable. The first application was an investigation of the effect of cold work on the magnetic properties of commercially pure titanium, containing 0·15 per cent iron, in order to find out if the magnetism was sufficiently low to ensure its suitability for an Armed Service application. After severe cold working no gain in ferro-magnetism was found.

A method was developed by which metallographic structure may be correlated with fatigue damage in aircraft skin material. It was found that different fatigue conditions produced characteristic crack patterns in the structure and that the pattern was also influenced by the thickness and kind of material employed. Thus, under certain conditions the fatigue stresses applied to a given material can be determined by examination of the microstructure. This, therefore, is a useful new tool in the investigation of unsatisfactory service performance of components subject to cyclic stress.

A micro-autoradiography method was developed in the Division by which it is possible to study micro-segregation of various elements in magnesium and some other alloys. These might have an adverse effect on their service life. Samples containing a radioactive tracer of the element which is suspected of being segregated are placed in contact with a photographic plate. The resulting autoradiograph is studied under a microscope for evidence of segregation. By the use of this method, the widely held belief that zinc tends to segregate at magnesium grain boundaries has been confirmed.

The spectrographic micro-volume technique developed in the Division has been used to detect segregation of elements such as manganese in steel and evaluate its extent in rolled and cast metals and alloys. The discovery of some dangerous examples of segregation in certain materials that have been examined has led to rejection of such material and revision of production methods to eliminate the cause of the defect.

Fundamental Research

The fundamentals of the 'creep' phenomenon in metals and alloys under heavy stresses induced either by load or by high speed are the subject of a study program recently initiated. Creep is a factor of crucial importance in many modern applications, notably under the conditions of high temperature generated in jet engines. In the absence of a satisfactory theory of creep, it is impossible to apply data from a specific alloy to new alloys under development. In order to develop such a theory, such matters as creep in relation to

grain size and crystal orientation, to purity and precipitation, and to other factors involved in the metallurgical history of a given alloy are being studied.

Other research dealt with variations in intensity ratios of spectral lines used in the spectrochemistry of metals and alloys. Unless these ratios are stable, significant errors are introduced in the analytical results obtained. It has been widely believed that these errors are caused by oxidation of the metal surface, but the results of the research carried out in this Division indicate that the cause is more properly attributable to certain inherent physical properties of the metal. In tests of brass and some nickel alloys, for example, large differences in volatility of the alloying constituents at very high temperatures has been shown to be responsible for most of the effect.

Other Activities

In addition to the evidence of activities tabulated below, the Division initiated, during the past year, the first conference of industrial spectrographers in Canadian history. It was held in the Conference Room of these laboratories, and was attended by about sixty representatives of Canadian industry, universities and government departments, who presented papers and exchanged information on spectrographic problems confronting Canadian industry, the Armed Services, and Atomic Energy of Canada Limited.

The reports completed and enquiries answered for the Division in the calendar year may be classified as follows:

—	Research Reports	Invest. Reports	P.M. Test Reports	Enquiries
Industry	2	8	121	.....
National Defence	.....	14	122	.....
Other Gov't Agencies	.....	1	21	.....
N.R.C. (T.I.S.)	.....	1	2	74
Research	11	.....	.....	.....
National Research Council	.....	1	2	.....

In addition, 43 lectures were given to technical organizations and 12 papers were published in technical journals.

Mineral Resources Division

The growth and expansion of the Canadian mineral industry, especially in the field of base metals and uranium, was reflected in the increased demands for information. The facilities, available to other government departments, industry, and private individuals, were used extensively. More than 2,500 written enquiries were handled in the course of the fiscal year and a number of special briefs were prepared.

At the request of government departments reports were prepared on: the mineral potential in the areas that would be served by suggested railway extensions to northern Canada; mineral occurrences and activity near the route of the proposed natural gas pipe line to Ontario; and the mineral-based

industrial potential of the Maritime provinces contingent on the development of base metal deposits in northern New Brunswick. At the request of the municipality of Timmins a report was prepared in collaboration with the Geological Survey of Canada on the mineral possibilities, other than gold, within a 25-mile radius of the city.

A number of mineral resource maps were prepared for inclusion in the new Atlas of Canada being prepared by the Geographical Branch.

In cooperation with other divisions of the Mines Branch and with the Geological Survey of Canada, reviews for 1953 were issued covering each of the metals or minerals produced or used extensively in Canada. Several articles on specific metals were written for publication in the technical press and a number of information circulars were prepared for distribution.

Field work included visits to base metal operations and metallurgical plants in Quebec, Ontario, British Columbia and Yukon; to the nickel mines in the Sudbury area, Ontario; to all active gold mines in Canada; to iron ore operations in Ontario, British Columbia and northern New York state; to oil and natural gas developments in western Canada; and to titanium developments in Quebec. Two officers visited the Bureau of Mines, Washington, D.C.

The Division's mineral occurrence index was maintained and continued to provide a valuable source of concise information on mining properties and deposits. The development of a map index system adapted to the rapid location of any available map in any of the numbered squares of the International Topographic World Map was initiated.

Two engineers assisted the Director General of Scientific Services in the administration of the Emergency Gold Mining Assistance Act. In cooperation with the Cost Inspection and Audit Division of the Office of the Comptroller of the Treasury, one engineer was responible for processing applications under the Act, the other carried out the field inspections required to ensure 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), Income Tax Act, and Section 1203 of the Income Tax Regulations. Thirty-one 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 metalliferous mines and of new industrial mineral mines certified by him to be contained in non-bedded deposits. The Division assisted in the processing of 22 applications by oil companies for approval of the special tax concessions made available under income tax legislation on proposed deep test wells. Four companies submitted applications for accelerated depreciation as provided for by legislation respecting oil or natural gas pipe lines.

The Chief of the Division resumed his duties in July on the completion of his assignment as mining adviser to the International Bank for Reconstruction and Development's Economic Survey Mission to the Federation of Malaya.

The Division was represented at the meetings of eight scientific societies and technical committees.

During the fiscal year, 71,301 copies of Mines Branch publications were distributed by the Division, of which 14,426 were editions of publications in French.

Library

The library of the Mines Branch is administered by the Division.

The following acquisitions were recorded.

Publications received:	
Publications of the Canadian Government	1,967
Publications of British, U.S. and foreign governments	2,911
Publications of Scientific Societies	1,806
Periodicals	5,711
Books and pamphlets by purchase	656
	13,051
Loans of books, pamphlets and periodicals, including inter-library loans of 1,026	25,490
Volumes bound	344
Volumes accessioned	1,325
Periodicals and annuals subscribed to	406
Cards added to general catalogue in Main Library and P.M.D.	2,004
Reference cards prepared and filed in Research Section	12,210

DOMINION OBSERVATORIES

C. S. Beals, Dominion Astronomer

A successful airborne expedition to observe a total eclipse of the sun was carried out over the Atlantic ocean east of Labrador on June 30. This was followed later in the summer by the first magnetic mapping flight across the Atlantic to England with the Observatory gyro-stabilized airborne magnetometer. Flights were also made over the eastern Arctic and over the Maritime provinces and their surrounding coasts.

A new catalogue of accurate star positions was compiled for use in time-keeping, navigation and surveying and the general usefulness of the time service was increased by the installation of a speaking clock for the radio broadcasting of time signals. New types of pendulum equipment were developed to measure gravity, and the principles of radio transmission were employed to study the earth's crust by the methods of explosion seismology.

At Victoria B.C., stress was placed on photoelectric and spectroscopic methods for studying the structure of the Milky Way and to investigate the motions, temperatures, densities and other physical properties of the stars. The delineation of areas of earthquake hazard on the west coast was continued and a map was prepared showing the location of 443 minor earth shocks.

The Dominion Observatory, Ottawa

Positional Astronomy

Meridian Circle

The meridian circle telescope is the fundamental observing instrument in positional astronomy. During the fiscal year it was used on 127 nights and 5,834 transits were observed. An observation involves recording the exact time of transit of a star and at the same time measuring its zenith distance. Photographic and electronic recording are both used as the observer follows the star across his field of view with the micrometer wires. On the average 45 stars were observed per night. Many nights are needed however to accumulate the required number of transits for each of the stars of a program. Discussion of the observations involves a considerable amount of computation, some of which is now done by punched card technique.

The intensive observation of a list of stars, required to determine time and variation of latitude by the photographic zenith telescope was completed. Preliminary positions were determined and compared with older catalogues to determine proper motions. It will still be necessary to keep the photographic zenith telescope stars under observation to ensure the accuracy required.

The results of observations made between 1935 and 1950 were published. These, along with positions of the fundamental stars observed during the years 1950-53, were sent to the Rechn-Institut, Heidelberg, Germany, where a new fundamental catalogue is being prepared.

The present program of 3,000 stars, which was commenced in 1954, was selected on an international recommendation. They will supplement the fundamental catalogue and provide sufficiently well-determined positions for

surveying in northern latitudes. The present list of stars for this purpose is sufficiently in error to require replacement within the next decade. The Ottawa program is part of an international cooperative effort.

Time Service

The photographic zenith telescope (PZT) was used on 166 nights, during which 4,337 star transits were obtained. The rates of primary quartz clocks were recorded and fundamental time established. Corrections to radio time signals were computed and published. Also the variation of latitude was computed and will be made available to the international latitude service. The Computing Centre of the University of Toronto provided the reduction to mean place of the stars used in this program.

The new projection type two-coordinate measuring engine was used for scaling the PZT plates. Examination of screw errors shows no periodic or progressive error of a type or magnitude that requires compensation. An improvement in accuracy was noted with an increase in magnification of star images from seven to fifteen times.

Correct time via the CHU frequencies 3330, 7335 and 14670 kilocycles was transmitted continuously except for minor shutdowns for repair and maintenance. The introduction of a voice announcement each minute, commencing the end of December, has greatly enhanced the usefulness of the signals. Favourable comment was received from Europe and New Zealand and from many places in Canada and the United States. The low power of transmission leaves a large section of the Canadian northwest beyond the useful range of CHU.

The speaking clock was designed and built by Ateliers Brillie Frères, of France, the voice being that of Frederick Martyn Meech who at the time was attached to the Canadian Embassy in Paris.

A ring type crystal was received from England and installed. This brings to three the number of precision quartz clocks now installed in the temperature-controlled vault formerly occupied by pendulum time keepers. Two secondary quartz clocks are used as time signal controls and their rates are adjusted as required, to keep them reading true time within a few hundredths of a second. Successive seconds beats are exact to a thousandth of a second. Daily intercomparisons between all quartz clocks are now made by beat frequency at 100 and 1000 kilocycles as well as at the seconds level.

Valuable cooperation between the Observatory and the frequency standard laboratories of National Research Council and Department of Transport was continued. Successful transmission of 100-kilocycle frequency by telephone line between the Observatory and NRC was achieved experimentally and will be improved.

The Observatory continued its normal services to the CBC, the two telegraph companies, the Bell Telephone, and several government and private groups.

Stellar Physics

Research in Meteor Astronomy

The Division continued its program of upper atmosphere research by meteor photography. Regular observing with the meteor cameras at Newbrook and Meanook was carried on to determine densities in the atmosphere from meteor decelerations. The first group of 18 doubly-photographed meteor trails was forwarded to Harvard University for reduction on the international program. A camera for copying the curved films onto flat glass plates necessary for accurate measurement was constructed at Ottawa.

Observations with smaller cameras and spectrographs were made at Ottawa, Meanook and Newbrook. In all, 2,820 exposures were made on the entire program and 976 meteors were visually observed and plotted. One excellent and several weak meteor spectra were obtained.

Improvements in the electrical systems at Newbrook and Meanook were made. Exceptionally wet weather restricted observations during much of the year and made extensive road improvements necessary.

A detailed study of a Perseid meteor spectrum obtained in 1950 was published. Investigations in progress include: other spectrum analyses; a contour study of the Ungava meteor crater; and a study of the rates of visually observed meteors.

Solar Physics

A major project was observation of the total solar eclipse of June 30, 1954. Since the probability of fine weather along the eclipse path in Canada was poor for the day of the eclipse an airborne expedition was planned in addition to a ground expedition. Overcast skies on the morning of the eclipse made observations from the ground impossible, but excellent results were obtained from the air and a series of the first slit spectra of a total eclipse ever to be photographed from an aircraft were obtained.

The ground expedition was located at Smoky Falls, Ont. very close to the eclipse central line. The equipment consisted of a large grating spectrograph with associated telescope and two interferometric cameras. The main objective was to obtain spectroscopic information which would lead to a better understanding of the physical properties of the solar chromosphere.

In cooperation with the Division of Physics, National Research Council and the Central Experimental and Proving Establishment, R.C.A.F., Rockliffe, the eclipse was successfully observed from an aircraft flying at a height of 27,500 feet over the North Atlantic ocean off the coast of Labrador. The equipment consisted of two quartz spectrographs, one to obtain spectra of the chromosphere and the other to obtain spectra of the corona. Both pieces of equipment operated satisfactorily and a photometric study of the spectra obtained is well under way. Observations of the general form of the corona and the positions of visible prominences were made for transmission by the CBC to the Swedish Broadcasting System for the use of scientific expeditions in Europe.

Other investigations in progress include: a study of the shifts of solar lines at the limb of the sun due to solar rotation and other causes; and a study of solar lines in the far infrared region of the spectrum.

Theoretical Astrophysics

Work was continued on the problem of a mathematical treatment of crater formation by meteor impact. A model, based on the hypothesis that the ground deforms like an elastic solid under the stress imposed by the meteoric explosion, was worked out and gave estimates of the probable meteoritic mass that are in fair agreement with the estimates advanced by other investigators and with the data obtained from controlled high-explosive experiments. Because the elastic model is clearly only a first approximation to the behaviour of matter when the stresses are of the order of 10^6 kg/cm^2 and the velocity of impact is several times the seismic velocity of propagation, the research turned to considering the refinements introduced by more general equations of state of a solid and by shock wave propagation. A treatment of the problem analogous to that used in studying underwater explosions was roughed out. Some of its quantitative consequences are being followed through.

During the year seven lectures were given to technical and non-technical groups in various parts of Canada.

Geomagnetism

Magnetic Surveys

The magnetic survey of Canada was continued by six parties operating on the ground and in the air. Three parties travelled by car along the highways and by-ways of Canada, one accompanied H.M.C.S. Labrador on that part of her cruise between Halifax and Vancouver, one operated in Quebec by chartered aircraft, and the remaining party flew in a R.C.A.F. aircraft.

Ground parties re-occupied previously established magnetic stations to determine the rate of change in the various components of the earth's magnetic field, and established stations in areas hitherto not covered by Dominion Observatory surveys. Observations for declination, inclination, and force were made at 88 points, comprising 21 repeat and 67 new stations. Of the total, 21 stations were in Quebec, 19 in Ontario, 9 in Alberta, 29 in British Columbia and 10 in Northwest Territories. In addition, 275 vertical force stations were occupied in Alberta during a survey of the environs of Meanook magnetic observatory.

The Dominion Observatory's three-component airborne magnetometer was flown about 30,000 miles, representing 145 flying hours, in a R.C.A.F. aircraft. Fairly detailed coverage was obtained of the region of the Atlantic east of Labrador and Newfoundland extending some 500 miles from the coast. Flights were made over Davis Strait, Baffin Bay, Lancaster Sound, Kane Basin, Ellesmere Island, Foxe Basin and Ungava Bay. Several flights were made over northern Quebec and the Maritime provinces. Two traverses were made over the Atlantic ocean, one along a great circle course between Gander, Newfoundland, and London, England, and the other from London to Goose Bay, Labrador, by way of Iceland. Magnetic profiles were obtained between Sydney, Nova Scotia, and Bermuda and a triangular flight was made from Bermuda extending 800 miles to the east. The aircraft was swung, to determine its magnetic field, over a magnetically flat area southeast of Quebec City before and after the series of flights and an additional swing was made near Canterbury, England. The operation was so reliable that only one hour was lost due to trouble with electronic components during the entire operation. While at London airport the magnetometer was exhibited to a group of British scientists.

The number of ground stations occupied was 15 per cent less than in the previous year, but the area covered was greater and there was a twofold increase in the mileage flown by the airborne magnetometer.

Magnetic Charts

Isomagnetic charts of Canada for the epoch 1955·0 depicting line of equal magnetic values and rates of annual change for declination, inclination, horizontal force, vertical force, total force and the north and east components of the magnetic field, were completed in preparation for printing.

Magnetic data required for new and revised topographical map sheets and marine and air navigation charts were supplied for 1,308 items, comprising 904 for the Surveys and Mapping Branch, 35 for the Geological Survey of Canada, 228 for the Department of National Defence and 141 for other agencies.

Fundamental research 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 at Cambridge University, England, by an officer of the Division.

Magnetic Observatories

The magnetic observatories at Agincourt, Ontario, Meanook, Alberta, and Baker Lake and Resolute Bay, N.W.T. were in continuous operation. All magnetic data were abstracted and prepared for publication. Tabulations of K-indices (three-hour disturbance ranges) were sent monthly to research centres in the Netherlands, Germany, United States, and Canada. Photostats of observatory magnetic records were made available to all major commercial geophysical prospecting agencies operating in Canada, and magnetic results from all Canadian magnetic observatories were supplied to the Department of Physics, University of Toronto, for theoretical analyses. Progress was made at Ottawa and Toronto in investigating the current systems operating in the region of the auroral zone in northern Canada.

A complete set of Ruska photographic recording variometers was installed at Agincourt magnetic observatory as a replacement for the obsolete Kew type variometers. A similar set of variometers was purchased for installation at Meanook magnetic observatory.

The rehabilitation of the old magnetic observatory building at Meanook was about 80 per cent completed. Three hundred and ten acres of land adjacent to the Meanook site have been purchased and negotiations for 220 additional acres are in progress. This large acreage is required for adequate protection against local disturbances and for the study of earth-current phenomena.

Geomagnetic Laboratory

The Division made further refinements on the airborne magnetometer circuits and designed electrical equipment for the study of rapid pulsations in the earth's magnetic field. It designed and constructed ancillary equipment for field and observatory requirements and constructed detecting coils for use with electrical magnetometers. These coils are for use of geomagnetic parties from France proceeding to the Antarctic for International Geophysical Year investigations. All field instruments were standardized at Agincourt magnetic observatory before the field season. Manuscript of the detailed report on the airborne magnetometer was completed.

International Union of Geodesy and Geophysics

Two members of the Division attended the Rome meetings and its chief was elected Chairman of Committee No. 8, Magnetic Instruments, of the International Association of Geomagnetism and Aeronomy.

Gravity

Gravimeter Surveys

Considerable progress was made in extending Canada's regional network of gravity measurements, the results of which are of international importance for geodetic purposes and in structural studies of the earth's crust.

Extensive gravity measurements were made in southern British Columbia in sufficient detail to proceed with a gravity map for this area. The results are expected to provide valuable information concerning the deformations of this interesting region and the forces that produced them.

Using aircraft transportation the Division established about 350 gravimeter stations over a large area of the Canadian Shield in northeastern Quebec. These measurements complete the gravity network for most of Quebec south of latitude 52° and for which a gravity map and report is in preparation.

Gravity measurements made near Manicouagan and Mushalagan Lakes about 160 miles north of Baie Comeau, Quebec, provide no evidence to support

the theory that the circular feature encircled by these two lakes is of meteoric origin. Diamond drilling carried out near the centre of a much smaller circular feature near Brent, Ontario, confirmed the results of the gravity measurements made in 1953 and gives further support to the view that this depression was formed by meteoric impact or explosion.

Instrument Calibration

The highly sensitive gravity meters of spring balance type used for the regional gravity measurements mentioned above require to be carefully calibrated from time to time in order to give accurate results. Pendulum stations as widely separated in latitude as possible are used for this purpose and part of the year was devoted to a calibration of the three Ottawa gravimeters using pendulum stations located along the Alaska Highway. This operation also made it possible to check the internal consistency of the base stations on the important north-south route which was found to be highly satisfactory.

Work on improving the comparison of gravity between Washington and Ottawa made it apparent that the relations between these two important stations, established in the past by various Canadian and United States observers, are not yet of sufficient consistency. It is hoped that a new type of pendulum equipment being developed in Ottawa will help clear up this uncertainty.

Seismology

Study of Earthquakes in Canada

The Dominion Observatory maintains a regular network of 10 seismograph stations across Canada. This network is designed to contribute to the study of world seismology and at the same time to throw light on the seismicity of the St. Lawrence Valley and of the Pacific coast of British Columbia. During the fiscal year three additional stations were maintained in the Cordillera coal fields of Alberta and British Columbia.

The seismograph network reaches from Halifax to Victoria, and stretches to Resolute Bay, Northwest Territories. Records from the 10 stations are carefully read and reported in bulletins and readings from three key stations—Ottawa, Resolute Bay and Victoria—are sent by radio to a central agency for the rapid location of epicentres. Records from the network stations are available to all investigators for the study of wave propagation. As an example, the presence of a particular phase, Lg, on the Resolute Bay records of a California earthquake, led Columbia University investigators to conclude that the Arctic Islands have a continental structure. The absence of the phase in the records of certain Asiatic earthquakes leads to the conclusion that the Arctic Ocean represents a true oceanic basin.

During the fiscal year the Associate Committee on the National Building Code, National Research Council, issued an earthquake probability map, prepared by the Division of Seismology. Two areas of this map, the Ottawa and St. Lawrence Valleys and the Pacific seaboard of British Columbia are shown as zones of potential major damage. This rating is justified by the large earthquakes that have occurred in these areas. Seismic networks for the detection of local earthquakes are maintained in both areas. Three stations maintained in southwestern British Columbia since mid-1951, have recorded more than 600 small local earthquakes, to date. These are listed in the Dominion Observatories publications. The large earthquakes in the St. Lawrence and Ottawa Valleys have been listed but no complete list of all earthquakes has been published. As a result of crustal studies conducted over

a period of several years, travel-time curves are now available to allow a detailed study, and methods have been developed that prevent this study from becoming laborious.

One other region in Canada is seismically active, namely, Yukon. No seismograph stations are available in the area, but the R.C.M.P. and the Army cooperate with the Observatory by reporting felt earthquakes.

Crustal and Other Field Studies

Several years ago the Dominion Observatory made studies of the crust in the Canadian Shield, using rockbursts at Kirkland Lake, Ontario, as a source of energy. These general studies are being supplemented by very detailed studies in particular areas. In 1954 the investigations were centered on a circular feature in the Lake Manicouagan area, in eastern Quebec.

These recent studies make use of instruments which were developed by the Dominion Observatory. They are unique in their field, in that they utilize specially designed radio equipment. Seismic impulses arriving at 12 outlying stations are converted to radio signals and transmitted to a central recording station over distances of up to 30 miles.

Mechanism of Earthquakes

The Observatory is an important centre for studies relating to the mechanism of earthquakes. Methods were known for many years but were never energetically exploited. Studies conducted over the past several years led to the surprising conclusion that most major earthquakes in the Pacific result from strike-slip faulting. Attempts are being made to fit this fact into existing theories or orogenesis.

Meetings

During the fiscal year representatives of the Division attended meetings of the Seismological Society of America, of the Eastern Section, Seismological Society of America, and of the International Union of Geodesy and Geophysics. The Division chief was elected a director of the Seismological Society of America and to the executive committee of the International Seismological Association.

Dominion Astrophysical Observatory, Victoria, B.C.

The Observatory's main work is the analysis and interpretation of spectroscopic observations of stars. The studies fall into two main groups, the understanding of the stars as physico-chemical bodies, and the nature and structure of the universe as revealed by the motions of the stars. Observations with the stellar spectrograph are now supplemented by measures of starlight with the aid of a precision photoelectric photometer.

The observing weather during the fiscal year was the worst on record. The telescope was used on 146 nights for a total time of 897 hours. The deficiency of 270 hours from the average, hampered progress on several important programs.

Research

Stellar Physics

A number of projects were completed or far advanced dealing with the nature of the stars. Powerful spectra of the famous eclipsing star 31 Cygni were analysed to reveal the violent and sporadic motions in the atmosphere

of the relatively cool giant star. Present studies will determine the atmospheric structure and its chemical composition. A study of the absorption lines in the spectra of the very hot stars has shown that the usual spectroscopic method of estimating brightness cannot be used and there is some reason to believe that these "early" O stars are all about the same brightness. As a part of this study it has become possible to examine further the relations between distance and the effects of the interstellar material.

Extensive tests have verified the Victoria method of measuring true brightness, and hence distance, of the hot and very luminous B stars. This verification is important since the spectroscopic luminosities will have wide application to studies of the mechanics and organization of the galaxy.

Measures of the relative energies in the spectra of the very cool stars were completed, showing the presence of an obscuring or "veiling" agent which absorbs the violet light. This result has encouraged laboratory experiments and the recent work on the stars, combined with laboratory work, suggests strongly a triatomic molecule of carbon as the absorbing material.

An exploratory study of the infrared radiations of certain cool stars was made, using newly available special emulsions. A number of new absorption features were discovered and their wave-lengths measured. The atoms or molecules responsible for these absorptions are not yet known.

Progress was made in theoretical studies with the calculation of "model" atmospheres for the hot stars by the aid of electronic computers. A new calculation of the ratio of hydrogen to helium in the high-temperature stars confirms the rather high value previously found.

Stellar Motions

The line-of-sight speeds were measured for some 150 stars not previously observed. These objects are part of the new data for further exploration of the dynamics of the galaxy.

A detailed study was made of the motions and distances of stars in the moving cluster in Taurus. These stars may now be regarded as so well known as to serve as standards in numerous astrophysical studies.

The motions of double stars continue to be measured. Orbital elements, not previously known, were found for five binary systems.

Photometry

Using the stellar photoelectric photometer, program work was commenced to supply new data needed in the interpretation of spectroscopic results. The brightnesses and colours of about 130 stars were measured.

Seismology

Improved pick-up and recording instruments were installed and brought into operation. The western Canada network (four stations) was kept in operation. Two hundred local earthquakes were recorded and located; none was of important practical intensity. The depth-charge program showed the crustal speed of seismic waves for this area to be about 6 kilometers a second, a normal value. Recording of earthquakes and shocks in the coal mining area of the Rockies was continued.

Instrumentation

Equipment was increased with the construction of a quartz spectrograph for photography of the far ultra-violet spectra of stars. Additional gratings and cameras increased the power and flexibility of the stellar spectrograph. An image-rotator and motor-driven scanner were constructed for the 73-inch

telescope. A powerful concave-grating laboratory spectrograph was acquired and development of an "electronics" shop has begun. A photoelectric exposure-meter for use with the stellar spectrograph was designed and construction was commenced. This device is expected to increase the efficiency of the telescope-spectrograph combination.

General

An expedition was prepared to observe the total solar eclipse of June 30, 1954, and proceeded to Hanson, Ontario. Overcast skies prevented observation, but valuable experience was gained regarding such expeditions.

The Observatory was represented at four scientific meetings at which 15 papers by staff members were read. The Observatory was visited by a number of leading astronomers and physicists.

An estimated 22,000 persons, including 12 special groups, visited the Observatory. Fourteen non-technical lectures were given by staff members before local societies and a special film on the Hale telescope (200-inch) was shown to 13 school groups. Times of sunrise, sunset, moonrise, and moonset, were supplied on request to airport authorities. Two broadcasts were made over the coast-to-coast network of the CBC.

GEOGRAPHICAL BRANCH

N. L. Nicholson, Acting Director

Increased defence requirements, particularly as a result of the decision to construct the Distant Early Warning line in northern Canada, coupled with continued economic development, resulted in additional demands upon the research facilities of the Branch. The work on the Atlas of Canada was consequently slowed down but toward the end of the year more progress was made.

The Branch provides basic geographical information to government departments, institutions and individuals. It acts as a co-ordinating centre for the Canadian Committee of the International Geographical Union; the U.N.E.S.C.O. Arid Zone project, and the Geography Commission of the Pan-American Institute of Geography and History.

It lost the services of Dr. J. W. Watson as Director in September 1954, when he resigned to accept the position of Professor of Geography at the University of Edinburgh. He was appointed as Chief of the Geographical Bureau in 1949 and became Director of the Branch in 1950.

The Branch dealt with the following research enquiries (as distinct from research projects):

Department	*Major Enquiries*	*Minor Enquiries*
Mines and Technical Surveys	7	40
Northern Affairs	5	15
National Defence	4	15
Trade and Commerce	1	33
External Affairs	1	20
Citizenship and Immigration	2	5
National Research Council	..	7
Transport	2	2
Others	37	106
	59	243

Systematic Geography

Canadian Ice Distribution Survey

Over 10,000 items describing ice distribution in Canadian waters were extracted from books and pamphlets and from data supplied by the government agencies collaborating in the project, the main agencies being the Departments of Transport and National Defence, R.C.M.P., and the United States Hydrographic Office. These items were distributed to the 35 agencies interested in the results of the work. The Branch continued to map this data on a 1-inch-to-8-mile scale, but gave special attention to northern waters where there is a need for information on the exact geographical limits of ice-free water during the critical break-up and freeze-up periods. A report, with maps, was published on ice distribution for these periods in the Gulf of St. Lawrence and the manuscripts of similar reports for the Hudson Bay-Hudson Strait sea-route and the Ungava Bay area were completed.

An officer of the Branch was selected as one of five representatives of Canada invited to attend the aerial ice observers course at the United States Navy Hydrographic Office in Washington, D.C. A valuable result of the course was the exchange of technical knowledge in dealing with sea ice observation and research.

Urban Geography

Seventeen additional settlements were studied in a continuation of the surveys of settlements on the island of Newfoundland carried out in 1951, 1952 and 1953. A comprehensive report with accompanying maps was prepared for each settlement. These reports were circulated among those federal and provincial authorities concerned with redevelopment of the Newfoundland fishing industry. As an aid to planning, the reports indicated the most favourable locations for the concentration of mechanized fishing activities. The advantageous use of natural resources was also emphasized.

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. Two black and white maps were completed showing the daytime distribution of populations in greater Winnipeg, and in more detail, in the downtown area of Winnipeg. The survey of Montreal was completed. The data acquired were recorded on five maps, in full colour, on scales of one inch to 1,000 feet and one inch to 800 feet. An officer of the Branch was loaned to the Department of National Health and Welfare for five months to assist in the organization of urban characteristics material already assembled.

Surface Conditions in Northern Canada

The Branch continued to extract data on surface conditions in northern Canada from published material and to plot this data on 1-inch-to-8-mile map sheets. Landforms, surface deposits, vegetation and water features are considered. Since the beginning of the project in 1951, approximately 12,200 cards have been completed. Emphasis has been placed on the map sheets covering the Arctic coast of the Canadian mainland.

Map Appraisal

In collaboration with the Federal map-producing agencies, work was continued on an evaluation of all maps published of Canada or parts of Canada, the appraisal being for use of the Department of National Defence. A preliminary report of some 500 pages, including 10 tables, 21 maps, and 1,075 separate items is nearing completion.

Regional Geography

Arctic and Subarctic Regions

Field surveys were made in the Bathurst Inlet, Coppermine, and Mackenzie delta areas, N.W.T. From the first two investigations aerial photograph-interpretation keys were prepared and were later applied to the planning of the Distant Early Warning line. Photo-interpretation keys of Cornwallis Island and Darnley Bay, N.W.T. and of Koksoak-Kaniapiskau Rivers, New Quebec, based on field work in previous years, was also completed and used in the same connection. A photo-interpretation key for Spence Bay area at the foot of Boothia Peninsula, N.W.T. is in final stages of completion.

In addition, geographical reports on the physical and human geography have been completed for Coppermine, Bathurst Inlet, and Mackenzie delta and on human geography for Spence Bay area.

One geographer was attached to the interdepartmental team which surveyed the possible sites for the relocation of Aklavik and Coppermine, N.W.T. Both reports were submitted to the Department of Northern Affairs and National Resources.

Geographical investigations connected directly with the D.E.W. line project were conducted for selected areas of northern Canada. Reports (for restricted distribution) on detailed analysis of the terrain elements for two map sheets on a scale of 1-inch-to-8-miles were completed, and the reports for three other sheets were partly completed. In addition, eleven aerial mosaics were prepared for selected areas in northern Canada for the organizations in charge of the D.E.W. line project.

Prairie Region

Field work in connection with the U.N.E.S.C.O. Arid Zone project was continued in southeastern Alberta.

Gulf of St. Lawrence Region

Field work was continued on land use in Nova Scotia, specifically in the Minas Basin and Halifax areas.

Administration and Special Projects

Publications Distributed

Publications distributed totalled 6,052, of which 1,780 were extracts and reprints. Among the projects completed were the preparation of a manuscript on Alaska for the Bureau of Current Affairs, Department of National Defence, and the preparation of special maps.

Atlas of Canada

Because of the increased attention to other projects less headway than was hoped for was made toward completion of the Atlas of Canada. Data for the plates dealing with ranges of plants (other than trees), principal mammals, birds and fish, profiles of major rivers, and population origin and citizenship were received from the contributing departments and preliminary compilation was started. Preliminary compilation was completed for 23 plates in the agricultural section; and of the plates dealing with types of settlement, land use and functional plans of major cities, and population distribution. Detailed specifications for 5 base maps were completed. Final draughting of the 1:10,000,000, 1:20,000,000, and 1:50,000,000 base maps was completed and stocks of blue line prints were delivered. Final draughting of the remaining bases and five of the plates in the historial section was commenced.

Book Library

Acquisitions during the year brought the number of volumes up to 15,216. Indexing of foreign periodical journals was continued and 13,865 cards were added to this catalogue. An accession list was published each month.

Other data:

No. of requests for information	1,070
No. of accessions (books and pamphlets)	1,274
No. of library loans (exclusive of periodicals)	3,456
No. of inter-library loans	552
No. of letters sent out	567
No. of form letters sent out	212
No. of books catalogued	1,410
No. of cards added to main catalogue	8,159
No. of cards added to periodical index catalogue	5 705
No. of shelf list cards added to catalogue	9,040

Map Library

Acquisitions brought the number of map sheets to over 176,000. About 250 series of maps were indexed and catalogued, including many of Japanese and Russian origin. Accession lists were prepared every two months, and a list of the chief maps published in Canada in 1953 was compiled for *Bibliographie Cartographique Internationale.*

Other data:

No. of requests for map information	913
No. of map accessions	6,800
No. of maps loaned	3,736
No. of letters sent out	604
No. of form letters sent out	157
No. of maps catalogued	1,875
No. of cards added to the catalogue	1,917

Photographs

No. of photograph accessions	1,715
No. of photographs loaned	50
No. of cards added to catalogue	4,116
No. of photographs indexed on maps	8,475

Draughting

Two hundred and eighty-two sketch maps and diagrams for Branch publications and reports were completed.

Seventy-two maps were drawn for other government agencies.

PUBLICATIONS

Administrative

Summary of Activities 1954. (Offset).
Report of the Explosives Division (Calendar Year 1952).
Report on the Administration of the Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31, 1954.
Emergency Gold Mining Assistance Act Regulations (Extract from the Canada Gazette, June 23, 1954).
Annual Report for the Fiscal Year ended March 31, 1954.

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Summary of Activities 1954. (Offset).
Report of the Explosives Division (Calendar Years 1944-51).
Report of the Explosives Division (Calendar Year 1952).
Report on the Administration of the Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31, 1954.
Annual Report for the Fiscal Year ended March 31, 1954.

Surveys and Mapping Branch

Canadian Hydrographic Service

British Columbia Pilot, Vol II (Third Edition.)
Catalogue of Canadian Hydrographic Service Nautical Charts and Sailing Directions for Inland Waters of Canada (Offset).
Covers for Catalogue of Nautical Charts.
Crustal Movement in the Lake Ontario-Upper St. Lawrence River Basin.
The Labrador and Hudson Bay Pilot (First Edition).
Supplement No. 1 to the 1952 edition of the Newfoundland Pilot.
Supplement No. 1 to the 1944 edition of the Great Lakes Pilot.
Supplement No. 1 to the 1949 edition of the St. Lawrence River Pilot (below Quebec).

Supplement No. 2 to the 1946 edition of the Gulf of St. Lawrence Pilot.

1. Tide Tables, 1955. *Atlantic Coast.*
2. Tide Tables, 1955. *St. Lawrence and Saguenay Rivers.*
3. Tide Tables, 1955. *Prince Edward Island and Adjacent Waters.*
4. Tide Tables, 1955. *Nova Scotia, Atlantic Coast.*
5. Tide Tables, 1955. *Bay of Fundy.*
6. Tide Tables, 1955. *Newfoundland, East and South Coasts.*
10. Tide Tables, 1955. *Pacific Coast.*
11. Tide Tables, 1955. *Strait of Georgia.*
12. Tide Tables, 1955. *British Columbia, Northern Waters.*
13. Tide Tables, 1955. *Vancouver Island, Southwest Coast.*

Geodetic Survey of Canada

Shoran Trilateration in Canada, 1949-1953, by J. E. R. Ross.
72. *Triangulation and Precise Traverse in the Interior of Southern British Columbia,* by W. H. MacTavish.

Legal Surveys

Descriptions of Land. A Text Book for Survey Students, by R. W. Cautley. (Reprint). (Offset).

Geological Survey of Canada

Memoirs:

223: *Mineral Resources, Hazelton and Smithers Areas, Cassiar and Coast Districts, British Columbia*, by E. D. Kindle (Revised edition).
272: *Geology and Mineral Deposits of the Zeballos-Nimpkish Area, Vancouver Island, British Columbia*, by J. W. Hoadley.
273: *The Lower Mackenzie River Area, Northwest Territories and Yukon*, by G. S. Hume.
274: *Geology and Mineral Deposits of Aiken Lake Map-area, British Columbia*, by E. F. Roots.
275: *Geology of Harbour Grace Map-area, Newfoundland*, by R. D. Hutchinson.
276: *La Poile-Cinq Cerf Map-area, Newfoundland*, by J. R. Cooper.
277: *Southeast Cape Breton Island, Nova Scotia*, by L. J. Weeks.

Bulletin:

27: *Contributions to the Economic Geology of Newfoundland*, by H. Johnson, D. M. Baird, Allen V. Heyl, and John J. Ronan.

Papers:

50-14: *Potential Mineral Resources of Yukon Territory*, by H. S. Bostock (Revised edition).
53-7 : *A Geological Reconnaissance of the Northern Selwyn Mountains Region, Yukon and Northwest Territories*, by J. O. Wheeler.
53-8 : *Geology of the Northeast Quarter of Dasserat Township, Temiscamingue County, Quebec*, by W. G. Q. Johnston.
53-10: *Geological Reconnaissance, North Coast of Ellesmere Island, Arctic Archipelago, Northwest Territories*, by R. G. Blackadar.
53-17: *Tertiary Rocks of the Hesquiat-Nootka Area, West Coast of Vancouver Island, British Columbia*, by J. A. Jeletsky.
53-27: *Burleigh Falls and Peterborough Map-areas, Ontario*, by C. G. Winder.
53-30: *Haldimand County and Parts of Brant, Wentworth, and Lincoln Counties, Ontario* (two maps), by B. V. Sanford.
53-31: *Preliminary Maps, Norfolk County, Ontario*, by B. V. Sanford.
53-32: *Preliminary Map, Millville, York and Carleton Counties, New Brunswick*, by F. D. Anderson.
53-33: *Preliminary Map, Woodstock, Carleton County, New Brunswick*, by F. D. Anderson.
53-34: *Findlay Creek Map-area, British Columbia*, (Map and descriptive notes), by J. E. Reesor.
54-1 : *A List of Publications on Prospecting in Canada and Related Subjects*, by A. H. Lang (Reprint).
54-2 : *Kvass Flats, Alberta* (Map with summary account), by E. J. W. Irish.
54-3 : *Holyrood, Newfoundland* (Map with marginal notes), by W. D. McCartney.
54-4 : *Gull Pond, Newfoundland* (Second preliminary map), by J. Kalliokoski.
54-5 : *Notes on Geology and Mineralogy of the Newman Columbium-uranium Deposit, Lake Nipissing, Ontario*, by R. B. Rowe.
54-6 : *Gulo Lake, Saskatchewan* (Map with marginal notes), by W. E. Hale.
54-7 : *Canal Flats, British Columbia* (Map and preliminary account), by Geoffrey B. Leech.
54-8 : *Crackingstone, Saskatchewan* (Map with marginal notes), by J. A. Fraser.
54-10: *McDame, British Columbia* (Map with marginal notes), by H. Gabrielse.
54-11: *Nechako River, British Columbia* (Map with marginal notes), by H. W. Tipper.
54-12: *Glenlyon, Yukon* (Map with marginal notes), by R. B. Campbell.
54-13: *Nelson House, Manitoba* (Map with marginal notes), by H. A. Quinn.
54-14: *Heming Lake and Elbow Lake, Manitoba* (Maps and preliminary account), by J. C. McGlynn.
54-17: *Campbellford Map-area, Ontario* (Map and descriptive notes), by C. G. Winder.
54-18: *A Geochemical Investigation of the Heavy Metal Content of the Streams in the Keno Hill-Galena Hill Area, Yukon Territory*, by R. W. Boyle, C. T. Illsley, and R. N. Green.

Geophysics Papers:
(Aeromagnetic maps):

22: *Pointe Verte, Restigouche and Gloucester Counties, New Brunswick* (Revised edition).

161: *Arthabaska; Arthabaska, Megantic, and Wolfe Counties, Quebec.*
162: *Warwick, Wolfe, Arthabaska and Richmond Counties, Quebec.*
163: *Dudswell, Richmond, Wolfe, and Compton Counties, Quebec.*
164: *Aston, Nicolet, Arthabaska, and Drummond Counties, Quebec.*
165: *Drummondville, Drummond, Arthabaska, Richmond, Yamaska, and Nicolet Counties, Quebec.*
167: *Richmond: Richmond, Shefford, Drummond, and Bagot Counties, Quebec.*
168: *Woburn, Frontenac County, Quebec.*
169: *Sherbrooke; Sherbrooke, Compton, Richmond, and Stanstead Counties, Quebec.*
170: *Malvina, Compton County, Quebec.*
171: *Granby, Shefford, Brome, Rouville, Bagot, St. Hyacinthe, and Missisquoi Counties, Quebec.*
172: *La Patrie, Compton and Frontenac Counties, Quebec.*
173: *Orford, Shefford, Sherbrooke, Brome, Richmond, and Stanstead Counties, Quebec.*
174: *Winchester, Dundas, Stormont, Carleton and Russell Counties, Ontario.*
175: *Coaticook, Stanstead, Compton, and Sherbrooke Counties, Quebec.*
181: *Russell; Russell, Prescott, Carleton, and Stormont Counties, Ontario.*
182: *Memphremagog, Stanstead and Brome Counties, Quebec.*
183: *Sutton, Missisquoi and Brome Counties, Quebec.*
184: *West Gander River, Newfoundland* (Advance edition).
185: *Dead Wolf Pond, Newfoundland* (Advance edition).
186: *Miguels Lake, Newfoundland* (Advance edition).
187: *Lake Ambrose, Newfoundland* (Advance edition).
188: *Noel Pauls Brook, Newfoundland* (Advance edition).
189: *St. Brendans, Newfoundland.*
190: *Gambo, Newfoundland.*
191: *Great Gull Lake, Newfoundland* (Advance edition).
192: *Kepenkeck Lake, Newfoundland* (Advance edition).
193: *Snowshoe Pond, Newfoundland* (Advance edition).
194: *Burnt Hill, Newfoundland* (Advance edition).
195: *Great Burnt Lake, Newfoundland* (Advance edition).
196: *Wakefield, Gatineau and Papineau Counties, Quebec.*
197: *Thurso, Papineau, Russell, and Prescott Counties, Quebec and Ontario.*
198: *Bonavista, Newfoundland.*
199: *Eastport, Newfoundland.*
200: *Glovertown, Newfoundland.*
201: *Pudops Lake, Newfoundland.*
202: *Mt. Sylvester, Newfoundland.*
203: *Meta Pond, Newfoundland.*
204: *Twillick Brook, Newfoundland.*
205: *Burnt Pond, Newfoundland* (Advance edition).
206: *Feeder Lake, Newfoundland* (Advance edition).
207: *King George IV Lake, Newfoundland* (Advance edition).
208: *Cold Spring Pond, Newfoundland* (Advance edition).
209: *Old Perlican, Newfoundland.*
210: *Bay de Verde, Newfoundland.*
211. *Tug Pond, Newfoundland.*
212: *Random Island, Newfoundland.*
213: *Trinity, Newfoundland.*
214: *Sweet Bay, Newfoundland.*
215: *Low, Gatineau, Papineau, and Labelle Counties, Quebec.*
218: *Magnetic Anomaly East of Atzinging Lake, District of Mackenzie, Northwest Territories* (Advance edition).
220: *Usborne Lake, Pontiac County, Quebec.*
221: *Quyon, Pontiac, Gatineau, Carleton and Renfrew Counties, Quebec and Ontario.*
229: *Port Blanford, Newfoundland.*

Miscellaneous:

Prospecting for Uranium in Canada (Reprint).

Supplement to List of Publications of the Geological Survey of Canada, by L. B. Leafloor.

French Translation

Paper:

53-3 : *Pegmatitic Beryllium and Lithium Deposits, Preissac-Lacorne Region, Abitibi County, Quebec,* by R. B. Rowe.

Mines Branch

836 *Analysis Directory of Canadian Coals.*

837 (Water Survey Report No. 3) *Upper St. Lawrence and Central Great Lakes Drainage Basin,* by J. F. J. Thomas.

842 (Water Survey Report No. 6) *Fraser River Drainage Basin 1950-51,* by J. F. J. Thomas.

844 *The Canadian Mineral Industry in 1952.*

847 *Cobalt in Canada,* by R. J. Jones.

848 *The Spectrum of Steel,* by John Convey and J. K. Hurwitz.

List No. 1-2, *Milling Plants in Canada, Part 1, Operators of Concentrating Mills Treating Metallic Ores,* by W. Dick. (Offset).

List No. 1-2, *Milling Plants in Canada, Part 2, Operators of Concentrating Mills Treating Industrial Minerals,* by W. Dick. (Offset).

List No. 2-2, *Cobalt-silver Mines in Canada,* by W. Dick. (Offset).

List No. 4-1, *Coal Mines in Canada 1954,* by K. Shimizu. (Offset).

List No. 5-2, *Petroleum Refineries in Canada 1953,* by R. B. Toombs. (Offset).

Technical Papers:

No. 7, *The Constitution of Bone China Part II, Reactions in Bone China,* by P. D. S. St. Pierre. (Offset).

8, *The Determination of Uranium in Uranium Concentrates Using Ethyl Acetate,* by R. Guest and J. B. Zimmerman. (Offset).

9, *Electrode Potentials and Dissolution of Gold,* by G. Thomas. (Offset).

Memorandum Series:

No. 109, *Determination of Uranium in Ores, Review of Chemical Methods,* by F. T. Rabbitts, 1950. (Reprint). (Offset).

115, *Radioassay of Uranium Ore with Geiger Type Equilibrium Counter,* by R. D. Wilmot and C. McMahon. (Offset).

127, *Preparation and Burning of Peat As a Domestic Fuel in Rural Areas,* by H. P. Hudson and T. R. Skerry. (Offset).

128, *Preliminary Report on Coated Lightweight Concrete Aggregate from Canadian Clays and Shales, Part VI, British Columbia,* by H. S. Wilson. (Offset).

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Current Investigations of Stress Relief in Canadian Coal Mines, by A. Ignatieff, A. Brown, R. C. A. Thurston and D. K. Norris. Bull. Can. Inst. Min. Met., vol. 47, 1954, p. 446.

A Report of the Current Mining Developments Committee Coal Division C.I.M. —Outbursts in Coal Seams, by A. Ignatieff. Bull. Can. Inst. Min. Met., vol. 47, 1954, p. 143.

Evaluating the Performance of a Cleaning Unit, by J. Visman. Mining Eng., vol. 6, No. 10, 1954, p. 1015.

The Significance of Agglomeration in the Mineral Industries, by E. Swartzman. Bull. Can. Inst. Min. Met., vol. 47, 1954, p. 318.

The Influence of Temperature on Efficiency of Grinding, by L. E. Djingheuzian. Bull. Can. Inst. Min. Met., vol. 47, No. 504, 1954, p. 251; Trans. Can. Inst. Min. Met., vol. LVII, 1954, p. 157.

The Constitution of Bone China: 1, High Temperature Phase Equilibrium Studies in the System Tricalcium Phosphate-Alumina-Silica, by P. D. S. St. Pierre, J. Am. Ceram. Soc., vol. 37, No. 6, 1954, p. 243.

Bone China, Part I, by P. D. S. St. Pierre, Chem. in Can., vol. 6, No. 4, 1954, p. 60.

The Romance of Mineral Dressing, by L. E. Djingheuzian. Bull. Can. Inst. Min. Met., vol. 47, No. 508, 1954, p. 500; Trans. Can. Inst. Min. Met., vol. LVII, 1954, p. 296.

Separation of Metals by Distillation, by R. A. Campbell. Chem. in Can., vol. 6, 1954, p. 66.

Metal Corrosion and Protection, by R. R. Rogers. Chem. in Can., vol. 6, 1954, p. 70.

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Liquidus Relationships on the 10% MgO Plane of the System Lime-Magnesia-Alumina-Silica, by A. T. Prince. J. Am. Ceram. Soc., vol. 37, No. 9, 1954, p. 402.

The Effect of Nickel and Hydrogen Overvoltage in the Precipitation of Gold, by H. A. Hancock and G. Thomas. Bull. Can. Inst. Min. Met., vol. 47, No. 508, 1954, p. 539; Trans. Can. Inst. Min. Met. vol. LVII, 1954, p. 337.

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Refining Bismuth by Distillation and Chlorination, by R. R. Rogers and R. A. Campbell. Bull. Can. Inst. Min. Met., vol. 48, No. 515, 1955, p. 121; Trans. Can. Inst. Min. Met., vol. LVIII, 1955, p. 71.

Metal Corrosion and Protection, Part I, by R. R. Rogers. Chem. in Can., vol. 7, No. 3, 1955, p. 37.

The Recovery of Elemental Sulphur from Pyrite and Pyrrhotite, by K. W. Downes and R. W. Bruce. Bull. Can. Inst. Min. Met., vol. 48, No. 515, 1955, p. 127.

Newfoundland Fluorspar, by G. F. Carr. Trans. Can. Inst. Min. Met., vol. LVII, 1954.

Kyanite in Canada, by V. A. Haw. Trans. Can. Inst. Min. Met., vol. LVII, 1954.

Efflorescence; Some Causes and Prevention, by W. Graham. Trans. Can. Inst. Min. Met., vol. LVIII, 1954.

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Notes on Germanium, by W. J. Beard. The Northern Miner, August 12, 1954.

Zinc in Canada, by R. E. Neelands. La Produccion Minero Metalurgica Mundial en el Ano 1953, Madrid, Spain.

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Tantalum and Columbium, by R. J. Jones. The Northern Miner, Oct. 14, 1954.

A Decade of Progress in Canadian Mining (1945-54), Part I, by H. A. Graves. Trans. Inst. Min. Met., vol. 64, 1954-55, Pt. 7.

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The Fatigue Strength under Bending, Torsional and Combined Stresses of Steel Pieces with Stress Concentrations, by R. C. A. Thurston and J. E. Field. Proc. Inst. Mech. Eng., vol. 168, No. 31, 1954, pp. 785-796. (Reprints available).

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843 *The Canadian Mineral Industry in 1951.*

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Dominion Observatories

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Gravity Measurements in Canada, by M. J. S. Innes.

National Report for Canada, Seismology and Physics of the Earth's Interior, by J. H. Hodgson.

Vol. XIV, No. 13:
Bibliography of Seismology—January to June, 1953, by W. E. T. Smith.

Vol. XIV, No. 14:
Bibliography of Seismology—July to December, 1953, by W. E. T. Smith.

Vol. XV, No. 3:
Results of Observations made with the Reversible Meridian Circle, 1935-1950, by W. S. McClenahan, E. G. Woolsey and R. W. Tanner.

Vol. XVI, No. 8:
The Establishment of Primary Gravimeter Bases in Canada, by M. J. S. Innes and L. G. D. Thompson.

Vol. XVI, No. 10:
Tables of Extended Distances for PKP and PcP, by J. H. Hodgson and J. F. J. Allen.

Vol. XVI, No. 11:
Tables of Extended Distances for PP and pP, by J. H. Hodgson and J. F. J. Allen.

Vol. XVI, No. 12:
Diamond Drilling in Permafrost at Resolute Bay, Northwest Territories, by Peter C. Bremner.

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