ANNUAL REPORT 1954

FISCAL YEAR ENDED MARCH 31

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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ANNUAL REPORT

for the

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1953-54

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

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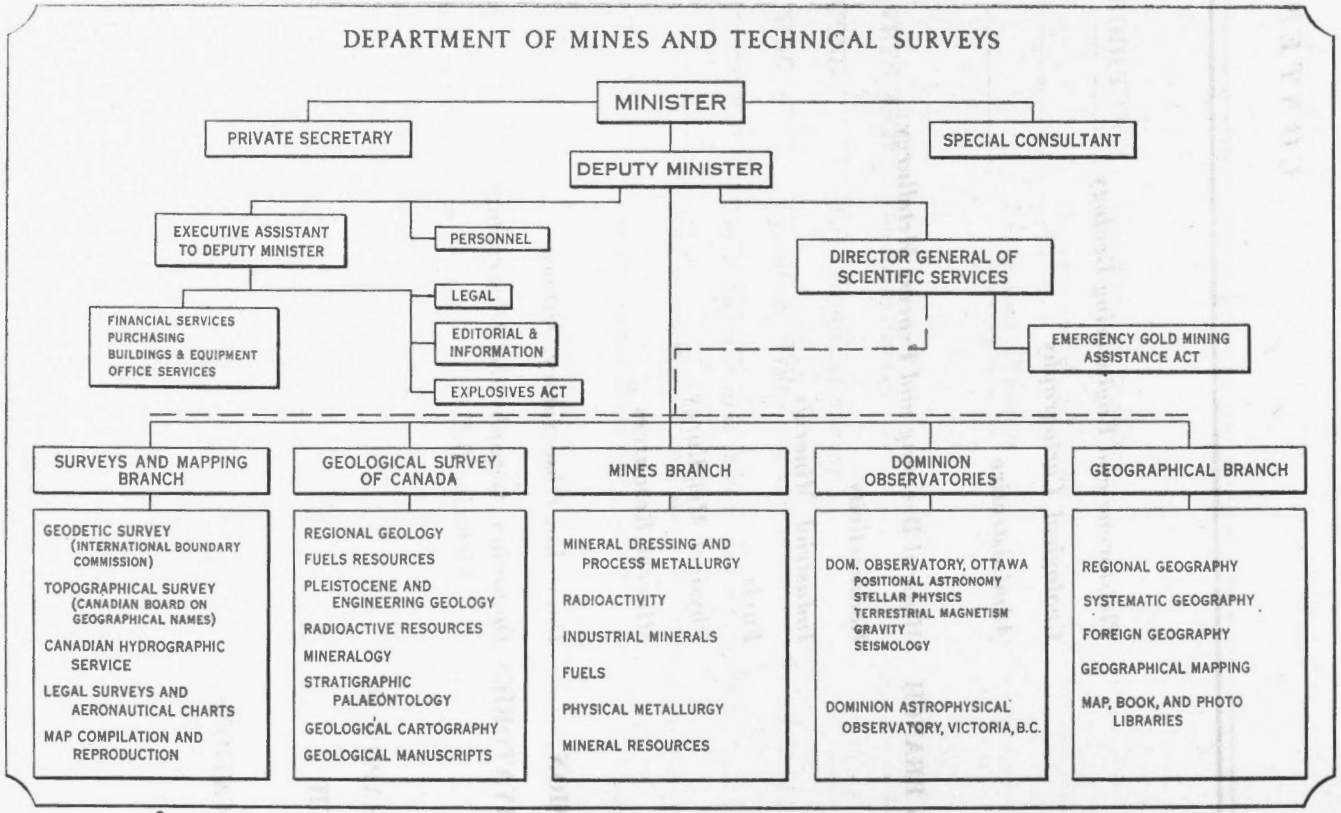

ORGANIZATION CHART

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, 1954.

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, 1954.

Your obedient servant,

MARC BOYER,
Deputy Minister.

INTRODUCTION

The Mineral Industry

A survey of the principal developments in the mineral industry during the fiscal year and an outline statement on the activities of the Department are given in this section of the report and are followed by accounts of the year's work by branches.

In 1953 Canada's mineral industry enjoyed the best year on record. The overall volume and value of production were higher than ever before.

A rise of nearly 4 per cent over the previous year brought the value of mineral production to $1,331,211,503, the reflection in the main of a $55,073,330 increase in the value of crude oil output, which more than offset substantial declines in the value of output of several other minerals. Crude oil headed the list, replacing gold which had held first place for nearly 25 years. Nickel was second and copper third, with gold in fourth place. Metals as a group reached a value of $708,912,835, the fuels, $311,235,192, and the industrial minerals $311,063,476, compared with $727,904,366, $263,582,319, and $293,855,668, respectively, in 1952.

In the value of its export trade the industry did not fare as well as in 1952. Exports of nickel, copper, lead, and zinc, the principal non-ferrous base metals, reached a combined value of $382,807,355, compared with $415,918,407 in 1952. However, the volume of exports of 859,000 tons was 7 per cent higher than in 1952. Sales of the four metals to the United States totalled $245,665,795, and those to the United Kingdom, $88,558,408, the corresponding figures for 1952 being $243,963,324, and $103,834,288, respectively. Exports of metals and minerals and their products, exclusive of gold, totalled $1,188,014,000 in 1953 and accounted for close to 30 per cent of Canada's export trade in that year. Uneasiness existed at the close of the fiscal year as to what action if any the United States would take toward raising the import duties and placing quotas on the imports of lead and zinc. Canadian exports of the two metals to that country in 1953 amounted to $67,846,311.

Employment in the mineral industry and expenditures for salaries and wages reached new highs in 1953 and contributed to the overall improvement in the Canadian economy.

The 32 per cent increase in crude oil production to 81,311,531 barrels valued at $198,111,542 further emphasizes the remarkable headway Canada is making in this direction. Although Canadian consumption of crude oil has been increasing steadily and in March 1954 was at a rate of 515,000 barrels a day compared with 222,000 barrels just prior to the discovery of the Leduc field early in 1947, domestic output, which was then only about 8 per cent of consumption had reached 43 per cent, in balance, at the end of the 1953-54 fiscal year. A major development in 1953 was the discovery of the Pembina field 65 miles southwest of Edmonton late in the year. Preliminary estimates of recoverable reserves range from 700,000,000 to 900,000,000 barrels, which would make it the largest field so far discovered in Canada. In Saskatchewan, discovery of the Smiley field about 70 miles southwest of Biggar in October 1953, marks the first important find of light oil in that province. In Manitoba, the Roselea field, a few miles from the producing Virden field, was the most promising discovery.

An estimated $390,000,000 was spent in 1953 on the development of Alberta's petroleum resources and in providing pipe line transportation facilities. Estimated expenditures in Saskatchewan on exploration, drilling and pipe lines reached a record of $51,337,000.

Two major crude oil transportation projects were completed during the fiscal year. The 718-mile Trans-Mountain pipe line connecting the Alberta fields with the Vancouver area, constructed at a cost of $93,000,000, and with a capacity of 120,000 barrels a day, came into operation in October, and by the end of 1953 crude oil from the prairies was flowing through the 643-mile Superior, Wisconsin to Sarnia, Ontario extension of the Interprovincial pipe line, built at a cost of $72,000,000 with ultimate capacity of 300,000 barrels a day. Spur lines from the Trans-Mountain system into the Seattle area are to be completed in 1954. Plans have been announced also for looping the older parts of the Interprovincial line. These pipe lines and the related units will provide an outlet for 600,000 barrels of oil a day from western Canada, which is sufficient to assure a rapid development of crude oil production as the markets for the fuel expand.

At the end of 1953 there were, in all, approximately 3,700 miles of crude oil trunk lines, gathering lines, and oil products lines in Canada exclusive of loops. In addition are the 960 miles of lines in United States between Gretna, Manitoba, and Sarnia, Ontario which carry Canadian crude oil.

The most important development in connection with natural gas during the fiscal year was the decision to build a pipe line from Alberta to Ontario and through to Montreal. Construction awaited the completion of necessary arrangements and the sanction of the Board of Transport Commissioners in Ottawa. The proposed line will be built by Trans-Canada Pipe Lines Limited at a cost that may exceed $300,000,000. The company has been granted a temporary export permit by the Alberta Government for a maximum of 540,000,000 cubic feet a day. The permit will become permanent on proof of certain details in reference to markets and finance. The pipe line would be almost 2,300 miles long and would serve an area with a population of more than 4·5 millions in about 200 communities between Alberta and Montreal. Natural gas services in 1953 were available to only about 15 per cent of this population.

Construction of the Westcoast Transmission line from the Peace River areas of Alberta and British Columbia to Vancouver and into northwest United States still awaited sanction of the Federal Power Commission in Washington to export the natural gas into the United States. The American outlet is essential to the project as the size of the British Columbia market alone would not warrant the expenditure required to construct the line.

Meantime, coal production continued to be adversely affected by the increasing competition from oil and natural gas. Output of 15,900,673 tons in 1953 was 10 per cent lower than in 1952 and 17 per cent below that of 1950, the record year. The output was lower in all producing provinces, the 18 per cent drop in Alberta being the greatest. Canadian consumption of coal in 1953 at 38,141,000 tons was 11 per cent lower than in 1952. Imports accounted for 60 per cent of the coal consumed, about the same as in 1952. Toward meeting the competition from other fuels the coal industry continued its efforts to improve the quality of its product by the use of modern methods of beneficiation such as cleaning, drying, and the briquetting of fines and by making increasing use of mechanization.

Iron ore, nickel, and uranium provided most of the newsworthy developments in metal mining. Most important event in the offing in connection with iron ore is the bringing into production of the Quebec-Labrador deposits. This is expected to take place in August 1954, when the first train load of

ore will be shipped to the port of Seven Islands over the 360-mile railway. By the end of the fiscal year there were increasing indications that the United States would agree to participate in the construction of the St. Lawrence Seaway, a project that has long been regarded as essential to the successful development of the Quebec-Labrador deposits.

About 32 per cent of Canada's iron ore output is exported to the United States and the declining demand in that country in the closing months of the fiscal year accounts largely for the lower production rates in Canada during that period.

Interest in nickel was centred largely in the operation at Lynn Lake in northern Manitoba, where Sherritt Gordon Mines Limited brought its deposits of nickel-copper ore into production late in 1953. Development of the deposits, including the erection of a refinery at Fort Saskatchewan near Edmonton, Alberta and the movement of mine and mill equipment and houses from Sherridon, Manitoba, has involved expenditures of approximately $48,000,000. Quite apart from this is the expenditure of $15,000,000 in building the 147-mile railway connecting Lynn Lake with Sherridon. The refinery at Fort Saskatchewan is expected to be completed in July 1954, and will treat the nickel concentrate from Lynn Lake. The copper concentrate is being shipped to Noranda Mines Limited for treatment. Later this too will be treated at Fort Saskatchewan.

Meantime, the International Nickel Company of Canada Limited, has been rounding out an extensive program of underground development and expansion of operations, which has cost approximately $150,000,000. The company's annual rate of nickel production is now about 137,500 tons, the total ore mined in 1953 being 13,667,000 tons. Falconbridge Nickel Mines Limited has also been undergoing extensive development and expansion, one of its main projects being the preproduction development of its Fecunis mine on the north rim of the Sudbury basin. Its East, Mount Nickel, and Hardy properties are expected to go into production in 1954.

Although the demand for nickel during the fiscal year remained high there was a substantial relaxation in governmental restrictions. Allocations by the International Materials Conference were discontinued for the fourth quarter of 1953, and in August the Organization for European Co-operation released member countries from their agreement to restrict the use of nickel. In October, controls on the civilian use of nickel were revoked in the United States, although safeguards were provided to assure adequate supplies to meet military and atomic energy requirements. All use and purchase controls were revoked in Canada and similar restrictions on nickel in the United Kingdom were removed in the last quarter of 1953.

Main development in connection with uranium was the bringing into production of the Ace-Fay mine of the Crown-owned Eldorado Mining and Refining Limited in the Beaverlodge area in northern Saskatchewan in April 1953, and the disclosure, by diamond drilling, of a large deposit on the property of Gunnar Mines Limited, also in northern Saskatchewan. Some time ago Eldorado announced it would eventually accept custom ore at its Ace-Fay plant and has provided for this by excavating underground storage bins and by installing special crushing and sampling equipment.

Ontario and Quebec also figured prominently in the uranium developments. Great activity took place in a large area north of Lake Huron after encouraging results were obtained at the former Breton property in Long township. Additional discoveries of radioactive conglomerate, as well as a few other types have been reported from such widely separated places as Baldwin and

Hyman townships north of Espanola and Parkin and Roberts townships north of Sudbury. Prospecting and staking have spread to the Timagami region, about 150 miles northeast of the original find.

In Quebec there was much prospecting and staking for uranium and 45 additional radioactive properties were reported. These are almost entirely in the extension of the Grenville geological sub-province in Quebec which has long been known to contain occurrences of radioactive pegmatite. Reports of discoveries caused much excitement and staking in the Maniwaki region during the spring and summer of 1953, and in Grand Calumet and Huddersfield townships not far from Fort Coulonge during the winter of 1953-54. Prospecting was also done in parts of the Abitibi and Ungava regions and in Gaspé and the Eastern Townships.

Canada in 1953 was the fifth largest producer and consumer of copper, production in all forms being 251,612 tons and consumption, 130,347 tons. Ontario contributed 52 per cent and Quebec was second with 22 per cent of the output. In Ontario, a new unit of International Nickel Company's Copper Cliff smelter was put into operation, permitting the treatment of all the company's copper concentrate by the oxygen-flash-smelting process which has been under investigation for several years. In Quebec, operations at the Noranda mine and smelter were suspended from August, 1953 to February, 1954, the result of a labour strike. The Chibougamau area became a contributor to the output in December 1953 when Opemiska Copper Mines (Quebec) Limited commenced the production of copper concentrate from its property in Levy township.

Lead output at 197,229 tons in 1953 was 17 per cent higher than in 1952 but the value at $51,969,847 was 5·4 per cent lower. The value of the zinc output at $95,398,683 was about $34,500,000 lower than in 1952 although output reached a record 398,824 tons compared with 371,802 tons in 1952. The lower values are the result of a decrease of 3 cents a pound in the average price of lead and of 5½ cents in that of zinc. Because of the lower prices production was suspended at a number of lead-zinc mines in British Columbia, the most important being Reeves MacDonald Mines Limited. The domestic consumption of refined lead at 58,364 tons was 5,000 tons higher than in 1952. Refined zinc consumption at 51,157 tons was slightly lower.

A development of considerable interest was the discovery in December 1953 of a large deposit of copper-zinc ore near Manitouwadge Lake about 40 miles northeast of Heron Bay on Lake Superior. Geco Mines Limited was formed to carry out a drilling and development program on the deposit. In New Brunswick most of the excitement that followed the discovery of base metal deposits in the Bathurst area late in 1952 had died down by the end of the fiscal year and efforts were mainly concentrated on determining the merits or otherwise of the various prospects. Brunswick Mining and Smelting Corporation continued exploration by drilling on its extensive zinc-lead-pyrite deposit 17 miles southwest of Bathurst.

Labour strikes which caused a suspension of operations at 13 producers in Ontario and Quebec for varying periods, largely accounted for the decrease in gold production from 4,471,725 ounces in 1952 to 4,061,205 ounces in 1953. The closing of 5 mines in Ontario owing to high costs or depleted reserves was a factor also. There was little prospecting for gold and new development was limited mainly to properties adjacent to established mines. No new mines were brought into production. Early in October 1953 the Federal Government announced that legislation would be introduced to extend the operation of the Emergency Gold Mining Assistance Act to the calendar year 1954. The Act was amended so as to redefine the "rate of assistance" factor used in the

assistance calculations for 1953. The general effect of this change was that during 1953 the mines received approximately one dollar per production ounce more than in the previous year.

Canada's output of the industrial minerals in 1953 showed a gain in value of $17,207,000 over 1952, the chief contributor being asbestos, valued at $87,633,124. Barite with an output almost double that of 1952 showed the largest percentage gain.

By the end of the fiscal year the cement industry had mainly completed an expansion program that has been under way continuously since the end of the war. The two major projects still in progress are the construction of the St. Lawrence Cement Company's $12,000,000 plant near Quebec City which is expected to be completed by the fall of 1955, and doubling of the capacity of Canada Cement Company's Fort Whyte plant in Winnipeg to 3,200,000 barrels a day. Completion of these projects will give the industry an overall capacity of approximately 25,700,000 barrels a year, which compares with 22,500,000 barrels early in 1953, and at present rate of consumption is sufficient to meet Canadian requirements, in balance. Demand for cement has been decreasing following the completion of various defence and engineering projects. Meantime, as noted above, the St. Lawrence Seaway and Power project shows promise of materializing and this would greatly increase the demand for cement and other structural materials.

With the bringing into production of Cassiar Asbestos Corporation mill on its property in the McDame Lake area in July 1953, British Columbia joined the list of Canadian producers of asbestos. Ontario became a producer a few years ago, but Quebec, a producer since 1878, still accounts for over 95 per cent of the annual output. Canada accounts for about 62 per cent of the world total. Canadian production of milled fibre in 1953 was 7 per cent lower than in 1952 because of a slackening in demand for several grades. The lower demand in the United States for fibre of spinning quality was the result of a substantial reduction in the output of asbestos textiles.

The expansion program that has been under way in Quebec during the past several years was further advanced. The $14,000,000 program of Canadian Johns-Manville Company Limited, the largest producer, includes the gradual conversion from open pit to underground mining at its Jeffrey mine, and the rebuilding of its mill. Asbestos Corporation is erecting a 5,000-ton mill on its Normandie property, and Johnson's Asbestos Company completed the erection of a 4,000-ton mill at its open-pit property at Black Lake.

The decline in the output of sulphur in all forms from 428,013 tons in 1952 to 349,945 tons in 1953 was due mainly to a decrease in the amount of by-product pyrites shipped by the major producers of western Quebec because of prolonged labour strikes. The continued expansion in the production of sulphur, in its various forms, from natural gas, pyrites, surface deposits of sulphur, anhydrite, and smelter stack gases, throughout the world has brought about a gradual improvement in supply and during 1953 consumers who had been on allocation were able to obtain their full requirements of elemental sulphur. Further improvements are expected in 1954 resulting from the bringing into production late in 1953 of two new salt dome mines, namely Garden Island Bay in Louisiana and Damon in Texas. In Canada, the plant being erected by Noranda Mines Limited at Port Robinson near Welland, Ontario for the recovery of elemental sulphur, sulphur dioxide, and iron sinter from pyrite is expected to be in operation in September 1954. Initial plans call for the roasting of 100,000 tons of pyrite annually, which is to be obtained as a by-product of operations at Noranda's Horne mine in Noranda, Quebec.

Activities of the Department

The attention given to the Arctic regions during the fiscal year in the mapping activities of the department deserves special mention. Part of such work has a direct or indirect bearing on defence but in the main it anticipates an increasing interest by mining and exploration companies in the years ahead in the mineral potentialities of these regions. This interest is being stimulated by such recent developments in the mainland portion of arctic Canada as the discovery of large deposits of iron ore west of Ungava Bay, and in the islands portion by the evidence found by the Geological Survey of Canada on Cornwallis Island in 1953 of the presence of important factors essential to the accumulation of commercial oil pools.

In line with its long range policy of mapping northern areas the Department plans ultimately to cover the whole of Yukon by 4-mile geological mapping, working outwards from the most accessible and economically promising areas; to map all unexamined areas in Mackenzie and Keewatin districts, Northwest Territories at 8-mile reconnaissance scale as rapidly as funds and personnel permit; and to carry out geological reconnaissance of the coast of all the arctic islands, with the highest priority to parts most accessible or thought likely to yield most information. In the establishment of control for mapping and in other work the plans call for: extension of the shoran geodetic net until complete coverage of Yukon and Northwest Territories is attained; complete coverage of the two territories in topographical mapping at scale of 1 to 250,000 as soon as possible, and coverage at a scale of 1 to 50,000 as developments warrant; revision of air charts as better information becomes available; improvement of general hydrographic charts and provision of detail charts of coast and harbour sites where required by developments and as facilities permit; and geographical surveys of terrain conditions at the high arctic weather stations, the posts on the north shore of the Canadian mainland, and of other areas.

In all, the department had 149 mapping parties in the field in 1953, comprising 79 geological parties, 19 geodetic, 31 topographic and 20 legal surveys. Nine ships and 5 motor launches were engaged in charting operations. Including the field work in 1953, the geology of approximately one-third of Canada has now been mapped on scales adequate to meet the requirements.

The great upsurge of interest in uranium resulted in a heavy demand on the various services the department provides to prospectors, companies, and others in connection with radioactive ores and minerals. The department continued to develop the essential metallurgy of the processing of radioactive ores and the finished nuclear fuel as needed by the Atomic Energy project. Atomic reactor technology is fairly standard but the metallurgical behaviour of the nuclear materials assembled in a high-energy reactor is becoming very involved and requires urgent and more expanded study. This is the part undertaken by the department as a means toward the development of atomic power.

The department has been coordinating the Canadian effort in the development of a possible titanium industry to meet the Canadian requirements for this metal. Its program of research covers all phases from the treatment of Canadian titanium ores through purification of the metal to melting, alloying, forging and casting. Knowledge gained will be made available to any Canadian industry engaged in processing titanium for use.

The increasing demands on the Department's services have made it necessary to undertake considerable laboratory and office construction. The present interest in the search for and development of uranium deposits, for instance, has greatly overtaxed available facilities in the Mines Branch for research work on uranium ores and minerals. Also, the chemical laboratories of the

Branch are much too small to meet present needs. It is the intention to construct a building that will house these laboratories and the Radioactivity Division and will provide offices for the administrative staff of the Branch.

In addition, the activities of the Geological Survey of Canada have far outgrown the available space in the National Museum of Canada building and it has been necessary to provide makeshift office space in various other buildings poorly suited to meet the special needs. Construction of a new building to house the activities of the Survey is receiving active consideration. Meantime, a tender has been awarded for the construction of a geophysical laboratory that will house the Terrestrial Magnetism, Gravity, and Solar Physics divisions of the Dominion Observatory, located on the grounds of the Central Experimental Farm.

Looking further ahead, the construction of an equipment depot, of a building to house the various units of the Surveys and Mapping Branch, and of a departmental administrative building that will also house the Geographical Branch is anticipated.

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

	Revenue	Ordinary Expenditures
Minister of Mines and Technical Surveys	.....	$ 12,000.00
Departmental Administration	$ 0.75	423,992.69
Explosives Act—Administration	5,280.86	85,976.00
Mines Branch	78,291.81	2,622,472.69
Geological Survey of Canada	21,263.43	1,899,565.66
Surveys and Mapping Branch	85,607.94	6,036,605.90
Geographical Branch	545.52	239,122.45
Dominion Observatories	2,327.11	590,421.51
General:—		
To provide for payments under the Emergency Gold Mining Assistance Act	.....	15,151,449.30
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 Interdepartmental Committee on Air Surveys	.....	1,086,913.79
Provincial and Territorial Boundary Surveys	.....	47,337.54
Gratuities to families of deceased employees	.....	2,076.64
Exchequer Court Awards	.....	262.00
	$193,317.42	$28,198,196.17

Explosives Division

As the Division issues its own annual report its activities during the fiscal year are dealt with only briefly in this report.

Members of the R.C.M.P. serve as deputy inspectors of explosives and thus render valuable assistance in the enforcement of the Explosives Act, particularly in remote areas.

A bill to amend the Explosives Act, 1946, received the approval of Parliament on February 11 and Royal Assent on February 16, 1954, the purpose of the bill being to amend certain sections of the Explosives Act in order to remove difficulties that have arisen in its administration.

Factories—Nineteen explosives factories and one storage depot were licensed in 1953, while inspectors of the Division made 38 inspections of licensed factories.

Production of commercial explosives in Canada in 1953 was 122,096,517 pounds, slightly less than in 1952.

Magazines, Registered and Unlicensed Premises—In all, 450 permanent and 1,072 temporary licences were in force at the end of 1953 compared with 410 permanent and 914 temporay licences at the end of 1952. Registered premises increased from 82 to 115.

Inspectors and deputy inspectors made 1,452 inspections of magazines and 160 inspections of registered premises. There were also 3,513 inspections of unlicensed premises which include premises where small quantities of blasting explosives are kept for private use. Dealers who retail small arms ammunition are required to keep records of sales and receipts and such records are subject to inspection.

Imports—Altogether, 768 permits and 18 special permits were issued for the importation of such items as: fireworks; distress signals; nitrocotton, for use in making paints and lacquers; propellant powders, used in making ammunition; blasting agents, for quarry work; and explosives used in exploration for oil. In 1952, 720 permits and 17 special permits were issued.

Accidents—There were no fatalities involving commercial explosives in explosives factories in 1953 and no serious injuries. Twelve persons were injured, none of them seriously, in minor explosions and flashes occurring during manufacture.

Playing or tampering with detonators and other explosives resulted in death to 3 persons and injuries to 49. Most of the victims were children who had access to explosives through the carelessness or neglect of adults who failed to lock up the explosives as required by regulation made under the Act.

	Accidents	*Killed*	*Injured*
Mines and quarries	48	6	57
Elsewhere in industry	42	20	25
Playing with detonators	12	0	17
Playing with other explosives	9	1	28
Miscellaneous	6	2	4
Manufacturing	9	0	12
Conveyance	1	0	2
	127	29	145

Laboratory—An agreement which was entered into in 1942 between the Department and the National Research Council, to maintain jointly an explosives laboratory for testing and research, was terminated by mutual consent in 1953. A new laboratory for the Division is now in operation near Uplands, Ottawa. In it, tests, analysis of explosives required in the administration of the Explosives Act, and investigation of the hazards attending manufacture, storage, shipment, and use of explosives are carried out. Assistance is also given to other government departments in matters concerning explosives. During 1953, 766 samples were received and examined.

Prosecutions—Proceedings were entered in 9 cases for violations of the Explosives Act and Regulations and convictions were obtained in all cases and fines imposed. The offences were: improper storage, stopping unnecessarily while conveying explosives by truck, and illegal sale of explosives.

Three men were fined for improper use of explosives under provincial mining Acts and three were fined under city by-laws for causing damage to property or injury to persons with fireworks.

Seven persons were charged under the criminal code with illegal possession of explosives.

Destruction—The Division is responsible for the destruction or disposal of abandoned or deteriorated commercial explosives. In all, 25,103 pounds of blasting explosives, 10,381 detonators, 20 cases of fireworks, and 1 case of Chinese firecrackers were destroyed in 1953.

SURVEYS AND MAPPING BRANCH

W. H. Miller, Director

During the fiscal year basic surveying, charting and mapping was carried on in areas chosen to meet the most urgent needs for natural resources development, defence and administrative purposes.

Close co-operation was maintained with the Army Survey Establishment, Department of National Defence.

There was an increase in requests for work in special form, for use of other government departments and agencies.

Geodetic Survey of Canada

During the fiscal year the Geodetic Survey completed 530 miles of primary and second-order triangulation, 200 miles of triangulation reconnaissance and tower building, and 1,017 miles of precise levelling. For the control of the accumulative errors of observation in triangulation nets, 3 base lines were measured and Laplace azimuths were determined at 3 stations. In connection with the demarcation of a provincial boundary, 9 precise determinations of latitude were made adjacent to the 60th parallel of latitude. In the eastern section of northern Canada, the shoran network was extended by the measurement of 101 new lines. In addition, 8 new stations were located in Yukon and were prepared for occupation in 1954.

At the request of the Department of Transport, the geodetic triangulation system of the City of Montreal is being extended over the harbour area, where control is required for detail surveys in connection with the St. Lawrence Seaway.

Distribution of Publications and Technical Data Sheets

	1953-54	*1952-53*
Number of publications distributed	1,500	2,000
Typed data sheets and blueprints distributed ...	5,600	13,500

Geodetic Field Parties

Province or Territory	Number of Parties 1953–54	1952–53
Northwest Territories (1)	1	3
Yukon (2)	1	0
British Columbia	3	3
Alberta (3)	2	2
Saskatchewan (4)	1	0
Ontario (5)	4	4
Quebec	2	2
New Brunswick / Nova Scotia	1	2
Newfoundland	3	4
Nova Scotia, Prince Edward Island and New Brunswick	1	.....
Totals	19	20

(1) Shoran computational unit was based for the first part of the season at Frobisher Bay during which time line measurements were made by the R.C.A.F. in the Ungava peninsula of Quebec and the Baffin Bay area of the Northwest Territories. On the completion of the work in this area, the unit was based at Rockcliffe while the line-measurement work was continued in Northern Ontario.

(2) Shoran reconnaissance party did some work in Ontario also.

(3) A levelling party did some work in British Columbia also.

(4) Did some work in Ontario also.

(5) A levelling party did some work in Quebec and New York State also.

SHORAN

The Geodetic Survey in cooperation with the R.C.A.F., the National Research Council, and the Meteorological Service, Department of Transport, extended the shoran network of trilateration from Ungava peninsula, in Quebec, northward across Hudson Strait to the central part of Baffin island. Near the westerly limit of Hudson Strait a connection was made with the shoran net which had been previously projected northerly and easterly from the Prairie Provinces. The junction of the two nets completed a 5,600-mile circuit of closed survey, comprised of 2,000 miles of conventional triangulation and 3,600 miles of trilateration. The diagonal loop closure discrepancy in geographic position at the west end of Hudson Strait was about 400 feet. The ratio of closing error to axial length of the shoran component of the loop is equivalent to one part in 47,000.

Seventy-three lines were measured in the northern Quebec-Hudson Strait-Baffin Island area. As soon as the transfer of personnel and equipment could be effected, the line-measurement operations were continued in northern Ontario and the measurement of 28 additional lines was completed in this network which covers 200,000 square miles.

Stations of the shoran network constitute the control necessary for the aerial mapping of the vast northern region. Certain inherent advantages of the method, such as the use of triangle sides greater than 200 miles in length, make it possible to project survey control into remote areas in a relatively short time. From 1949 to 1953, inclusive, 86 stations and 325 measured lines, ranging from 16 to 365 miles in length, have been incorporated into the Canadian network. With the exception of Yukon, where reconnaissance was carried on in 1953 the sparsely settled area south of the Arctic Archipelago is now fairly well covered with shoran trilateration.

TRIANGULATION

Primary and second-order triangulation nets were extended in British Columbia, Alberta, Ontario, Quebec, Newfoundland Labrador, and Newfoundland.

British Columbia

Two observation parties operating between Fort St. John and Fort Nelson closed a 150-mile gap in the Alaska Highway net. This arc is a component part of a 2,000-mile loop of survey control extending from Prince Rupert to Whitehorse and onward through Fort Nelson, Dawson Creek, Prince George, and back to Prince Rupert. The section between Prince Rupert and Whitehorse, situated chiefly in Alaskan territory, was executed years ago by the United States Coast and Geodetic Survey. The diagonal closure in geographic position of the 2,000-mile loop, as indicated by preliminary computations of the 1953 field work is about 90 feet. This represents a ratio of closing error to axial length of loop of one part in 117,000 and indicates the maintenance of the geodetic work at a high standard of precision.

Alberta

Work was continued on the extension of the Alaska Highway arc from Dawson Creek towards Edmonton. The completion of this 500-mile section will provide control in the Grande Prairie-Lesser Slave Lake area. It will greatly strengthen the western geodetic network by closing a 1,200 mile loop of primary triangulation which connects geodetically the following places:—Dawson Creek, Edmonton, Jasper, Williams Lake, Prince George, and Dawson Creek. Reconnaissance, station preparation, and the erection of observation towers were

completed between McLennan and the east end of Lesser Slave Lake and from Grimshaw northward for 40 miles along the Mackenzie Highway—in all, a distance of 200 miles.

Ontario

The primary triangulation north of Lake Superior was extended northward from Nipigon to the town of Armstrong on the Canadian National Railways. This net is of particular importance as its future extension westward about 500 miles into Manitoba will complete the only all-Canadian east-west arc of triangulation extending from the Atlantic to the Pacific Oceans. Up to the present all triangulation in western Canada has been connected to the eastern Canadian network by means of junctions with the United States Coast and Geodetic Survey arcs adjacent to the International Boundary.

Quebec and Newfoundland (Labrador Section)

One party continued the Hamilton River secondary arc southeasterly about 100 miles to the easterly end of Lake Winokapau. This net will furnish mapping control for the prospecting area adjacent to the Hamilton River and for the investigation of the potential power development of Grand Falls. When the triangulation arc is finally projected to the Labrador coast the terminal stations will constitute an origin for the extension of much-needed triangulation along the north Atlantic seaboard.

A second party extended the Havre St. Pierre-Allard Lake triangulation arc northbound from the titanium ore area as far as the 52nd parallel of latitude. During 1954, the net will be continued northward to make a junction with the Hamilton River arc.

Newfoundland

Along the south coast of Newfoundland a second-order triangulation arc was advanced from Francois westward about 50 miles. The prevalence of fog and gales greatly retarded the progress of the field operations in this area.

Special Control Survey for the St. Lawrence Seaway Development Project

To provide control for surveys of the Department of Transport in connection with the St. Lawrence Seaway development project, the Geodetic Survey commenced the extension of the Montreal City triangulation net over the adjacent harbour area. After the completion of the reconnaissance and the location of two base lines, angular measurement work was commenced. Although the project was incomplete at the end of the fiscal year, 18 triangulation stations were selected and about a quarter of the angular measurement work was completed.

PRECISE LEVELLING

Regular operations were carried out in British Columbia, Alberta, Ontario, Nova Scotia, New Brunswick, and Newfoundland. Special levelling operations were undertaken in Ontario and Quebec in connection with the proposed St. Lawrence Seaway development project. In all, 1,017 miles of levelling were completed during the 1953 season.

In the Maritime Provinces, the inspection of bench marks was carried out prior to the publication of revised levelling data. In connection with this work, the sites of about 1,300 bench marks were visited, and notations were made of the physical conditions of the markers.

British Columbia

Work was commenced at Prince George on a line of levels northward along the Hart Highway. About 61 miles of this line were completed.

Alberta

The northerly 91 miles of the Lake Louise-Jasper line of levels, commenced in 1952, were finished.

Ontario

Lines joining Red Lake and Red Lake station, and Kenora and Emo were completed in northern Ontario, the distances involved being 100 and 120 miles respectively.

Ontario and Quebec—Special Project—St. Lawrence Seaway Development

A special field project was carried out in 1953 to supply levelling data required for the St. Lawrence Seaway development project. The field work was spread over a wide area in Ontario, including Kingston, Ivy Lea, Cornwall, Iroquois, Cardinal, and Prescott. In addition, a few miles of levels were run in Quebec and in New York State in connection with a 76-mile line starting at Rouses Point and passing through Huntingdon and Dundee, in Quebec, and terminating at Fort Covington, New York. The projection of this line formed part of an observational program for the coordination of levelling datums on both sides of the International boundary. In all, 240 miles of levelling were completed in connection with the St. Lawrence Seaway.

Nova Scotia and New Brunswick

Precise levelling was extended 107 miles along the railway from Pictou to Oxford Junction and from Moncton 159 miles along the highway to Bathurst. In 1954, this line is to be continued north-westerly to Rimouski, Quebec.

Newfoundland

Between Botwood and Corner Brook, 139 miles of re-levelling were carried out along the line of the Canadian National Railways. The purpose was to clear up discrepancies that existed between original geodetic levelling and mean sea-level datums as indicated by tidal-gauge installations at St. John's, Corner Brook, and Port aux Basques.

Comparative Table of Levelling by Provinces—Fiscal Years 1953-54 and 1952-53.

Province	Number of Parties 1953–54	Number of Parties 1952–53	Mileage 1953–54	Mileage 1952–53	Bench Marks 1953–54	Bench Marks 1952–53
British Columbia	1-S	1-S	61	88	35	32
Alberta			91	309	44	142
Ontario	1-S	1-S	220	52	114	15
Ontario (St. Lawrence Seaway)	1-D	1-S	131	17	40	12
N.Y. State (St. Lawrence Seaway)	.....	.....	28	.....	3	.....
Quebec (St. Lawrence Seaway)	1-S	1-S	81	.....	38	.....
Quebec	.....	1-S	.....	292	.....	145
New Brunswick	1-S		159	321	77	
Nova Scotia		1-S	107 (Re-Lev.)		32	167
Newfoundland	1-S	.....	139 (Re-Lev.)	.....	.....	.....
Totals	6	6	1,017	1,079	383	513

Total Mileage of Levelling by Provinces, Canadian Net to End of March, 1954.

Province or Territory	Precise	Secondary	Public Works	Total
Yukon	1,333·0	26·0	.....	1,359·0
British Columbia	5,772·0	52·0	.....	5,824·0
Northwest Territories	93·0	.....	.....	93·0
Alberta	4,585·0	3,799·0	.....	8,384·0
Saskatchewan	4,203·0	5,098·0	.....	9,301·0
Manitoba	2,963·0	467·7	113·0	3,543·7
Ontario	7,593·0	1,376·0	2,012·0	10,981·0
Quebec	4,877·0	1,428·8	1,750·0	8,055·8
New Brunswick	1,263·0	.....	403·0	1,666·0
Nova Scotia	1,023·7	.....	309·0	1,332·7
Prince Edward Island	284·0	.....	.....	284·0
Newfoundland	834·8	.....	.....	834·8
Minnesota, U.S.A.	89·0	.....	.....	89·0
Vermont, U.S.A.	6·0	.....	.....	6·0
New York, U.S.A.	43·0	.....	.....	43·0
	34,962·5	12,247·5	4,587·0	51,797·0

GEODETIC ASTRONOMY AND BASE LINE MEASUREMENTS

Geodetic astronomy is used for the establishment of inter-provincial boundary lines, for horizontal mapping control, and for the control of small accumulative errors causing twist in triangulation arcs. Base line measurements are used for the control of errors causing distortion in scale in triangulation.

During the fiscal year two Laplace azimuth stations adjacent to the Alaska Highway were observed in British Columbia, one at East Base, Mill Creek and the other at Armsig geodetic station. At Schreiber, Ontario, a Laplace observation, begun in 1952, was finished.

For control in the demarcation of the boundary line between Saskatchewan and Northwest Territories, 9 precise latitude stations were observed adjacent to the 60th parallel of latitude between the 104th and 110th meridians of west longitude. These stations were established at intervals of about 22 miles with probable errors in latitude of approximately 0·10 second of arc. In each case the longitude was observed to a somewhat lesser order of accuracy.

Two base lines were measured in British Columbia in connection with the Alaska Highway triangulation, one near Mill Creek and the other near the Sikanni Chief River. A third base line was measured in Newfoundland Labrador near Sandgirt Lake.

Topographical Survey

The field and office work completed during the fiscal year showed an increase over the previous year. The number of field parties was smaller, but the total area controlled by field surveys was larger. The total area of new mapping increased by about 14 per cent.

The field program was featured by two major projects using helicopter transport. One of these parties completed vertical and horizontal control for mapping the iron-bearing belt of rocks known as the Labrador Trough at a scale of 1 to 50,000 from near Fort Chimo about 20 miles south of Ungava Bay to Schefferville (Knob Lake) in the Quebec-Labrador iron ore region, an area of about 20,740 square miles. This party later established vertical control on about 9,670 square miles in the Gaspé-New Brunswick region. A photographic method of determining the height of the helicopter above the ground, developed in the Division, proved very useful in densely wooded areas. The other large operation was in the oil-rich areas in northwestern Alberta and northeastern

British Columbia, where one party equipped with two helicopters established vertical control for mapping on a 1 to 50,000 scale over about 51,800 square miles. Worthy of note also was the completion of 580 miles of spirit levelling along the Mackenzie River from near Wrigley to Arctic Red River.

Army Survey Establishment, Department of National Defence, which works in collaboration with the Division, extended the area covered by shoran-controlled photography in the Northwest Territories by about 120,000 square miles.

About 11,000 advance information prints of new mapping were distributed to federal and provincial authorities and to other interested parties.

FIELD SURVEYS

Original ground surveys for control of mapping from aerial photographs were carried out over widely scattered areas totalling about 133,000 square miles. Seventeen of the 48 field survey parties were supplied by Army Survey Establishment, and these accounted for an additional 211,000 square miles including the aforementioned 120,000 square miles covered by shoran-controlled photography. Field projects carried out by the Division during the year are summarized as follows:

Province or Territory	Number of parties	Type of Work	Publication Scale	Area (Square Miles)
Northwest Territories	1	Astronomic observations	.....	
	1	Spirit levels	.....	580 (linear miles)
	1	Topographical control	1:50,000	1,445
Yukon	1	Photo-topographical control	1:50,000	3,265
	1	Photo-topographical control	1:250,000	3,665
British Columbia	1*	Vertical control (helicopter)	1:50,000	17,660
	4	Photo-topographical control	1:50,000	5,250
	1	Photo-topographical control	1:50,000	1,170
		Topographical control (detail)		175
	3	Photo-topographical control	1:250,000	17,285
Alberta	1*	Vertical control (helicopter)	1:50,000	34,134
	1	Photo-topographical control	1:50,000	880
	1	Vertical control	1:50,000	1,660
	1	Horizontal control (chain traverse)		250 (linear miles)
Saskatchewan	4	Vertical control	1:50,000	4,428
	1**	Topographical control (winter traverse)		100 (linear miles)
Manitoba	2	Vertical control	1:50,000	2,100
	1	Horizontal control (stadia)	1:50,000	3,430
	1**	Topographical control (winter traverse)		50 (linear miles)
Ontario	1	Vertical control (spirit levels)		103 (linear miles)
		Field interpretation	1:50,000	5 (map sheets)

Province or Territory	Number of parties	Type of Work	Publication Scale	Area (Square Miles)
Quebec	1***	(Topographical control (helicopter)	1:50,000	20,740
		Vertical control (helicopter)	1:50,000	5,365
	1	Topographical control (chain traverse)		231 (linear miles)
	1	Vertical control (spirit levels)		147 (linear miles)
		Radar altimeter control—Anticosti Island	1:250,000	
	1	Topographical control (Magdalen Islands)	1:50,000	200
		Field interpretation	1:50,000	10 (map sheets)
New Brunswick	1***	Vertical control (helicopter)	1:50,000	4,305
		Field interpretation	1:50,000	1 (map sheet)
Newfoundland	1	Topographical control	1:50,000	1,532
		Field interpretation	1:50,000	2 (map sheets)

*Same party as the other so marked.
**Same party as the other so marked.
***Same party as the other so marked.

Topographical detail was plotted on areas totalling approximately 18,000 square miles on which the planimetry was drawn by photogrammetrical methods.

During the winter of 1953-54 two field officers completed about 150 miles of chain traverse in areas near Flin Flon, Manitoba, and Beaverlodge, Saskatchewan.

One senior officer carried out special investigations in the Arctic Islands: one was in charge of the above-mentioned Alberta-British Columbia helicopter project; one coordinated and supervised the work of the field parties in British Columbia and the Prairie Provinces; and the other was in charge of the Labrador Trough-Quebec helicopter operation.

AIR SURVEYS

The work of the Air Surveys unit includes the plotting of maps from aerial photographs on control established on the ground. A total of 105,725 square miles of mapping was completed during the fiscal year, a summary by provinces being as follows:

Province or Territory	Number of Map Sheets	Scale of Publication	Area in Square Miles
1. Planimetric			
Yukon	8	1:250,000	37,328
Northwest Territories	1	1:250,000	3,833
		1:50,000	596
British Columbia	3	1:250,000	11,835
Alberta	1	1:50,000	374
Saskatchewan	22½	1:50,000	7,763
Manitoba	10	1:50,000	3,571
New Brunswick	1	1:50,000	200
Nova Scotia	1	1:50,000	178

Province or Territory	Number of Map Sheets	Scale of Publication	Area in Square Miles
Coastal Areas for Hydrographic Service:—			
Northwest Territories	5	1:12,500	57
	2	1″:1·73 miles	2,200
	1	1″:½ mile	934
	2	1″:1 mile	2,000
	1	1″:¼ mile	75
	5	1″:2 miles	3,342
Total, planimetric			74,286
2. Contoured Maps			
Northwest Territories	5½	1:50,000	565
British Columbia	6½	1:50,000	2,348
Alberta	½	1:50,000	187
Saskatchewan	1	1:50,000	390
Ontario	4	1:50,000	1,678
Quebec	24½	1:50,000	7,665
New Brunswick	12	1:50,000	4,526
Nova Scotia	1½	1:50,000	332
Newfoundland	45	1:50,000	13,422
*Special Projects:**			
Yukon	1	1″:500′	5
British Columbia	1	1″:2,000′	28
	1	1″:1,000′	28
Alberta	1	1:21,600	14
	1	1″:½ mile	25
Quebec	1	1″:¼ mile	120
Ontario	2	1″:1,000′	22
Newfoundland	1	1:16,000	84
Total, contoured mapping			31,439
3. Mosaics			
National Parks	11	.....	200
Yukon	3	.....	14,037
Northwest Territories	1	.....	4,640
Alberta	3	.....	2,024
Saskatchewan	1	.....	1,400
Quebec	16	.....	40,552
Newfoundland (Que.-Nfld.)	2	.....	5,680
Newfoundland	1	.....	700
Total, Mosaics	38	.....	69,233

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

Map Sheets forwarded for Publication

Province or Territory	1:50,000	1:250,000	Total	Area Square Miles
Newfoundland	45	.....	45	12,172
Nova Scotia	10	.....	10	2,802
New Brunswick	16	.....	16	5,232
Quebec	29	.....	29	7,869
Ontario	1	.....	1	424
Manitoba	2	.....	2	770
Saskatchewan	6	.....	6	2,288
Alberta	2	.....	2	362
British Columbia	8	2	10	13,929
Yukon	.....	3	3	12,410
	119	5	124	58,258

Maps Sheets inked or traced for advance information prints

Newfoundland	5
Nova Scotia	9
New Brunswick	11
Quebec	20
Ontario	2
Manitoba	15
Saskatchewan	35
Alberta	2
British Columbia	11
Yukon	4
Northwest Territories	7
Total	121

NATIONAL AIR PHOTOGRAPHIC LIBRARY

During the fiscal year 59,494 photos were added, bringing the total to 2,430,305. Coverage by vertical photography totalled 248,745 square miles. Of this, 238,274 square miles was high-altitude photography, taken from altitudes of more than 30,000 feet above sea level. Coverage by tri-camera photography totalled 4,200 square miles.

During the fiscal year, 3,258 requisitions, involving the purchase of 401,634 prints, were prepared and forwarded to the Photographic Establishment of the Royal Canadian Air Force at Rockcliffe, Ontario. These prints were for various Federal and Provincial Government Departments, and mining and industrial concerns, as well as private individuals engaged in the development of Canada's resources. In practically every case index maps were supplied.

A new "Air Photo Coverage Map of Canada" was compiled, copies of which are available on request.

Canadian Hydrographic Service

The planning of hydrographic work during the fiscal year took place against a background of navigational requirements in connection with coastal mineral developments, a great fishery modernization program, and coastal defence requirements. Charting operations were carried on with the use of nine vessels and several large motor-launches, all equipped with the latest hydrographic instruments.

Four of the hydrographic ships operated on the Atlantic seaboard and three on the West Coast. Two ice-strengthened sealing vessels were hired for charting in northern Labrador and the Hudson Strait area. The motor launches were used for hydrographic operations in the Great Lakes, Lake Winnipegosis, Great Slave Lake and in the inshore waters and harbours of the Atlantic and Pacific coasts. As a result of the coastal survey scores of hitherto unknown shoals and reefs were found and placed on the charts.

ATLANTIC COAST

Gulf of St. Lawrence and Atlantic Coast

The *Kapuskasing* in its principal operation charted an area between the west coast of Cape Breton Island and the east coast of Prince Edward Island. A reported shoal area southwest of Anticosti Island was examined and its existence disproved. Other work was a survey of new installations at Seven Islands, Que., charting in the eastern approaches of the Strait of Canso, and the calibration of the navigational radio direction-finding stations at Camperdown and Yarmouth, Nova Scotia.

As a result of the work, three new nautical charts will be published: "Cheticamp to Cape Mabou", "East Point to Cape Bear" and "Plans of Harbours, Cheticamp, Grand Etang and Margaree".

Summary of season's work:

Ship sounding	3,061	linear	nautical	miles
Boat sounding	1,547	"	"	"
Shoals examined	20			

Approaches to the Strait of Canso, N.S.

The launch *Henry Hudson* carried out survey operations in the Atlantic approaches to the Strait of Canso.

Summary of season's work:

Boat sounding	651	linear	nautical	miles
Coastlining	50	"	"	"
Shoals examined	41			

Cape LaHave, N.S.

The launch *Anderson* engaged in a survey of the Nova Scotia coast between Cape LaHave and Liverpool Bay, an area not charted since 1866.

Summary of season's work:

Boat sounding	1,328	linear	nautical	miles
Coastlining	85	"	"	"
Shoals examined	12			

Placentia Bay, Nfld.

The *Fort Frances* conducted detailed charting on the west side of Placentia Bay and westward to the islands of St. Pierre and Miquelon. At the request of the Federal Department of Public Works and to assist it in deciding upon the feasibility of developing a harbour in the Grand Codroy River district, an area of approximately 66 square miles was sounded between Shoal Point and Cape Anguille, the westernmost point of the island of Newfoundland. Oceanographical observations were made en route between Halifax and Placentia and thence westward to Cape Anguille.

As a result of the season's work the surveying for two new charts is well advanced.

Summary of season's work:

Ship sounding	1,007	linear	nautical	miles
Boat sounding	2,252	"	"	"
Coastlining	125	"	"	"
Shoals examined	112			
Oceanographical stations occupied	16			

The launch *Dawson*, under the supervision of the *Fort Frances*, worked in the inner portion of Placentia Bay.

Summary of season's work:

Boat sounding	686	linear	nautical	miles
Coastlining	22	"	"	"
Shoals examined	1			

Cape Bonavista, Nfld.

The hydrographic ship *Acadia*, operated by the Canadian Hydrographic Service since 1912, continued the charting of the exposed eastern coast of Newfoundland. Special attention was given to the offshore approaches to St. John's and the inner approaches to Bonavista. The work accomplished constituted one of the largest seasons on record for this vessel and will result in the publication of two charts, "Conception Bay and Cape St. Francis to

St. John's" and "Cape Bonavista". In addition, a great deal of data were obtained for two additional charts.

Summary of season's work:

Ship sounding	3,462	linear nautical miles
Boat sounding	2,109	" " "
Coastlining	30	" " "
Shoals examined	116	
Oceanographical stations occupied	18	

Shippigan and Lake Melville

The *Cartier,* at the request of the Federal Department of Public Works, started the charting of the approaches to Shippigan Harbour. To meet an urgent request from Brunswick Mining and Smelting Corporation Limited, a reconnaissance survey of a small area in Baie de Chaleur was carried out. The chief project, however, was the charting of the western portion of Lake Melville, Labrador, on the shipping route to Goose Bay.

Summary of season's work:

Ship sounding	335	linear nautical miles
Boat sounding	809	" " "
Shoals examined	1	
Oceanographical stations occupied	9	

Ungava Bay-Hudson Strait

In connection with the extensive iron ore developments on the west coast of Ungava Bay, the chartered sealer *Algerine* continued the detailed hydrographic survey of the Leaf Bay area for the purpose of locating a suitable harbour and navigational approaches thereto. Tidal investigations were also carried on, during which a maximum tidal range of 54½ feet, probably the highest in the world, was recorded. A brief reconnaissance was made of Kyak Bay in Payne Bay to ascertain the possibilities for an ore-loading site.

As a result of the season's work three new charts, "Approaches to Leaf Bay", "Leaf Inlet" and "Leaf Basin" will be published.

Summary of season's work:

Ship sounding	743	linear nautical miles
Boat sounding	1,310	" " "
Coastlining	352	" " "
Shoals examined	22	
Oceanographical stations occupied	11	

Hopedale, Diana Bay, Pictou Harbour

The *Theron,* also a chartered vessel, extended the survey of the Hopedale area about midway up the Labrador coast. The principal operation was the charting of Diana Bay in Hudson Strait. The re-charting of Pictou Harbour, N.S., was completed.

As a result of the season's work two new charts "Diana Bay" and 'Diana Bay, Southern Portion" and a new edition of the chart "Pictou Harbour" will be issued. The new work at Hopedale will permit the issue of two new charts in that area.

Summary of season's work:

Ship sounding	259	linear nautical miles
Boat sounding	1,955	" " "
Coastlining	60	" " "
Shoals examined	30	
Oceanographical stations occupied	4	

Eastern Arctic

One hydrographer was assigned to the Department of Transport vessel the *C. D. Howe* and was later transferred to the *d'Iberville*. Much useful hydrographic data were obtained at the twenty ports of call. This information, along with soundings taken along the vessels' tracks, will be added to the charts.

Summary of season's work:

Ship sounding	5,840	linear nautical miles
Boat sounding	451	" " "

INLAND WATERS

Bay of Quinte

The launch *Boulton* completed the survey of Quinte area, Picton Bay to Belleville. As a result of the past two seasons' operations two new charts, "Upper Gap to Telegraph Narrows" and "Telegraph Narrows to Belleville" will be published.

Summary of season's work:

Boat sounding	646	linear nautical miles
Coastlining	77	" " "
Shoals examined	6	

Lake Huron-Georgian Bay

The launch *Bayfield* completed surveys of Owen Sound Harbour and South Baymouth and made progress in a re-survey of the approaches to Parry Sound.

Summary of season's work:

Boat sounding	760	linear nautical miles
Coastlining	30	" " "
Shoals examined	270	

Lake Winnipegosis

The small launch *Sandpiper* conducted survey operations in the south end of Lake Winnipegosis for fishery development purposes.

Summary of season's work:

Boat sounding	945	linear nautical miles
Coastlining	25	" " "

Great Slave Lake

The launch *Rae* was reconditioned for survey work off Yellowknife Bay. Progress was greatly hindered by the short season of open navigation and unfavourable weather conditions.

Summary of season's work:

Boat sounding	135	linear nautical miles
Coastlining	95	" " "
Extension of triangulation net	25	" " "

PACIFIC COAST

The *Wm. J. Stewart* completed surveys of Juskatla Inlet in the northern end of Graham Island and also of the Kitkatla Inlet and Porcher Island area east of Hecate Strait. The charting of the intricate waters east of Queen Charlotte Strait was continued and surveys in Nanaimo Harbour and Sidney were completed.

Summary of season's work:

Ship sounding	180	linear nautical miles
Boat sounding	2,122	" " "
Coastlining	362	" " "
Shoals examined	623	
Oceanographical stations occupied	12	

The *Marabell,* commissioned September 5, continued the survey of the central portion of Johnstone Strait, including Havannah Channel, Port Neville and Port Harvey.

Summary of season's work:

Boat sounding	157	linear nautical miles
Coastlining	42	" " "
Shoals examined	3	

The *Parry* engaged in hydrographic and tidal work, the former consisting of survey operations in Yuculta Rapids and vicinity and at Powell River.

Summary of season's work:

Boat sounding	145	linear nautical miles
Coastlining	26	" " "
Shoals examined	42	

As a result of the season's operations on the Pacific Coast, seven new charts will be published.

CHART PRODUCTION

The rapidly increasing demand for nautical charts has necessitated the development and adoption of improved and new methods of production. The output of standard charts showed an increase of 120 per cent over the previous year.

Production was a follows:

Standard charts (first editions)	32
New editions of existing charts	53
Reprints	5
Arctic charts	24
Special charts (plotting, instructional, etc.)	12

PILOTS AND SAILING DIRECTIONS

The following volumes were issued:

Newfoundland Pilot, 1st edition;
Sailing Directions, Quebec to Kingston, 1st edition;
Great Lakes Pilot, Vol. 1, 3rd edition;
British Columbia Pilot, Vol. 1, 3rd edition and
Supplement No. 2 to Nova Scotia and Bay of Fundy Pilot.

Two other volumes and two supplements to existing volumes are being prepared.

PRECISE WATER LEVELS

The Hydrographic Service maintains self-registering water-level gauges at 46 strategically located stations along the 1,400 miles of St. Lawrence-Great Lakes Waterway from Quebec to Port Arthur. As a result of about 15,000 days of continuous recordings, well over 13,000 sheets of information were issued through regular mailing lists or upon request during the year.

The demand for authentic and coordinated water level records was increased as a result of the damage resulting from the high stage and flood conditions on the Great Lakes during 1952. Information was also required by the Ontario Hydro-Electric Power Commission for its surveys in conjunction with the Seaway Project, and by the Seaway Authority itself. Water level data were exchanged with related services in the United States.

HYDROLOGIC PROJECTS

An International Co-ordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data was formed in May 1953. It is composed of representatives of the agencies in the United States and Canada associated with the various

activities pertaining to the waterway and the many intricate problems arising therefrom. The Committee's objective is to agree upon identical basic data for vertical controls, lake levels and river flows throughout the waterway which will be acceptable to both countries. The Canadian Hydrographic Service through its representative has had an active part in all phases of this work by providing extensive records and by carrying out intensive research into the movement of the earth's crust, which progressively and continuously upsets the relative values of basic data throughout the upper St. Lawrence-Great Lakes Basin.

TIDAL AND CURRENT SURVEY

Considerable attention was given during the fiscal year to physical oceanography, involving the study of techniques, theory, apparatus and the preparation of a special report. Sixteen principal tide stations were kept in continuous operation, in addition to a number of seasonal tide stations established for special projects. A comprehensive study of the tides and currents in the Strait of Canso, which was started in 1952, was continued and will be carried on until the causeway is completed. Sales and distribution of the ten annual editions of tide tables during the calendar year 1953 totalled 62,948 copies.

DISTRIBUTION OF HYDROGRAPHIC PUBLICATIONS

The distribution of standard charts for 1953 was the highest in peacetime records. The demand for charts of northern and Arctic waters increased by 62 per cent over 1952.

Hydrographic publications distributed during 1953 were as follows:

Catalogues of charts, Sailing Directions and Tidal Information, with index maps	1,922
Standard navigation charts	60,685
Instructional charts, special charts, etc.	46,185
Pilots and Sailing Directions	1,625
Supplements to Pilots	321
Tide Tables	62,948
Water level bulletins, graphs, etc., exclusive of those distributed through Notices to Mariners, approximately	13,000

Canadian nautical publications are made available to shipping either from headquarters at Ottawa, from Victoria, or from agencies in the principal ports from coast to coast. In accordance with international practice, information contained in Canadian Hydrographic Service charts and publications is reproduced by the hydrographic offices of foreign countries for the use of their own nationals. World circulation of Canadian charts is therefore much higher than that indicated by the figures given above.

Legal Surveys and Aeronautical Charts

LEGAL SURVEYS

Provincial and Territorial Boundary Surveys

Recent surveys of the most northerly 142 miles of the Alberta-British Columbia boundary were inspected in the field as a final verification. Examination of the final returns of these surveys was completed.

The British Columbia-Northwest Territories boundary was surveyed and monumented westerly 30 miles from the most westerly crossing of the Petitot River to the Liard River, and 30 miles easterly from the most easterly crossing of the Petitot River.

The British Columbia-Yukon boundary was surveyed and monumented westerly from the Liard River to the Beaver River.

Examination of the final returns of surveys of the Alberta-Northwest Territories boundary was completed from the Little Buffalo River to a point 65 miles east of the Mackenzie Highway, a distance of 50 miles, and from the Mackenzie Highway westerly to the Alberta-British Columbia boundary.

On behalf of the Saskatchewan-Northwest Territories Boundary Commission arrangements were made with the Geodetic Survey for execution of nine precise astronomical observations to control the location of the boundary between Saskatchewan and Northwest Territories. Some preparatory work was done for a survey of the boundary during the winter of 1954-55, including purchase of posts.

Substantial progress was made on the preparation of the final report and maps relative to the Manitoba-Ontario boundary.

Indian Reserve Surveys

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

New Brunswick	Oromocto.
Quebec	Natashquan, Oka, Restigouche, Romaine.
Ontario	Constance Lake, Goulais Bay, Lac Seul, Serpent River.
Manitoba	Riding Mountain, Rolling River, Dawson Bay.
Saskatchewan	Key.
Alberta	Blood Timber Limit A, Sarcee.
British Columbia	Bella Bella, Campbell River, Esquimalt, Hazelton, Kitseguecla, Langley, Marktosis, Nanaimo, East Saanich, Tsahaheh.

Surveys were also made of an Indian Residential School site at Amos, Quebec; of Cecilia Jeffrey Indian Residential School cemetery sites; and of part of Hamilton Island in Ontario.

Surveys in Yukon

Three survey parties headed by staff surveyors operated in Yukon. The first completed the survey of 67 mineral claims in the Keno area and surveyed 7 lots near Mayo. The second carried out miscellaneous legal surveys of 25 group lots and a survey of the Administration housing subdivision at Upper Whitehorse, consisting of 39 lots. The third carried out surveys of 9 miscellaneous group lots, the survey of 102 miles of the right-of-way of the Whitehorse-Mayo Highway, and one subdivision survey at Deep Creek, consisting of 45 lots.

Instructions were issued to a private surveyor for the survey of 115 mineral claims in the Mayo mining district.

Surveys in Northwest Territories

Two parties headed by staff surveyors surveyed 211 miles of the 34th base line east and west of the sixth meridian, in accordance with the Canada Lands Surveys Act.

Instructions were issued to private surveyors for surveys of 266 mineral claims in the Yellowknife and Mackenzie mining districts.

Other Surveys

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

Banff in Alberta,
Mount Revelstoke in British Columbia,
Wood Buffalo in the Northwest Territories.

Historic sites were surveyed at Halifax, Nova Scotia; Morpeth, Ontario; and Kamsack, Saskatchewan.

Inspection surveys were carried out in Jasper National Park, Alberta, and Kamloops Indian Reserve, British Columbia.

Office

The Division made 232 miscellaneous plans, tracings and Indian location ticket sketches; approved 27 plans of base lines in Alberta and drafted 18 plans thereof preparatory to confirmation; corrected and examined the plans of survey of Carmacks-Mayo road, Yukon, and the Atlin road, British Columbia; completed the examination of several plans of Indian reserves surveyed several years ago, some of which have been recorded as official plans; completed several other assignments which had been held in abeyance; and processed the returns of a number of miscellaneous surveys in Indian reserves and Crown lands, which had been made by private agencies.

It recorded 138 plans and the respective field notes in the Indian Affairs survey records of the Indian Affairs Branch, Department of Citizenship and Immigration; examined 238 plans of legal surveys and the field notes thereof; despatched 3,346 blue or "OCE" prints and 1,149 photostatic copies of survey records; and prepared 308 legal descriptions for use in conveyance of land rights, 54 descriptions of mineral claims and 32 descriptions for petroleum and natural gas applications.

AERONAUTICAL CHARTS

Air Photogrammetry (Tri-Camera)

Planimetric detail for aeronautical chart bases was plotted from tri-camera photography for the following areas:

National Topographic Series Index No.	*Area Plotted in Square Miles*
13	4,755
14	27,302
23	5,803
24	32,347
57	24,627
86	4,146
87	3,346
88	1,500
96	15,594
97	31,188
	150,608

Over 6,000 tri-camera photographs were indexed and filed and copies of the revised index sheets were supplied to the National Air Photographic Library.

Five hundred linear miles of photography are required to complete the tri-camera photography program in Canada and operational flight line maps were prepared for this photography.

The following special plots were prepared to meet requests for copies of the original plotting sheets for field survey use.

1. North Ellesmere Island coast.

   Two areas of this coast were plotted at the scale of 1 inch to ½ mile for the Defence Research Board.

2. 34th Base Line.

   A plot of 300 miles of the proposed base line was prepared for field use.

3. Prince of Wales Strait.

   This area was plotted from tri-camera photography 1 inch to 4 miles for use of the Canadian and United States Hydrographic Services, in compiling their 1953 field returns and for their operations in the area in the summer of 1954.

4. Inadequately mapped portions of the Arctic.

   To assist in an urgent hydrographic charting requirement for the 1954 season the Division undertook the plotting, at the scale of 1 inch to 8 miles, of all the inadequately mapped portions of the Arctic, with particular emphasis on detail along the shore lines and off-shore islands. This information will be used also by the Defence Research Board for a new air navigation publication.

5. 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.

Chart Construction and Air Information

1. 8-mile Aeronautical Charts: Fourteen new air information plates were prepared to conform to revised topographical information and map sheet format; 83 sheets were examined for revision, of which 62 were revised and 21 reprinted.
2. 1:1,000,000 World Aeronautical Chart Series: Three new charts were compiled and subsequently published to further augment this series; 26 sheets were examined for revision; of which 22 were revised and 4 reprinted.
3. Favourable progress was made on the new series of aeronautical route charts. Three charts, the first of the 14 chart series, were published. Compilation was completed on another 3. The air information on the 3 charts which comprise the navigation plotting chart series 1:3,000,000 was revised.

Canada Air Pilot

The Division cooperates with the Department of Transport in the publication of the Canada Air Pilot, which is issued under the authority and direction of that Department.

Amendments are issued weekly, alternating between the eastern volume and the western volume. Each amendment includes all the corrections in the "master copy" issued as either written statements of correction in a mimeographed section, or contained in another section of new and revised sheets for the manual.

The following were issued:

revisions to

416 aerodrome pages
88 miscellaneous pages (facility listings, indexes etc.)
47 instrument approach and landing charts (in three colours)
22 instrument landing system charts (16 in three colours)
97 radio facility charts (in two colours)

first publication of

9 aerodrome pages
13 instrument approach landing charts (in three colours)
2 instrument landing system charts.

The new aerodrome pages were for Pine Point, N.W.T.; Dawson (Callison), Yukon; Buttress, Sask.; Ilford and Lynn Lake, Man.; Bobcaygeon, Killaloe (Bonnechere) and Timmins, Ont.; and La Macaza, Que. Buttress is a reactivated aerodrome which was abandoned after the last war.

Forty-one of a total requirement of 87 radio range instrument approach and landing charts to ICAO specifications have been published and 17 are in production.

Radar Altimetry

Since 1948 when the work began, approximately 69,700 linear miles of ground profile information have been obtained by radar altimetry field operations for aeronautical charting purposes. About 12,300 miles were obtained during the fiscal year. The Division, in cooperation with the R.C.A.F. and the National Aeronautical Establishment, accounted for 5,566 miles in northern areas and 2,000 miles on Anticosti Island. The remaining 4,734 miles in Ontario and Quebec were completed by contract with a private company. In total area the year's operation amounted to 118,800 square miles, the total since 1948 being 959,500 square miles.

Sufficient profile information was obtained to prepare a reasonably accurate depiction of critical heights and 500-foot contours on manuscripts of aeronautical charts at the 1-inch to 8-mile scale. Three such manuscripts were completed. To date 8 manuscripts have been published.

Columbia River Basin

Preparation of the series of 89 detailed and contoured topographical plans required by the International Joint Commission for study of the development of the Columbia River and its tributaries was continued. To date 63 of the sheets have been compiled and advance prints made available. Forty sheets have been printed.

During the year 5 map sheets were printed, 7 were proofed, and compilation was completed on 15 additional sheets.

SURVEY RECORDS AND ELECTORAL MAPS

Survey Records

During the year 145 field books and 144 plans of survey returns were recorded. To supply information from the records, 801 photostatic copies of plans and pages from the field books were prepared. In all, 942 township plans, 2,823 settlement plans, and 173 blueprints were distributed. Stocks of plans pertaining to settlements, townsites and lots in the provinces of British Columbia, Alberta, and Saskatchewan, created prior to 1930, were transferred to the provinces concerned; 5 copies of each plan were retained for office use.

Electoral Maps

A new set of electoral maps according to The Representation Act, 1952 was completed. It comprises 263 maps of individual electoral districts, 11 province maps, 12 maps of cities having two or more electoral districts, 16 maps of other cities with a population of over 30,000 and wholly contained within one electoral district, and 4 index maps of larger cities for the key map volume.

The binding of 5 sets of volumes containing all the electoral maps of Canada was completed, together with a volume of 78 key maps for the use of defence service electors.

A map of Canada on the scale of 1 inch to 64 miles showing all the electoral districts was prepared for use in the office of the Chief Electoral Officer.

The descriptions of proposed new electoral districts in the Northwest Territories Council were checked and a map was prepared showing these districts.

Miscellaneous

A total of 227 airline distances were computed and supplied as requested.

Astronomical field tables for the altitude and azimuth of the Pole Star, and the right ascension and declination of the sun for 1954 were checked and prepared for reproduction.

The geographic co-ordinates of a number of existing legal landmarks were computed and supplied as requested.

A summary was prepared of azimuth observations made on the Alberta-British Columbia Boundary in 1952. The geographic co-ordinates of monuments on the Ontario-Manitoba Boundary were checked.

The railway distances between Montreal and 273 places across Canada were checked and supplied to the Dominion Bureau of Statistics for use in the Canada Year Book.

BOARD OF EXAMINERS FOR DOMINION LAND SERVICE

The principal meeting of the Board was the regular annual meeting called for by Section 10 of the Canada Lands Surveys Act.

Examinations were held at Ottawa, Saskatoon, Edmonton, Calgary and Victoria.

Twelve certificates of preliminary examination, 21 commissions as Dominion Land Surveyor, and one certificate as Dominion Topographical Surveyor were issued as provided for in the Act.

Map Compilation and Reproduction

During the fiscal year 752 maps, charts and plans were printed, an increase of 16 over the previous fiscal year. The number of impressions reached a new high of 8,260,898, an increase of almost 2,000,000 over the previous year. This large increase was achieved even though, with new techniques, the Division is combining several tones of one colour on a single printing plate.

The maps, charts and plans printed include: 6 new Canadian charts of the world aeronautical charts series at a scale of 1:1,000,000, produced under Canada's agreement with the International Civil Aviation Organization; revisions of 27 Canadian aeronautical charts on a scale of 1 inch to 8 miles; 4 new aeronautical route charts; 6 new sheets of the Columbia River Basin series; 175 electoral maps; 132 Canadian Hydrographic Service charts of coastal and inland waters; and 43 Geological Survey of Canada maps and figures, an increase of 29 over the previous fiscal year.

COMPILATION

About 15 special compilations, including necessary computations, were made, examples of these being the 20-mile map of Canada for the Railway Committee Room of the House of Commons; maps for the new Atlas of Canada the Department is preparing; small scale maps for a Defence Research Board manual on Arctic navigation; a new map of New Brunswick on a scale of 1:500,000; and a new edition of the trade map of the world. Special computations were made on a new air navigation grid overprint required by the R.C.A.F.

During the fiscal year a new compilation technique was introduced. It involves the use of blue line prints on opaque plastic, instead of vandyke prints, and has definite advantages in speed and accuracy.

Summary of Compilation

	Scale	First Edition	Revised Edition
Aeronautical charts (NTS)	8 mi.	..	22
World aeronautical charts	1:1,000,000	3	..
Aeronautical route charts	1:1,000,000	2	..
National Topographic Series	1:250,000	18	..
National Topographic Series	2 mi.	..	1
National Topographic Series	1 mi.	..	1
Sectional maps	3 mi.	..	1
Miscellaneous	..	3	6

MAP DRAFTING

The most significant development during the fiscal year was the introduction of map engraving on plastic sheets, whereby the draftsman produces a direct negative at publishing scale. This has resulted in a reduction of drafting time with less optical distortion and higher quality in the finished map.

In order to bring about a higher degree of standardization, a manual was printed covering the scales of 1:50,000 and 1:250,000. A complete cartographic manual covering all the drafting and the compilation methods used in the Division is in preparation.

Efforts by the Division to find improvements and shortcuts in negative engraving met with considerable success, examples being: the introduction of name affixing to a photographic contact print from the original engraved negative; the speeding up of checking of the engraved negative through a method developed by one of the draftsmen, using a grease pencil and black paper; the application of ordinary linoleum cement to the mounting of plastic prints; a successful experiment in remaking of a negative from a broken-down lithometal plate by drawing in all necessary corrections on a litho pull made on a transparent plastic sheet.

Summary of New and Revised Maps for Which Drawings were Completed

	Scale	Number
Aeronautical charts (NTS)	8 mi.	21
World aeronautical charts	1:1,000,000	2
Aeronautical route charts	1:1,000,000	3
National Topographic Series (Map Compilation and Reproduction)	1:250,000 2 and 1 mi.	.. 17
National Topographic Series (Topographical Survey)	1:50,000	62
Columbia River Basin series	1:31,680	11
Electoral maps	.....	134
Overprints	.....	115
Miscellaneous	.....	14

Photo-mechanical

A chromeline colour proofing was introduced which speeds up production by allowing maps to be proofed before printing plates are made.

A new Monotype-Heubner camera was installed.

Summary of Photo-mechanical Output

Photo Processing	
Wet plate negatives (sq. ft.)	362
Film negatives (sq. ft.)	22,311
Photo-litho plates	1,304
Ferro prussiates (metal)	198
Chrome line and plastic blues (sheets)	800
Multilith plates (large)	296
Multilith plates (small)	680
Photography	
Infrared plates developed	2,174
Infrared plates (enlargements)	1,530
Rolls of film developed	99
Bromides (sq. ft.)	7,829
Contact prints	3,367
Sensitized linen (sq. ft)	3,631
Photostat (sheets)	15,422
Transaloid (sq. ft.)	102
Contact and Blueprinting	
Blueprints (sq. ft.)	26,594
Vandykes (sq. ft.)	23,841
"OCE" (sq. ft.)	207,474

Lithographic Printing

Summary

	Maps Published	*Total Copies*	*Impressions*
New maps printed	25	104,920	622,540
Revised maps printed	170	502,600	1,765,915
Maps reprinted	193	941,295	4,774,830
Geological maps and figures	43	83,330	242,365
Overprints	189	434,850	434,850
Hydrographic charts	132	118,802	420,398
	752	2,185,797	8,260,898

Under an agreement with the Department of National Defence, that Department's Army Survey Establishment printed 5 new 1:250,000 sheets and 6 revisions and 6 reprints of topographical maps. About 59,500 copies of the 17 maps were made.

MAP DISTRIBUTION

Plans are in hand to improve the services to the public and include provision for a modern sales room where maps can be displayed properly.

A total of 249 new maps became available for distribution during the fiscal year. The Division handled 47,434 requests for maps, charts and publications, a decrease of 2,460 from the previous year.

Summary of Distribution

National Topographic Series maps	372,132
Aeronautical and plotting charts	437,548
Sectional maps	8,784
Old Geographic Series	1,326
Miscellaneous	41,700
Electoral maps	1,528
Distribution—Maps and aeronautical charts	863,018
Publications	4,083
Total, exclusive of Canada Air Pilot	867,111
Canada Air Pilot—(Volumes 1 and 2)	511
Amendments	12,863
Sheets	17,890
Total issue, Canada Air Pilot	31,264
Total distribution	898,375

List of New or Revised Maps Produced by Map Compilation and Reproduction Division

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(I) Aeronautical Charts—National Topographic Service				
Labrador	13 SE.	Battle Harbour-Cartwright	8 mi.	52°00′–54°00′	55°00′– 60°00′	Prelim. edition—rev.
Labrador-Quebec	13 NW.	Naskaupi	8 "	54°00′–56°00′	60°00′– 64°00′	Stan. edition—rev.
Labrador-Quebec	23 SE.	Ashuanipi	8 "	52°00′–54°00′	64°00′– 68°00′	Prelim. edition—rev.
Labrador-Quebec	23 NE.	Dyke Lake	8 "	54°00′–56°00′	64°00′ –68°00′	Prelim. edition—rev.
Labrador-Quebec-N.W.T.	25 SE.	Resolution Island	8 "	60°00′–62°00′	64°00′– 68°00′	Prelim. edition—rev
Quebec	12 NW.	Mingan-Cape Whittle	8 "	50°00′–52°00′	60°00′– 64°00′	Stan. edition—rev.
Quebec	22 NE.	Clarke City-Mingan	8 "	50°00′–52°00′	64°00′– 68°00′	Stan. edition—rev.
Quebec	22 NW.	Pletipi	8 "	50°00′–52°00′	68°00′– 72°00′	Stan. edition—rev.
Quebec	23 NW.	Kaniapiskau	8 "	54°00′–56°00′	68°00′– 72°00′	Prelim. edition—rev.
Quebec	31 NE.	Parent-Three Rivers	8 "	46°00′–48°00′	72°00′– 76°00′	Stan. edition—rev.
Quebec	33 NE.	Lac Bienville	8 "	54°00′–56°00′	72°00′– 76°00′	Prelim. edition—rev.
Quebec	33 SE.	La Grande	8 "	52°00′–54°00′	72°00′– 76°00′	Prelim. edition—rev.
Quebec-Ontario	31 SE.	Ottawa-Montreal	8 "	44°00′–46°00′	72°00′– 76°00′	Stan. edition—rev.
Ontario	41 SE.	Manitoulin-Owen Sound	8 "	44°00′–46°00′	80°00′– 84°00′	Stan. edition—rev.
Manitoba	62 NE.	Neepawa-Gypsumville	8 "	50°00′–52°00′	96°00′–100°00′	Stan. edition—rev.
Manitoba-Saskatchewan	62 W.	Indian Head-Brandon	8 "	49°00′–51°00′	100°00′–104°00′	Stan. edition—rev.
Saskatchewan	73 NE.	Green Lake-Stanley	8 "	54°00′–56°00′	104°00′–108°00′	Stan. edition—rev.
British Columbia	92 SE.	Victoria-Vancouver	8 "	48°00′–50°00′	120°00′–124°00′	Stan. edition—rev.

List of New or Revised Maps Produced by Map Compilation and Reproduction Division—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
N.W.T.	16 S.	Hoare Bay	8 "	64°00′–66°00′	56°00′– 64°00′	Prelim. edition—rev.
N.W.T.	56 N.	Chantrey Inlet	8 "	66°00′–68°00′	88°00′– 96°00′	Prelim. edition—rev.
N.W.T.	65 SW.	Kazan River	8 "	60°00′–62°00′	100°00′–104°00′	Prelim. edition—rev.
N.W.T.	66 S.	Aberdeen Lake	8 "	64°00′–66°00′	96°00′–104°00′	Prelim. edition—rev.
N.W.T.	66 N.	Ogden Bay	8 "	66°00′–68°00′	96°00′–104°00′	Prelim. edition—rev.
N.W.T.	68 N.	Barrow Strait W.	8 "	74°00′–76°00′	96°00′–104°00′	Prelim. edition—rev.
N.W.T.	78 S.	Hadley Bay	8 "	72°00′–74°00′	104°00′–112°00′	Prelim. edition—rev.
N.W.T.	85 SW.	Providence	8 "	60°00′–62°00′	116°00′–120°00′	Prelim. edition—rev.
Yukon	115 S.	St. Elias	8 "	60°00′–62°00′	136°00′–143°00′	Prelim. edition—rev.
		(II) Other National Topographic Series Maps				
Labrador-Quebec	23 I	Michikamau Lake	1:250,000	54°00′–55°00′	64°00′– 66°00′	First edition
Quebec	24 C	Cambrian Lake	1:250,000	56°00′–57°00′	68°00′– 70°00′	"
Quebec	24 F	Lac Herodier	1:250,000	57°00′–58°00′	68°00′– 70°00′	"
Quebec	31 I/SW	Joliette	2 mile	46°00′–46°30′	73°00′– 74°00′	Revision
Quebec	31 O/SW	Petawaga	"	47°00′–47°30′	75°00′– 76°00′	"
Quebec	31 O/NW	Choquette	"	47°30′–48°00′	75°00′– 76°00′	"
Quebec	32 B/SW	Oskelaneo	"	48°00′–48°30′	75°00′– 76°00′	"
Quebec	32 D/SE	Rouyn Lake	"	48°00′–48°30′	78°00′– 79°00′	"

Quebec	32 D/NE	Taschereau	"	48°30′–49°00′	78°00′– 79°00′	"
Quebec-Ontario	31 G/15/12	Ottawa-Gatineau	1 mile	45°21′–45°41′	73°35′– 76°00′	"
Ontario	31 E/SE.	Haliburton	2 mile	45°00′–45°30′	78°00′– 79°00′	"
Ontario	31 E/NW.	Sundridge	2 mile	45°30′–46°00′	79°00′– 80°00′	"
Ontario	31 F/12	Round Lake	1 mile	45°30′–45°45′	77°30′– 78°00′	"
Ontario	42 M	Fort Hope	4 mile	51°00′–52°00′	86°00′– 88°00′	"
Ontario	52 D	Rainy River	4 mile	48°00′–49°00′	94°00′– 96°00′	"
Saskatchewan	64 E	Reindeer Lake North	1:250,000	57°00′–58°00′	102°00′–104°00′	First Edition
Saskatchewan	72 H	Willowbunch Lake	1:250,000	49°00′–50°00′	104°00′–106°00′	First Edition
Saskatchewan	73 J	Green Lake	4 mile	54°00′–55°00′	106°00′–108°00′	Revision
Saskatchewan	73 O	Ile-a-la-Crosse	4 mile	55°00′–56°00′	106°00′–108°00′	"
Saskatchewan	74 B	Mudjatik	4 mile	56°00′–57°00′	106°00′–108°00′	"
Alberta	83 H	Edmonton	1:250,000	53°00′–54°00′	112°00′–114°00′	First edition
Alberta-British Columbia	82 N/NE.	Mistaya	2 mile	51°30′–52°00′	116°00′–117°00′	Revision
Alberta-British Columbia	82 N/SE.	Yoho	2 mile	51°00′–51°30′	116°00′–117°00′	"
Alberta-British Columbia	82 N/8	Lake Louise	1 mile	51°15′–51°30′	116°00′–116°30′	"
British Columbia	82 L/NE.	Revelstoke	2 mile	50°30′–51°00′	118°00′–119°00′	"
British Columbia	82 N/SW.	Glacier Park	2 mile	51°00′–51°30′	117°00′–118°00′	"
British Columbia	92 I/SE.	Merritt	2 mile	50°00′–50°30′	120°00′–121°00′	"
British Columbia	92 L/1	Schoen Lake	1 mile	50°00′–50°15′	126°00′–126°30′	"
British Columbia	92 L/2	Woss Lake	1 mile	50°00′–50°15′	126°30′–127°00′	"
British Columbia	92 L/8	Adams Lake	1 "	50°15′–50°30′	126°00′–126°30′	"
British Columbia	93 A/5	Beaver Creek	1 "	52°15′–52°30′	121°30′–122°00′	First edition

List of New or Revised Maps Produced by Map Compilation and Reproduction Division—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
British Columbia	93 A/6	Horsefly	1 "	52°15′–52°30′	121°00′–121°30′	"
British Columbia	93 L	Smithers	1:250,000	54°00′–55°00′	126°00′–128°00′	"
British Columbia	94 A	Charlie Lake	1:250,000	56°00′–57°00′	120°00′–122°00′	"
N.W.T.	86 C	Hardisty Lake	1:250,000	64°00′–65°00′	116°00′–118°00′	"
N.W.T.	86 F	Camsell River	1:250,000	65°00′–66°00′	116°00′–118°00′	"
Yukon	115 J	Snag	1:250,000	62°00′–63°00′	138°00′–140°00′	"
Yukon	115 P	McQuestin	1:250,000	63°00′–64°00′	136°00′–138°00′	"
		(III) World Aeronautical Charts				
Quebec	2180	Fort George River	1:1,000,000	52°00′–56°00′	72°00′– 80°00′	First edition
Saskatchewan	Special	Saskatoon	1:1,000,000	50°00′–54°00′	104°00′–112°00′	"
British Columbia	2138	Iskut River	1:1,000,000	56°00′–60°00′	128°00′–141°00′	"
British Columbia	Special	Scott Islands	1:1,000,000	48°00′–52°00′	128°00′–136°00′	"
N.W.T.	2082	Koukdjuak River	1:1,000,000	64°00′–68°00′	64°00′– 80°00′	"
N.W.T.	2112	Dubawnt River	1:1,000,000	60°00′–64°00′	96°00′–104°00′	"
		(IV) Columbia River Basin Series				
British Columbia	18	Arrow Lakes Area	1:31,680	49°57′–50°18′	117°46′–117°58′	First edition
British Columbia	33	Big Bend Area	1:31,680	51°56′–52°04′	118°03′–118°20′	"

British Columbia	34	Big Bend Area	1:31,680	51°51′–51°59′	117°46′–118°03′	"
British Columbia	46	Upper Columbia River Area	1:31,680	50°37′–50°45′	116°03′–116°20′	"
British Columbia	49	Upper Columbia River Area	1:31,680	50°17′–50°27′	115°27′–116°03′	"
British Columbia	60	Upper Kootenay River Area	1:31,680	50°09′–50°17′	115°39′–115°56′	"
		(V) Aeronautical Route Charts				
Newfoundland-Quebec	7	Montreal-Goose Bay	1:1,000,000			First edition
Nova Scotia to Ontario	5	Ottawa-Sydney	1:1;000,000			"
Manitoba	13	Winnipeg-Churchill	1:1,000,000			"
Manitoba to Alberta	2	Medicine Hat-Winnipeg	1:1,000,000			"
		(VI) Miscellaneous				
Atlantic Coast		Northwest Atlantic Fisheries Map				New. Fisheries Dept.
World		World Current Affairs Map				New. For Department of National Defence
Canada		Orographical Map of Canada				New. For Canada Year Book
Canada		Forest Classification of Canada				New. For Canada Year Book

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction Division and Reproduced at the Army Survey Establishment. Fiscal Year 1953-54

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Newfoundland	2 C/5	Sweet Bay	1:50,000	48°15′–48°30′	53°30′– 54°00′	First edition
Newfoundland	2 C/6	Trinity	1:50,000	48°15′–48°30′	53°00′– 53°30′	"
Newfoundland	2 C/11	Bonavista	1:50,000	48°30′–48°45′	53°00′– 53°30′	"
Newfoundland	2 C/12	Eastport	1:50,000	48°30′–48°45′	53°30′– 54°00′	"
Newfoundland	2 C/16	Gambo	1:50,000	48°45′–49°00′	54°00′– 54°30′	"
Newfoundland	2 E/16	Bishops Islands	1:50,000	49°45′–50°00′	54°00′– 54°30′	"
Newfoundland	2 F/3	Cabot Islands	1:50,000	49°00′–49°15′	53°00′– 53°30′	"
Newfoundland	2 F/12	Wadham Islands	1:50,000	49°30′–49°45′	53°30′– 54°00′	"
Nova Scotia	11 D/15	Tangier	1:50,000	44°45′–45°00′	62°30′– 63°00′	"
Nova Scotia	11 E/9	Merigomish	1:50,000	45°30′–45°45′	62°00′– 62°30′	"
Nova Scotia-P.E.I.	11 E/15	Pictou Island	1:50,000	45°45′–46°00′	62°30′– 63°00′	"
Nova Scotia	11 F/13	Cape George	1:50,000	45°45′–46°00′	61°30′– 62°00′	"
Nova Scotia	11 F/15	Grand Narrows	1:50,000	45°45′–46°00′	60°30′– 61°00′	"
Nova Scotia	11 K/2	Baddeck	1:50,000	46°00′–46°15′	60°30′– 61°00′	"
Nova Scotia	11 K/7	St. Ann's	1:50,000	46°15′–46°30′	60°30′– 61°00′	"
Nova Scotia	20 P/5	Cape Sable Island	1:50,000	43°15′–43°30′	65°30′– 66°00′	"
Nova Scotia	21 A/5	Weymouth	1:50,000	44°15′–44°30′	65°30′– 66°00′	"
Nova Scotia	21 A/10	New Germany	1:50,000	44°30′–44°45′	64°30′– 65°00′	"
Nova Scotia	21 A/11	Milford	1:50,000	44°30′–44°45′	65°00′– 65°30′	"

Nova Scotia	21 A/13	Granville Ferry	1:50,000	44°45′–45°00′	65°30′– 66°00′	"
Nova Scotia	21 A/16	Windsor	1:50,000	44°45′–45°00′	64°00′– 64°30′	"
New Brunswick	21 B/10	Grand Manan	1:50,000	44°30′–44°45′	66°30′– 67°00′	"
New Brunswick	21 G/11	McAdam	1:50,000	45°30′–45°45′	67°00′– 67°30′	"
New Brunswick	21 G/12	Forest City	1:50,000	45°30′–45°45′	67°30′– 68°00′	"
New Brunswick	21 G/13	Fosterville	1:50,000	45°45′–46°00′	67°30′– 68°00′	"
New Brunswick	21 G/14	Canterbury	1:50,000	45°45′–46°00′	67°00′– 67°30′	"
New Brunswick-Nova Scotia	21 H/10	Alma	1:50,000	45°30′–45°45′	64°30′– 65°00′	"
New Brunswick	21 J/2	Burtts Corners	1:50,000	46°00′–46°15′	66°30′– 67°00′	"
New Brunswick	21 P/13	Pointe Verte	1:50,000	47°45′–48°00′	65°30′– 66°00′	"
Quebec-Labrador	23 I/12	Andre Lake	1:50,000	54°30′–54°45′	65°30′– 66°00′	"
Labrador	23 J/7	Menihek Lakes	1:50,000	54°15′–54°30′	66°30′– 67°00′	"
Labrador	23 J/8	Marble Lake	1:50,000	54°15′–54°30′	66°00′– 66°30′	"
Labrador	23 J/9	Cavers Lake	1:50,000	54°30′–54°45′	66°00′– 66°30′	"
Labrador	23 J/10	Stakit Lake	1:50,000	54°30′–54°45′	66°30′– 67°00′	"
Quebec	23 O/9	Rivet Lake	1:50,000	55°30′–55°45′	66°00′– 66°30′	"
Ontario	41 G/16	Kagawong	1:50,000	45°45′–46°00′	82°00′– 82°30′	"
Ontario	41 H/5	Flowerpot Island	1:50,000	45°15′–45°30′	81°30′– 82°00′	"
Saskatchewan	62 E/2	Estevan	1:50,000	49°00′–49°15′	102°30′–103°00′	"
Saskatchewan	62 E/4	Bromhead	1:50,000	49°00′–49°15′	103°30′–104°00′	"
Manitoba	63 K/7	Yawningstone Lake	1:50,000	54°15′–54°30′	100°30′–101°00′	"
Manitoba-Saskatchewan	63 C/13	Roscoe	1:50,000	52°45′–53°00′	101°30′–102°00′	"
Manitoba	63 C/14	Barrows	1:50,000	52°45′–53°00′	101°00′–101°30′	"

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List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction Division and Reproduced at the Army Survey Establishment. Fiscal Year 1953-54—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Manitoba	63 C/16	Pelican Bay	1:50,000	52°45′–53°00′	100°00′–100°30′	First edition
Manitoba	63 F/1	Mossy Portage	1:50,000	53°00′–53°15′	100°00′–100°30′	"
Manitoba	63 F/2	Spruce Island	1:50,000	53°00′–53°15′	100°30′–101°00′	"
Manitoba	63 F/3	Dawson Bay	1:50,000	53°00′–53°15′	101°00′–101°30′	"
Manitoba-Saskatchewan	63 F/4	Chemong Creek	1:50,000	53°00′–53°15′	101°30′–102°00′	"
Manitoba	63 I/12	Cross Lake	1:50,000	54°30′–54°45′	97°30′– 98°00′	"
Manitoba	63 K/13	Root Lake	1:50,000	54°00′–54°15′	101°00′–101°30′	"
ϕManitoba-Saskatchewan	63 K/4	Namew Lake	1:50,000	54°00′–54°15′	101°30′–102°00′	"
Manitoba	63 K/6	Egg Lake	1:50,000	54°15′–54°30′	101°00′–101°30′	"
Manitoba	63 K/8	Dyce Lake	1:50,000	54°15′–54°30′	100°00′–100°30′	"
Saskatchewan	72 H/10	Pangman	1:50,000	49°30′–49°45′	104°30′–105°00′	"
Saskatchewan	72 H/16	Lang	1:50,000	49°45′–50°00′	104°00′–104°30′	"
Saskatchewan	72 I/1	Riceton	1:50,000	50°00′–50°15′	104°00′–104°30′	"
Saskatchewan	72 I/6	Drinkwater	1:50,000	50°15′–50°30′	105°00′–105°30′	"
Saskatchewan	72 I/7	Regina	1:50,000	50°15′–50°30′	104°30′–105°00′	"
Alberta	73 L/5	Goodfish Lake	1:50,000	54°15′–54°30′	111°30′–112°00′	"
Alberta	73 L/9	Marie Lake	1:50,000	54°30′–54°45′	110°00′–110°30′	"
Alberta	73 L/13	Lac la Biche	1:50,000	54°45′–55°00′	111°30′–112°00′	"
Alberta	73 L/14	Touchwood Lake	1:50,000	54°45′–55°00′	111°00′–111°30′	"

Alberta	73 L/15	Wolf River	1:50,000	54°45′–55°00′	110°30′–111°00′	"
Alberta	73 L/16	Medley River	1:50,000	54°45′–55°00′	110°00′–110°30′	"
Alberta-British Columbia	82 J/10	Mount Rae	1:50,000	50°30′–50°45′	114°30′–115°00′	"
Alberta	82 P/4	Dalroy	1:50,000	51°00′–51°15′	113°30′–114°00′	"
Alberta-British Columbia	83 D/16	Jasper	1:50,000	52°45′–53°00′	118°00′–118°30′	"
ϕManitoba-Saskatchewan	63 K/5	Goose Lake	1:50,000	54°15′–54°30′	101°30′–102°00′	"
Alberta	83 H/13	Morinville	1:50,000	53°45′–54°00′	113°30′–114°00′	"
Alberta	83 H/14	Redwater	1:50,000	53°45′–54°00′	113°00′–113°30′	"
Alberta	83 I/3	Thorhild	1:50,000	54°00′–54°15′	113°00′–113°30′	"
Alberta	83 I/4	Westlock	1:50,000	54°00′–54°15′	113°30′–114°00′	"
Alberta	83 I/6	Perryvale	1:50,000	54°15′–54°30′	113°00′–113°30′	"
Alberta	83 I/11	Athabaska	1:50,000	54°30′–54°45′	113°00′–113°30′	"
Alberta	83 I/13	Grosemount	1:50,000	54°45′–55°00′	113°30′–114°00′	"
British Columbia	104 H/1	Skelhorne Creek	1:50,000	57°00′–57°15′	128°00′–128°30′	"
N.W.T	75 L/10	Pearson Point	1:50,000	62°30′–62°45′	110°30′–111°00′	"
N.W.T	75 L/15	Lost Channel	1:50,000	62°45′–63°00′	110°30′–111°00′	"
N.W.T	75 L/16	Wildbread Bay	1:50,000	62°45′–63°00′	110°00′–110°30′	"
N.W.T	85 G/1	Pine Point	1:50,000	61°00′–61°15′	114°00′–114°30′	"

International Boundary Commission

At their first meeting of the year, held in Ottawa from April 15 to 17, 1953, the Commissioners reviewed the boundary situation between the two countries and agreed: that a United States party with a Canadian representative should do work on the Saint John River in connection with the use of aerial photographs in the revision of boundary maps in that section; that a Canadian party and a United States party should carry out maintenance operations on the Quebec-Maine highlands section; and that a Canadian party should conduct maintenance operations on the Turtle Mountain section of the Manitoba-North Dakota boundary and set three new monuments required on the British Columbia-Washington boundary. The Commissioners further agreed that 5 steel towers ranging the boundary at Point Roberts and Boundary Bay should be scraped and painted and that a second application of chemicals should be made in the programme of vegetation control being tested at Point Roberts and near Blaine and Huntington on the British Columbia-Washington boundary.

The Commissioners met in Washington from March 25 to 27, 1954 to consider boundary matters in general and to adopt a programme of maintenance operations for the 1954 field season. It was agreed: that an engineer of the United States section should do maintenance work at Passamaquoddy Bay and on the Saint John River and carry out map revision at various points of the Highlands and Halls Stream sections of the boundary; that a Canadian party should continue vista reclearance begun on the Quebec-Maine highlands in 1953 and that Canadian and United States parties should carry out monument repair and vista reclearance on the Quebec-Vermont and Quebec-New York sections of the boundary.

The Commissioners inspected the work of the maintenance party operating in the Turtle Mountain section of southern Manitoba. Following this they proceeded by plane to Whitehorse and Aklavik. For the Canadian Commissioner, the work in Yukon was a combined inspection of the Alaska-Yukon boundary and an advanced reconnaissance for the shoran project of the Geodetic Survey. Flights were made to various sections of the 141st meridian boundary. Monument 1 at Demarcation Point on the Arctic was seen but others immediately south of it did not show up against the surrounding terrain. On a flight west of Forty-mile River the boundary vista was not visible but it was plainly seen on a section from Monument 133 to Monument 241, south of Sixty-mile River.

The Commissioners next inspected the boundary at Point Roberts and at Blaine about 30 miles southeast of Vancouver, noting in particular the results of vegetation control on the boundary vista. Pre-growth on the vista was heavy on the eastern half of Point Roberts, last cut in 1951.

Later they inspected the work of the Canadian and United States maintenance parties operating in the Quebec-Maine highlands. They also visited the United States party working on the Saint John River section where it was noted that destruction and moving of boundary reference monuments was a continuing problem.

On the Saint John River section of the New Brunswick-Maine boundary a Canadian and a United States engineer made ties to establish control for aerial photographs to be used in revision of the boundary maps. On the Quebec-Maine highlands the boundary was inspected and vista was recleared for 24½ miles.

At Cornwall, 2 tablets marking the boundary across the Roosevelt bridge were re-located above and outside the guard rail to protect them from further damage from passing trucks.

On the Manitoba-North Dakota section of the 49th Parallel, 32½ miles of boundary were inspected, 25 miles of vista were recleared, and 31 monuments were inspected.

On the British Columbia-Washington boundary 3 new boundary monuments were established, one to mark the Carson-Danville highway crossing near Grand Forks and the other 2 on high land on the boundary east and west of the Skagit River to reference 2 monuments subject to future flooding. A second application of chemicals was made on a 16-mile section of boundary extending from Point Robers, B.C. to Blaine and Huntington, and 5 steel towers ranging the boundary at Point Robers were scraped and painted, and the bulwark of one tower was repaired.

The preparation of a special report summarizing maintenance operations and the re-establishment and repair of monuments on the North Line and Saint John River sections of the boundary is being continued. This report will contain the geographic positions of triangulation stations, monuments, and other marks recomputed on the 1927 North American datum which has superseded the old North American datum upon which positions were based in the original boundary report.

Canadian Board on Geographical Names

The Board is responsible by Order in Council for official Canadian nomenclature. All departments of the Federal Public Service must accept and use its decisions.

The Board adopted names for 159 new maps and 22 new hydrographic charts and considered the names for a number of map revisions, new names, name changes, and other items of related business. It continued the preparation of the Gazetteer of Canada series, the second volume of which (British Columbia) was published during the fiscal year.

Five provincial members or their representatives and two members of the Geographic Board of Alberta attended the February 1954 meeting of the Board at which several items of particular interest to the provinces were discussed.

The present membership of the Board is:

Chairman	P. E. Palmer
Executive Committee	C. H. Smith
	F. C. G. Smith
	E. D. Baldock
Members	A. McFarlane
	Norman Fee
	G. W. Rowley
	N. L. Nicholson
	H. S. Bostock

Provincial Members:

British Columbia	W. H. Hutchinson
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	T. E. MacNutt
Newfoundland	L. E. F. English
Secretary	G. M. Munroe

The province of Quebec has an independent Board that co-operates with the Canadian Board on Geographical Names on matters pertaining to that province.

GEOLOGICAL SURVEY OF CANADA

G. Hanson, Director

The Survey placed 79 geological parties in the field in 1953, of which 51 were engaged in regional geological mapping, 7 on palæontological studies, 14 on Pleistocene and engineering geology, 5 on oil and gas and other fuels investigations, and 2 on investigations of radioactive mineral occurrences. The parties were distributed as follows: Northwest Territories, 6; Yukon, 11; British Columbia, 12; Alberta, 6; Saskatchewan, 5; Manitoba, 4; Ontario, 6; Quebec, 5; Quebec-Labrador, 6; New Brunswick, 4; Nova Scotia, 4; Prince Edward Island, 1; Newfoundland, 5; and general, 4.

In addition, geological assistance was given to other Federal Government organizations in connection with specific problems, instances of this assistance being: assignment of the geologist in charge of the British Columbia office of the Survey to the Associate Committee on Navigation Facilities on the West Coast (National Research Council) to supervise the drilling and to report on the geological factors relating to the proposed removal of Ripple Rock in Seymour Channel; continued use of the services of a geologist by the Department of Northern Affairs and National Resources in the examination of drill-cuttings and cores and the correlation of geological information at proposed dam sites on Columbia River; and assignment of a geologist to assist the Special Projects Branch, Department of Transport, in the search for and study of potential sources of concrete aggregates required in the construction of the St. Lawrence Seaway.

On the recommendation of the National Advisory Committee on Research in the Geological Sciences the Geological Survey paid out grants-in-aid totalling $24,331 to eight Canadian universities in continuation of its efforts to stimulate and support geological research.

At his own request Dr. W. A. Bell was relieved of his duties as Director of the Geological Survey of Canada in October 1953. He is now serving as chief geological consultant to the Survey, in which capacity he is devoting much of his time to palæobotanical research. He joined the Survey in 1919 and became its Director in February 1950.

The Survey lost the services of three senior members of the staff by retirement on superannuation, namely, C. E. Cairnes, C. Lawson, and A. Sullivan. Dr. Cairnes had more than 40 years of service, mostly on geological mapping, during which he made valuable contributions in the form of reports and maps, particularly of British Columbia. During the past 10 years he was technical editor of geological manuscripts. Mr. Sullivan, also with service of more than 40 years, was supervisory draughtsman, and Mr. Lawson was in charge of the photographic section.

Regional Geology Division

FIELD WORK

Forty-one of the fifty-one geologists assigned to field work were engaged in studying and mapping potential mineral and fuel areas of Canada. Thirty-five of these conducted standard geological mapping on scales of 1 inch to 1 mile or 1 inch to 4 miles across Canada and six made reconnaissance surveys in northern little-known regions. The rest did detailed mapping and studied

specific problems related to various types of mineral deposits. Detailed work included studies of ore deposits at Yellowknife, N.W.T., Goldfields, Sask., and Mayo, Yukon, and studies of iron and kyanite deposits in Ontario and lithium deposits in Ontario and Manitoba.

Northwest Territories

R. G. Blackadar explored geologically a strip along the north coast of Ellesmere Island between longitudes 60°00′ and 72°15′ and made some long exploratory trips inland. He gained valuable information on the rocks and structure of this little-known area and found some deposits of Tertiary lignite.

I. C. Brown completed the detailed study of the Yellowknife gold belt, with special reference to the complex structures that contributed to the localization of ore shoots in the mines of the area.

W. L. Davison completed, for the present, geological exploration along the coasts of southern Baffin Island. The rocks consist of gneisses and schists of the Grenville type with mineral potentialities similar to those of the Grenville geological sub-province in Ontario and Quebec.

W. W. Heywood carried on geological reconnaissance of the northern part of Ellef Ringnes Island. His work included a visit to a circular structure, several of which can be seen on air photographs of the region. The one visited proved to be a piercement dome, a structure favourable for the accumulation of oil and gas.

B. D. Prusti completed geological mapping of the O'Connor Lake area (longitude 111°45′ to 112°, latitude 61°15′ to 61°30′), which contains deposits of lead and zinc.

R. Thorsteinsson completed a geological reconnaissance of Cornwallis Island, extending the work along the coast by overland trips into the interior of the island. The thick series of Palæozoic rocks have features favourable for the accumulation of oil and gas.

Yellowknife Office. The facilities of the Yellowknife office, under J. C. McGlynn, continued to be made available to prospectors of the area, and local investigations were made for compilation of data on the mineral industry of the District of Mackenzie. Co-operation was given to the Department of Northern Affairs and National Resources in the administration of mineral explorations and to the Canadian Institute of Mining and Metallurgy in its courses for prospectors.

Yukon

R. W. Boyle commenced a detailed study of the silver-lead-zinc ores of the Mayo mining area. This is in part fundamental research on the nature of the solutions from which the ore was derived and the causes of its localization in certain ore shoots, and should aid in finding and developing new orebodies.

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 are likely to occur.

R. L. Christie commenced geological mapping of the Teepee Lake area (longitude 140° to 141°, latitude 61° to 62°), which fills the gap between the Kluane Lake area and the Alaska boundary. Nickel mineralization has been found in the area.

L. H. Green continued geological mapping of the Mayo Lake area (longitude 134°30′ to 135°, latitude 63°45′ to 64°), which adjoins the Keno Hill area. The study of these two areas should aid in the search for and development of new orebodies in this very complex region.

E. D. Kindle continued geological mapping of the Keno Hill area (longitude 135° to 135°30′, latitude 63°45′ to 64°), the most active silver-lead-zinc mining area in Yukon.

J. E. Muller continued geological mapping of the Kluane Lake area (longitude 138° to 140°, latitude 61° to 62°) where recent discoveries of nickeliferous pyrrhotite are attracting considerable attention.

R. Mulligan completed geological mapping of the Teslin Lake area (longitude 132° to 134°, latitude 60° to 61°), which is crossed by the Alaska Highway. Small showings of asbestos were found.

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

E. F. Roots conducted an exploratory geological survey from Watson Lake northward up Hyland River and thence across South Nahanni River to the headwaters of Redstone River. From there the party returned by a more easterly route, reconnoitring a large, little known area. Some promising prospecting areas were found and the presence of thick sections of well-exposed strata deserving further study was established.

J. O. Wheeler commenced geological mapping of the Kaskawulsh area (longitude 138° to 139°, latitude 60°30′ to 61°). Placer mining is being carried on in the area and deposits of gypsum and some metallic minerals were found.

British Columbia

J. D. Aitken continued geological mapping of the Atlin area (longitude 132° to 134°, latitude 59° to 60°). He outlined a large body of rock of a type in which asbestos is likely to occur and examined new finds of radioactive minerals. He also continued studies of the various sites of the proposed Sloke Lake-Tahi Creek diversion of the headwaters of Yukon River.

S. Duffell commenced geological mapping of the Terrace area (longitude 128° to 129°, latitude 54° to 55°), which is crossed by the Prince Rupert branch of the Canadian National Railways. The east flank of the Coast Range batholith with which mineral deposits are commonly associated passes through the area. There are many mineral deposits in the area, some of which are being developed. Large deposits of sand and gravel and some clay were found.

H. Gabrielse continued geological mapping of the McDame map-area (longitude 128° to 130°, latitude 59° to 60°), and made a study of the Cassiar asbestos deposits. Many occurrences of gold and various base metals are now readily accessible for development by means of the road that connects the asbestos camp with the Alaska Highway.

G. B. Leech commenced geological mapping of the Canal Flats area (longitude 115°30′ to 116°, latitude 50° to 50°15′), which straddles the Rocky Mountain Trench and includes the flanks of the Rocky and Purcell Mountains. A large area underlain by thick deposits of gypsum was discovered behind the front range of the Rocky Mountains.

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 commenced geological mapping of the Lardeau area (longitude 116° to 117°, latitude 50° to 51°), which lies immediately north of the Sullivan mine at Kimberley.

J. E. Roddick commenced 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 deposits. Although it is close to transportation and is bounded by areas containing important mines, it has received little prospecting attention.

J. Souther commenced a study of the granitic rocks of the Terrace area, 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 completed geological mapping of the Nechako area (longitude 124° to 126°, latitude 53° to 54°). Much of it is drift covered and a special effort was made to examine all outcrops in the area to be flooded by the dam being constructed by Aluminum Company of Canada as these areas will not again be available for inspection.

Vancouver Office. The Geological Survey's office at Vancouver gave local assistance in relation to problems of mineral occurrences, ground-water supplies, and engineering geology. Many visitors registered at the office and inquiries were answered by mail and telephone. Determinations were made of many rock and mineral specimens and reports and maps were issued in response to requests from the public.

W. E. Cockfield, in charge of the office, spent about 6 weeks in an investigation concerning the removal of Ripple Rock in Seymour Channel by mining methods.

Alberta

R. J. W. Douglas commenced the geological revision of a group of map-areas (longitude 116° to 116°30′, latitude 52°15′ to 52°45′; longitude 116°30′ to 116°45′, latitude 52°30′ to 53°; and longitude 116°45′ to 117°, latitude 52°45′ to 53°). They contain structures favourable for the accumulation of oil and gas, and recent advances in the knowledge of the stratigraphy of the rocks concerned made revision of the earlier work desirable.

E. J. W. Irish completed geological mapping of the Kvass Flats area (longitude 119°15′ to 119°30′, latitude 53°45′ to 54°), where there are large reserves of coal but apparently few structures favourable for the accumulation of oil and gas.

Saskatchewan

J. A. Fraser commenced and completed geological mapping of the Crackingstone Peninsula area (longitude 108°45′ to 109°, latitude 59°15′ to 59°30′), where many occurrences of uranium-bearing minerals have been found, including the Gunnar deposit.

W. E. Hale completed geological mapping of the Gulo Lake area (longitude 109°00′ to 109°15′, latitude 59°30′ to 59°45′) west of Beaverlodge in northern Saskatchewan where a number of radioactive mineral deposits are being developed.

L. P. Tremblay continued detailed geological mapping in the Beaverlodge Lake area. Tentative conclusions already suggest a relationship between the uranium mineralization and certain structures.

Manitoba

H. A. Quinn commenced and completed geological mapping of the Nelson House area (longitude 98° to 100°, latitude 55° to 56°). Sinuous bodies of nickel-bearing peridotite occur in the area, some of which are being actively explored.

R. B. Rowe studied the lithium- and beryllium-bearing pegmatites in southeastern Manitoba.

Ontario

E. R. Rose continued the mineralogical investigation of iron deposits in the Grenville series of eastern Ontario.

R. B. Rowe examined the radioactive mineral occurrences on Manitou Islands, Lake Nipissing.

Quebec

K. R. Dawson completed the field study of the Preissac-Lacorne batholith, Abitibi county, to establish its relationship to the associated mineral deposits.

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

W. H. Fahrig mapped the Herodier Lake area, west half (longitude 69° to 70°, latitude 57° to 58°), which straddles the Labrador Trough and contains deposits of iron oxides on the west and non-ferrous metals on the east.

M. J. Frarey completed geological mapping of the Thompson Lake area (longitude 66° to 66°30′, latitude 55°15′ to 55°30′) in the eastern part of the Labrador Trough. Most of the rock is lava and occurrences of sulphide minerals and asbestos were noted.

J. M. Harrison made a geological reconnaissance of the area between latitude 58 degrees and Hudson Strait. He made a brief study of the Ungava crater and found it to be pre-glacial in age.

S. M. Roscoe commenced and completed geological mapping of the Cambrian Lake area, east half (longitude 68° to 69°, latitude 56° to 57°), which also straddles the 'Labrador Trough'. A band of iron formation crosses the west side of the area and copper occurs in lavas on the east side.

Quebec-Labrador

J. E. Howell continued detailed geological mapping of a strip through Burnt Creek across the Labrador Trough in order to determine the sequence, character, and structure of the strata concerned and their relationship to the contained iron formations and iron ore deposits.

New Brunswick

F. D. Anderson commenced geological mapping of the Coldstream area (longitude 67° to 67°30′, latitude 46°15′ to 46°30′), which contains iron and manganese mineralization.

R. Skinner commenced geological mapping of the Tetagouche Lake area (longitude 66° to 66°30′, latitude 47°30′ to 47°45′), which contains zinc deposits and is being actively prospected as a result of the base metal discoveries near Bathurst in the adjoining map-area.

Nova Scotia

D. G. Kelley continued geological mapping in the Baddeck area (longitude 60°30′ to 61°, latitude 46° to 46°15′) where deposits of gypsum, manganese, and base metals occur.

I. M. Stevenson commenced geological mapping of the Shubenacadie area (longitude 63° to 63°30′, latitude 45° to 45°15′), which contains large deposits of gypsum and occurrences of barite and base metals.

Newfoundland

F. Barnes and G. C. Riley completed geological mapping of the St. Georges area (longitude 58° to 59°, latitude 48° to 49°), which contains bodies of magnetite and of titaniferous magnetite, gypsum, and coal.

W. D. McCartney commenced geological mapping of the Argentia area (longitude 53°30′ to 54°, latitude 47°15′ to 47°30′) as part of the systematic mapping of the Avalon Peninsula. Silver-lead deposits occur in the area and a small vein of fluorite was noted.

T. O. H. Patrick commenced geological mapping of the Twillingate area (longitude 54°30′ to 55°, latitude 49°30′ to 49°45′), which contains deposits of copper and antimony.

C. H. Smith mapped the Trout River area (longitude 58° to 58°30′, latitude 40°15′ to 49°30′), which contains large bodies of ultrabasic rocks, associated with which are deposits of chromite and copper.

General

J. W. Hoadley examined kyanite deposits in various parts of Canada, but mainly in Ontario.

GEOPHYSICS

The airborne magnetometer was redesigned to facilitate compilation of the data and to improve the accuracy. An additional electronic laboratory was established for use in developing new instruments for geophysical work.

Newfoundland

F. P. DuVernet conducted an aeromagnetic survey across the island of Newfoundland between latitudes 48 and 49 degrees, covering an area of about 20,000 square miles. He also made an aeromagnetic survey of Conception Bay to assist in estimating the extension of the Wabana iron ore deposits. In all, about 34,200 line miles were flown.

Nova Scotia

An aeromagnetic survey, involving, in all, about 10,200 line miles, was made over that part of Cape Breton Island south of latitude 46° and over areas on the mainland between longitude 61° to 61°30′, latitude 45° to 45°30′, and longitude 61°30′ to 62°, latitude 45°15′ to 46°. A series of profiles was also flown over the Sydney coal fields.

Fuels Resources Division

The Division received 85,933 drill samples from wells drilled for oil and natural gas, bringing the number available for study and reference at Ottawa to 1,641,012. The samples received were from 468 wells, of which 348 were drilled in Ontario, 117 in Alberta, and 7 in Quebec. Altogether, 87,607 samples were prepared for microscopic examination.

Acknowledgment is made to the following persons and organizations through whose co-operation information and samples were received: Petroleum and Natural Gas Branch, Department of Lands and Forests, 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; Saskatchewan 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; R. B. Harkness, Ontario Natural Gas Commissioner, for drillers' logs and for samples of wells drilled in Ontario; Paul Payette, for samples of wells drilled in the eastern part of Gaspe, Quebec; I. W. Jones, Chief, Geological Survey Division, 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,

for information regarding wells drilled by their respective companies in Ontario; and to the officials of numerous oil companies for much useful information on activities in Canada. Acknowledgment is also made to L. J. Severson, Vice-President, Oliver Iron Mining Division, United States Steel Corporation, for donation of a core representing the entire Palæozoic section near Simcoe, Ontario; to K. F. Bickford, manager Trent River Iron Limited, for permission to examine cores representing the Palæozoic formations in central Ontario; and to B. K. Glassford and C. W. Greenland, Department of Highways, Toronto, Ontario, for permission to examine cores resulting from drilling at Hagersville, Ontario.

Jointly with the Mines Branch, the Division advises the Department of National Revenue regarding tax benefits in special cases on deep test wells.

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 facilities available to the oil industry for study and reference. It also distributes Geological Survey reports.

In all, 254,421 drill samples were acquired, comprising 139,170 from wells drilled in Alberta, 92,086 from wells drilled in Saskatchewan, 9,273 from wells drilled in Manitoba, 12,166 from wells drilled in British Columbia, and 1,726 from wells drilled in the Northwest Territories.

Studies of the detailed stratigraphy and of problems of correlation of subsurface formations in the plains region of western Canada were continued. Progress was made in the study and correlation of subsurface formations of Devonian age in central Alberta. A cross-section showing the succession and lithology of the subsurface sedimentary formations in Saskatchewan was prepared for publication, and revision of a report on the Mesozoic Stratigraphy of the Eastern Plains, Manitoba and Saskatchewan, published in 1945, was completed.

Coal

The work on coal comprised in the main: the collection of available data on coal mines, coal occurrences, and coal prospects for use in estimating the coal reserves of Canada; detailed geological mapping of coal deposits in the Springhill and Joggins coalfields of Nova Scotia; assisting in the solution of geological problems connected with coal mining; 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 Alberta plains; and the collection of approximately 300 coal samples, representative of seams from all parts of Canada, for testing for possible germanium content. At the request of the Department of Northern Affairs and National Resources, an investigation and report were made on the coal reserves underlying certain land in Banff National Park, Alberta.

Activities at the Sydney office, maintained by the Geological Survey of Canada in co-operation with the Nova Scotia Department of Mines and the Nova Scotia Research Foundation, dealt mainly with the following projects, each of which involved microscopic examination of the coals:

(a) correlation of coal seams in the Sydney, St. Rose, Port Hood, and Pictou coalfields;

(b) studies related to spontaneous combustion of coal. Petrographic studies on pyrite in coals from Sydney coalfield were completed;

(c) petrographic analysis of coal from the Harbour View mine at Port Hood was made to determine the character of the coal;

(d) in co-operation with the Mines Branch, petrographic examination of coal from seams in western Canada was continued as part of a study of rock pressure and gas outbursts in coal mines.

FIELD WORK

Alberta

D. K. Norris commenced geological study and mapping of the coal-bearing Blairmore map-area (longitude 114°15′ to 114°30′, latitude 49°30′ to 49°45′). He continued to co-operate with the Mines Branch by studying geological structures involved in violent stress relief in coal seams in the Blairmore area and vicinity and made a trip to Springhill, Nova Scotia, for a similar purpose.

Ontario

B. V. Sanford continued to establish the location and elevation of wells drilled for natural gas and oil in southwestern Ontario. These data are being used to prepare maps showing bedrock contours and drift thicknesses in the region.

G. C. Winder continued geological mapping of the Palæozoic formations in central Ontario between longitudes 77° and 78°30′ and from Lake Ontario to the southern border of the Canadian Shield. This work is designed to assist in the detailed subsurface studies of the formations where they underlie younger rocks in the potential oil and gas areas in southwestern Ontario.

Nova Scotia

M. J. Copeland carried out a geological study of the Joggins and Springhill coalfields to determine the sequence, structure, and potentialities of the coal-bearing strata.

General

B. A. Latour continued to collect data from coal mines, coal prospects, and coal occurrences for use in estimating the coal reserves of Canada. He also carried out a field examination and prepared a report on the coal reserves underlying a part of Banff National Park at the request of the Department of Northern Affairs and National Resources.

In connection with the work of the Sydney office, P. A. Hacquebard collected coal samples for petrographic analysis from: the Point Aconi, Lloyd Cove, Hub, Harbour, and Backpit coal seams, in Nova Scotia; Sydney coalfield; the 6-foot seam at John MacLeod's Brook in the St. Rose coalfield; the Harbour View mine in the Port Hood coalfield; and from Stellarton and Westville in the Pictou coalfield. He made several trips to the Mabou coal area and studied the exposed cliff sections in an effort to obtain additional data for solution of the complex structural relationships in that field.

Stratigraphic Palæontology Division

The systematic study of Canadian stratigraphy based on fossil collections submitted by members of the Geological Survey of Canada, and by oil and mining companies and others, was continued. The Division received 171 boxes containing thousands of specimens and prepared 104 reports. Seventeen of these reports were for oil companies in western Canada, the remainder for the Geological Survey, provincial government services, universities, and others. Many of the reports clarified stratigraphic and structural conditions in the areas concerned.

Fossil collections were donated by Royalite Oil Company, Shell Oil Company, Socony Vacuum Oil Company, Sohio Petroleum Company, and others.

Accommodation was provided for several oil geologists who visited the Division to study the palæontological collections.

FIELD WORK

British Columbia

J. A. Jeletzky continued the study of the Mesozoic rocks on the west coast of Vancouver Island between Kyuquot Sound and Quatsino Sound. This project, which it is hoped to complete during the 1954 field season, will assist geological mapping in many parts of British Columbia by clarifying the stratigraphy of the sedimentary and volcanic rocks and will assist in determining the age and character of the tectonic movements.

Yukon

E. T. Tozer revised the stratigraphy of the Triassic rocks in the Laberge area. His work resulted in a new interpretation of the section and will assist geological mapping in this part of Canada.

Alberta and British Columbia

H. Frebold completed the study of the Jurassic Fernie group in Alberta and eastern British Columbia. The palæogeographic conclusions from this study will be of assistance in the search for oil in western Canada.

Alberta

D. J. McLaren completed a detailed study of reef development in the Devonian rocks with particular attention to the important facies changes at the fringes of the reefs. These reefs are centres of oil and gas accumulation and a clear understanding of their nature is essential for efficient exploration.

Ontario

Thomas E. Bolton completed the study of the Silurian stratigraphy of Manitoulin Island. He examined over 200 sections and made extensive collections of fossils. This study will allow correlations with sections in other parts of Canada and in other countries.

Ontario and Quebec

Miss Frances J. E. Wagner studied the Pleistocene deposits and fauna of the Champlain Sea in the Ottawa-Montreal area. This study should determine the extent to which that former sea invaded the Ottawa River Valley. Sediments deposited in this sea are the main source of sand and gravel in the area and the investigation will aid in the search for these materials, which will be used also in the construction of the St. Lawrence Seaway.

New Brunswick

L. M. Cumming studied the stratigraphy of the Silurian of southwest New Brunswick. The invertebrate fauna of these beds will allow correlation with other Acadian and with British sequences.

Radioactive Resources Division

The Division makes field and laboratory studies on Canadian resources of radioactive raw materials, maintains free testing and advisory services for uranium prospectors, and compiles and publishes data on Canadian radioactive

deposits. The unprecedented interest in uranium in many parts of the country placed great demands on all activities of the Division throughout the fiscal year. As agent for the Atomic Energy Control Board, the Geological Survey of Canada, through the Division, receives reports of discoveries, results of analyses for uranium or thorium, and quarterly reports describing work done by about 250 companies and individuals to whom exploration permits have been issued by the Board. This information, results of field and laboratory studies, and other related data are incorporated in a confidential inventory that is revised annually. The inventory was brought up to date to December 31, 1953.

The Division made quantitative tests for radioactivity on 1,224 samples from prospectors and reported almost all results within a day of receipt of sample. Ordinary radiometric tests do not distinguish between uranium and thorium, but special equipment purchased during the year enables the reporting of rapid supplementary tests to determine the uranium content of those samples that show significant total radioactivity. In addition, 108 identifications were made of radioactive minerals in prospectors' samples.

To aid in research, about 1,000 mineral identifications were made by X-ray powder patterns; work on a comprehensive collection of standard X-ray patterns was continued; 427 X-ray fluorescence analyses and 479 spectrographic analyses were made; the construction of a special mass-spectrometer for making age determinations on radioactive rocks and minerals was almost completed; and preparations were made for the chemical work required in connection with age determinations.

FIELD WORK

Saskatchewan

A. S. MacLaren examined uranium deposits in the Goldfields region to obtain information for the confidential inventory on Canadian deposits of uranium and thorium.

S. C. Robinson visited the Goldfields (Beaverlodge) area to complete his detailed study of the mineralogy of the uranium deposits.

General

A. H. Lang examined uranium deposits in Saskatchewan, Ontario, and Quebec and supervised the other activities of the Division.

Mineralogy Division

The chemical laboratory was modernized in an effort to meet the growing demand for assistance to prospectors and educational institutions.

The 11,050 specimens of minerals, rocks, soil, water, etc., submitted by prospectors, mine operators, educational institutions, farmers, and others, were examined free of charge and 2,200 reports were made as to their nature, uses, and possible commercial value. About 3 per cent of this large number of specimens warranted closer examinations of the properties or exposures from which they were derived. More than 250 reports were made in answer to inquiries dealing with mineral localities, many from United States citizens who were planning motor and collecting trips in Canada. About 1,125 visitors were supplied with information on specimens or mineral occurrences.

In all, 90,313 specimens of rocks and minerals were prepared for distribution to the public, and 2,514 collections were sold to prospectors, schools, and the public generally. Orders for approximately 12,000 specimens were on hand at the end of the fiscal year.

The specimens and collections were distributed as follows:

	Specimens	Collections
Ontario	32,285	794
Quebec	10,386	333
New Brunswick	4,505	117
Nova Scotia	1,500	66
British Columbia	11,803	354
Alberta	16,977	478
Saskatchewan	7,879	222
Manitoba	1,888	60
Newfoundland	144	15
Others	2,946	75

To maintain this service 10 tons of minerals and rocks were collected in more than fifty localities in Quebec, New Brunswick, and Nova Scotia.

Much work was done on minerals and rocks from various geological formations and ore deposits. This included: silica determinations of 15 rocks from Yellowknife area and of 6 rocks from the Negus mine, N.W.T.; complete analyses of 3 specimens of altered wall-rock from the Negus mine; and three carbonate and three partial analyses of 6 samples from Monarch Mountain, Atlin, B.C.

About 600 specimens of museum quality were added to the Geological Survey collections, among the most interesting being: newberyite and struvite from Shipton Caves, Victoria, Australia; a collection of high-grade zinc-copper ores from Waite Amulet Mines Limited; large slabs of brucite from Wakefield, Que.; chrysotile asbestos, exhibiting cross fibres 4½ inches in length, from East Broughton, Que.; and a specimen of millerite from Ascot, Que.

Grateful acknowledgment is made to the following for specimens donated to the Geological Survey and for help received in connection with the educational collections: Dr. W. K. Gummer, Aluminum Company of Canada, Arvida, Que.; Mr. Blight, Canadian Gypsum Company, Limited, Hillsborough, N.B.; Mr. A. Boivin, Girardville Centre, Que.; Mr. Barret, Aluminum Company of Canada, Wakefield, Que.; Mr. R. G. Merrill, Quebec Asbestos Corporation, East Broughton, Que.; Dr. H. G. Way, Ascot Metal Corporation, Ascot, Que.; Mr. O. H. James, Canadian Johns-Manville Company, Limited, Asbestos, Que.; Mr. J. M. McGuire, Malagash Salt Company, Limited, Malagash, N.S.; Mr. Cyr, Broughton Soapstone Quarry Company, Limited, Leeds Station, Que.; Mr. P. Robitaile, Granit National Ltée, Alma, Que.; Mr. K. G. Eisner, Windsor Plaster Company, Limited, Windsor, N.S.; Mr. King, Canadian Gypsum Company, Windsor, N.S.; Mr. J. Eaton, Canadian Industrial Minerals Limited, Walton, N.S.

Pleistocene and Engineering Geology Division

FIELD WORK

British Columbia

J. E. Armstrong continued to map the Pleistocene geology of the Fraser Delta. The information gained is of immediate practical importance in developing the sand and gravel, peat, and ceramic industries in the region, and in solving engineering, water-supply, and flood control problems.

J. G. Fyles completed mapping the Pleistocene geology of the Horne Lake and Parksville areas (longitude 124° to 125°, latitude 49°15′ to 49°30′). The knowledge gained will help agricultural development, and provide information on local problems of ground-water supply and gravel deposits.

E. Hall continued to assist the Engineering and Water Resources Branch, Department of Northern Affairs and National Resources, in geological studies connected with the Columbia River project.

Alberta

A. M. Stalker continued mapping the Pleistocene geology of the Beiseker area (longitude 113° to 114°, latitude 51° to 52°). The data he obtained on the distribution and sedimentary deposits of numerous shallow but widespread glacial lakes and on other deposits will have a direct bearing on agricultural development.

Saskatchewan

B. G. Craig continued to map the Pleistocene geology of the Battleford area (longitude 108° to 109°, latitude 52° to 53°). He examined many gravel deposits that are being used for road metal and railroad ballast or are potential sources of these materials.

Manitoba

J. A. Elson commenced mapping the Pleistocene geology of the Souris area (longitude 100° to 101°, latitude 49° to 50°). Most of the area was once covered by glacial Lake Souris and much of his work was directed to mapping associated deposits and establishing the boundaries of the lake.

E. C. Halstead completed a study of the ground-water supply of the Brandon area (longitude 98° to 100°, latitude 49° to 50°). He gained valuable information on the occurrences of ground water in this area, which is subject to drought.

Ontario

C. P. Gravenor completed mapping the Pleistocene geology of the Lindsay area (longitude 78°30′ to 79°, latitude 44°15′ to 44°30′). This completes the study of a block of four map-areas and will provide data on the material from which the soils are derived and on areas of potential structural and ceramic materials.

E. B. Owen continued the study of ground-water conditions in the vicinity of Ottawa. Shortage of ground water is being experienced in several outlying communities and the survey will provide basic data concerning ground-water supply. His services were made available in midsummer to the Special Projects Branch, Department of Transport. This latter work included studies to assist in the search for material suitable for concrete aggregate for use in the construction of the St. Lawrence Seaway and also locating and logging test and bore-holes in overburden and bedrock.

Quebec

N. R. Gadd continued mapping the Pleistocene geology of the Aston area (longitude 72° to 72°30′, latitude 46° to 46°15′). Few gravel deposits are known south of the St. Lawrence River in the vicinity of the area, so that the outlining of deposits even of poor grade gravel is of importance.

E. I. K. Pollitt continued to study the ground-water resources of Montreal Island and outlined areas in which the greatest supply can be expected. The data obtained will be of aid in planning rural housing development.

New Quebec-Labrador

E. P. Henderson commenced a study of the history and deposits related to the glacial deposits of the Labrador ice centre. During this study sources of gravel were discovered for ballast for the right of way for the railway to the iron deposits at Schefferville (Knob Lake).

New Brunswick

H. A. Lee continued the study and mapping of Pleistocene deposits along the Saint John River Valley. The work will be of aid in the search for structural materials, and provide valuable data on foundation and reservoir conditions in connection with the Saint John River power development.

Nova Scotia

O. L. Hughes resumed the mapping of Pleistocene deposits in the Shubenacadie area (longitude 63° to 63°30′, latitude 45° to 45°15′). He examined deposits of clay being used and outlined new sources of clay and gravel.

Prince Edward Island

V. K. Prest commenced the geological study and mapping of the bedrock and unconsolidated deposits of the province and an inventory of such mineral resources as may exist. His study of the glaciation will assist the search for gravel deposits, scarce in most of Prince Edward Island.

Geological Cartography Division

Maps Published from April 1, 1953, to March 31, 1954

Publication number	Title	Remarks
	YUKON	
1019A	Dezadeash; scale, 1 inch to 4 miles	Geology. For Memoir 268 and separate distribution.
52-30A	Whitehorse; scale, 1 inch to 2 miles	Preliminary geological map. Paper 52-30.
53-20	Kluane Lake (West Half); scale, 1 inch to 4 miles	Preliminary geological map. Paper 53-20.
	NORTHWEST TERRITORIES	
1021A	Ghost Lake; District of Mackenzie; scale, 1 inch to 1 mile	Geology. For memoir and separate distribution.
1022A	Ranji Lake; District of Mackenzie; scale, 1 inch to 1 mile	Geology. For memoir and separate distribution.
1023A	Chalco Lake; District of Mackenzie; scale, 1 inch to 1 mile	Geology. For memoir and separate distribution.
52-24	Yellowknife (Sheet 5), District of Mackenzie; scale, 1 inch to 500 feet	Preliminary geological map. Paper 52-24.
52-28A	Yellowknife Greenstone Belt, District of Mackenzie; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-28.
52-32A	Robeson Channel-Kane Basin Coastal Area, Ellesmere Island; scale, 1 inch to 8 miles	Preliminary geological map. Paper 52-32.

Maps Published from April 1, 1953, to March 31, 1954—(Continued)

Publication number	Title	Remarks
	NORTHWEST TERRITORIES—*Concluded*	
53-22	Southern District of Keewatin (2 maps); scale, 1 inch to 8 miles	Preliminary geological maps. Paper 53-22.
53-24	Cornwallis Island, District of Franklin; scale, 1 inch to 8 miles	Preliminary geological map. Paper 53-24.
	BRITISH COLUMBIA	
737A	Hope, Yale and New Westminster Districts (reprint); scale, 1 inch to 4 miles	Geology. For separate distribution.
53-25	Dewar Creek, Kootenay District; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-25.
53-28	Vancouver North; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-28.
	ALBERTA	
52-10	Waterton, West of Fourth Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-10.
	SASKATCHEWAN	
638A	Etomami River (reprint); scale, 1 inch to 4 miles	Geology. For Memoir 239 and separate distribution.
53-15	Black Bay; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-15.
	SASKATCHEWAN-MANITOBA	
637A	Mafeking (reprint); scale, 1 inch to 4 miles	Geology. For Memoir 239 and separate distribution.
713A	Assiniboine (reprint); scale, 1 inch to 8 miles	Geology. For Memoir 239 and separate distribution.
	MANITOBA	
1020A	Weldon Bay, West of Principal Meridian; scale, 1 inch to 1 mile	Geology. For Memoir 270 and separate distribution.
53-12	Uhlman Lake; scale, 1 inch to 4 miles	Preliminary geological map. Paper 53-12.
	ONTARIO	
	Southwestern Ontario, Principal Oil and Natural Gas Fields; scale, 1 inch to 6 miles	For separate distribution.
52-31A	Fenelon Falls, Victoria, Peterborough, and Haliburton Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 52-31.

Maps Published from April 1, 1953, to March 31, 1954—(Continued)

Publication number	Title	Remarks
	ONTARIO—*Continued*	
52-33A	Lindsay, Victoria, Durham, Ontario, and Peterborough Counties; scale, 1 inch to 1 mile....	Preliminary geological map. Paper 52-33.
53-2A	Newmarket, Ontario and York Counties; scale, 1 inch to 1 mile....	Preliminary geological map. Paper 53-2.
53-6	Elgin County and Parts of Middlesex County (2 maps); scale, 1 inch to 2 miles....	Preliminary geological maps. Paper 53-6.
53-9	Alliston, Simcoe, York, and Dufferin Counties; scale, 1 inch to 1 mile....	Preliminary geological map. Paper 53-9.
53-11	Rice Lake, Northumberland, Durham, and Peterborough Counties (Glacial Geology); scale, 1 inch to 1 mile....	Preliminary geological map. Paper 53-11.
53-13	Barrie, Simcoe County; scale, 1 inch to 1 mile. .	Preliminary geological map. Paper 53-13.
53-16	Orr Lake, Simcoe County; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-16.
53-18	Oshawa, Ontario and Durham Counties; scale, 1 inch to 1 mile....	Preliminary geological map. Paper 53-18.
53-19	Scugog, Durham, Ontario, and Victoria Counties; scale, 1 inch to 1 mile....	Preliminary geological map. Paper 53-19.
53-26	Scugog, Durham, Ontario, and Victoria Counties (Glacial Geology); scale, 1 inch to 1 mile..	Preliminary geological map. Paper 53-26.
113G	Orillia, Simcoe, Ontario, and Victoria Counties: scale, 1 inch to 1 mile....	Preliminary aeromagnetic map.
118G	Gravenhurst, Victoria, Simcoe, and Ontario Counties, and Muskoka District; scale, 1 inch to 1 mile....	Preliminary aeromagnetic map.
124G	Orr Lake, Simcoe County; scale, 1 inch to 1 mile....	Preliminary aeromagnetic map.
126G	Lake Joseph, Muskoka and Parry Sound Districts; scale, 1 inch to 1 mile....	Preliminary aeromagnetic map.
127G	Seguin Falls, Parry Sound and Muskoka Districts; scale, 1 inch to 1 mile....	Preliminary aeromagnetic map.
128G	Penetanguishene, Simcoe County and Muskoka District; scale, 1 inch to 1 mile....	Preliminary aeromagnetic map.
146G	Gooderham, Peterborough, Haliburton, and Hastings Counties; scale, 1 inch to 1 mile....	Preliminary aeromagnetic map.

Maps Published from April 1, 1953, to March 31, 1954—(Continued)

Publication number	Title	Remarks
	ONTARIO—*Concluded*	
148G	Bracebridge, Muskoka District; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	ONTARIO-QUEBEC	
1038A	Ottawa, Carleton, Gatineau, and Papineau Counties; scale, 1 inch to 1 mile	Geology. For separate distribution.
	QUEBEC	
149G	St. Malachie, Bellechasse, Dorchester, and Lévis Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
150G	St. Joseph, Dorchester and Beauce Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
151G	Beauceville, Beauce, Dorchester, and Frontenac Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
152G	Megantic, Frontenac County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
153G	St. Evariste, Frontenac and Beauce Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
156G	Disraeli, Wolfe, Frontenac, and Megantic Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
157G	Scotstown, Frontenac, Compton, and Wolfe Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
158G	Lyster, Lotbiniere, Megantic, Nicolet, and Arthabaska Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
159G	Thetford, Megantic, Beauce, Frontenac, and Wolfe Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
160G	St. Sylvestre, Lotbiniere, Megantic, Beauce, and Dorchester Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	NEW BRUNSWICK	
53-29	Bathurst, Gloucester and Restigouche Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-29.
57G	Bathurst, Gloucester and Restigouche Counties (revised edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
59G	Tetagouche Lakes, Restigouche, Northumberland and Gloucester Counties (revised edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
64G	Nepisiguit Lake, Restigouche, Northumberland, and Victoria Counties (revised edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
66G	California Lake, Northumberland, Gloucester, and Restigouche Counties (revised edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1953, to March 31, 1954—(Continued)

Publication number	Title	Remarks
	NEW BRUNSWICK—*Continued*	
125G	Grand Falls, Victoria and Madawaska Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
129G	Tobique, Victoria County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
130G	Florenceville, Carleton County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
131G	Plaster Rock, Victoria County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
132G	Andover, Victoria and Carleton Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
133G	Doaktown, Northumberland and York Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
134G	Aroostook, Victoria County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
135G	Napadogan, York County; scale 1 inch to 1 mile	Preliminary aeromagnetic map.
136G	McAdam, York and Charlotte Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
137G	Forest City, York County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
138G	Hayesville, York, Northumberland, Carleton, and Victoria Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
139G	Fosterville, York and Carleton Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
140G	Woodstock, Carleton County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
141G	Burtts Corner, York County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
142G	Juniper, Carleton, Victoria, and York Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
143G	Coldstream, Carleton and York Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
144G	Tuadook Lake, Victoria, Northumberland, York, and Carleton Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
145G	Canterbury, York and Carleton Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
147G	Millville, York and Carleton Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
154G	Charlo, Restigouche County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
155G	Campbellton, Restigouche County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1953, to March 31, 1954—(Continued)

Publication number	Title	Remarks
	NEW BRUNSWICK—*Concluded*	
166G	Upsalquitch Forks, Restigouche County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	NEWFOUNDLAND	
53-5	Springdale; scale, 1 inch to 1 mile	Preliminary geological map. Paper 53-5.
53-14	Central Labrador Coast; scale, 1 inch to 8 miles	Preliminary geological map. Paper 53-14.
176G	Badger (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
177G	Buchans (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
178G	Mount Peyton (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
179G	Gander (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
180G	Grand Falls (advance edition); scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Eight maps were published to accompany water supply papers; 127 maps and scientific figure drawings were draughted for reproduction by photo-lithography or by zinc-cut process for illustrating memoirs, reports, articles, and papers.

Six geological maps were at the Printing Bureau for lithographing at the end of the fiscal year. Nine maps and two map figures were at the Surveys and Mapping Branch for printing. Work was in progress on ten standard geological sheets, four preliminary geological maps, and fifteen preliminary aeromagnetic maps.

Administrative

Geological Information and Distribution Section

Reports and maps issued totalled 231, of which 125 were reprints. New editions included 4 Memoirs, 8 Water Supply Papers, 33 Preliminary Papers, 2 Bulletins, 5 Miscellaneous Series (Geology), 46 Geophysics Papers (Maps), and 8 Geological Maps. Publications distributed totalled 128,770.

Library

Acquisitions:

Books acquired by purchase	503
Books (complete unbound volumes by purchase)	439
Books by transfer, exchange, and gift	488
Canadian periodicals	2,282
Canadian Government publications	2,227
British and foreign Government publications	4,792
Proceedings, transactions, and bulletins of societies	3,332
British and foreign periodicals	6,963
	21,026

Other data:

Recorded loans of books, pamphlets, periodicals	22,306
Inter-library and occasional loans	2,622
Books borrowed from other libraries	541
Maps and charts added to the library	2,471
Maps and charts borrowed from the library	361
Lantern slides borrowed	434
Lantern slides added to the library	78
Cards added to lantern slide catalogue	206
Photographs loaned (exclusive of albums)	418
Volumes bound	500
Volumes accessioned	1,343
Cards added to general catalogue	16,420
Cards added to map catalogue	713
Letters and cards received	3,015
Letters and cards sent	5,655
New serials received and catalogued	248

Photographic Section

The major items of production included:

Kodalith negatives, up to 24" x 30"	884
Bromide enlargements, up to 24" x 30"	3,428
Vandyke prints	2,098
Contact prints, up to 11" x 14"	25,375
Dry-plate negatives	2,536
Colour transparencies	180
Photomicrographs	340
Exposures developed, field work	5,711
Lantern slides	392
Magnetometer film developed, field work	24,800 ft.
Magnetometer film printed	25,500 ft.

Reproduction Processes

Blueprints	301,053 sq. ft.
Océ prints	20,176 sq. ft.
Photostats (18" x 22")	9,344 sheets
Mimeograph	580,416 impressions

Lapidary

Mineral and rock specimens prepared for scientific study were:

Thin sections	4,792
Polished sections	391

Library

Acquisitions:

Books acquired by purchase	503
Books (complete unbound volumes by purchase)	439
Books by transfer, exchange, and gift	482
Canadian periodicals	2,283
Canadian Government publications	2,327
British and foreign Government publications	4,782
Proceedings, transactions, and bulletins of societies	3,332
British and foreign periodicals	6,968
	21,056

Other data:

Recorded loans of books, pamphlets, periodicals	22,306
Inter-library and occasional loans	2,822
Books borrowed from other libraries	541
Maps and charts added to the library	2,471
Maps and charts borrowed from the library	361
Lantern slides borrowed	134
Lantern slides added to the library	78
Cards added to lantern slide catalogue	206
Photographs loaned (exclusive of albums)	418
Volumes bound	800
Volumes accessioned	1,343
Cards added to general catalogue	16,420
Cards added to map catalogue	713
Letters and cards received	3,015
Letters and cards sent	5,655
New serials received and catalogued	248

Photographic Section

The major items of production included:

Kodalith negatives, up to 24" x 30"	884
Bromide enlargements, up to 24" x 30"	3,428
Vandyke prints	2,098
Contact prints, up to 11" x 14"	25,275
Dry-plate negatives	2,558
Colour transparencies	180
Photomicrographs	510
Exposures developed, field work	3,411
Lantern slides	382
Magnetometer film developed, field work	24,800 ft.
Magnetometer film printed	25,200 ft.

Reproduction Processes

MINES BRANCH

John Convey, Director

The continued expansion in the mineral industry coupled with defence requirements resulted in an increased demand on the research and investigational facilities of the Branch. In order to further the application of electric smelting to Canadian ores, a 250 KVA electric arc furnace was installed in the laboratories of the Mineral Dressing and Process Metallurgy Division. The program of investigation that was commenced has already furnished encouraging results.

The Branch continued its policy of providing laboratory facilities to a number of companies for conducting special investigations.

The research on ore grinding continued to provide information of considerable potential value to the mineral industry. Corrosion studies were carried out and numerous improvements in analytical procedure were developed. An electronic device for determining the temperatures at which the minerals in an orebody were deposited was studied with the object of providing additional scientific aid in the exploration and development of ore deposits.

Testing of uranium ores and the development of improved methods of concentration and recovery again received major attention.

Numerous technical problems affecting the coal industry were investigated. The study of rock pressures in coal mines was continued in cooperation with coal mining companies in eastern and western Canada. An engineer was appointed to handle the certification of electric equipment for use in coal mines. A coal-cleaning laboratory was established at Calgary.

In the field of physical metallurgy, research and development problems to meet defence needs and those of Atomic Energy of Canada, Limited covered a wide range of subjects and investigations. Testing procedures were studied in the development of inspection techniques for low-temperature brittleness of some structural steels.

Extensive investigations were carried out on foundry castings, the flow of metal in moulds, centrifugal castings, and problems in rolling uranium.

A number of economic studies were made on Canadian metals. As in past years, assistance was given to the Department of National Revenue in the administration of those sections of the Income Tax Act applying to mining, oil drilling, natural gas, and pipe lines.

Work on the industrial minerals included development of a flowsheet for the recovery of Canadian kyanite in marketable form; completion, except for Newfoundland, of the field survey of lightweight aggregate; and sand from quarry rock that would be suitable for use in construction of the St. Lawrence Seaway.

An enlarged special Section with staff and services continued to be provided at the Branch for work for the Royal Canadian Navy. The Section was engaged in producing new types of equipment and in repairing anti-submarine devices. It continued the processing of quartz for radio-frequency control units for the armed services and did further research on the use of piezo-electric ceramics. All quartz for Government use was inspected and graded by the Section.

A. Thunaes, who was chief of the Radioactivity Division since June 1, 1951, resigned on August 1, 1953 to accept the position of manager of the newly organized Research and Development Division of Eldorado Mining and Refining Limited. He was succeeded by E. A. Brown.

Accounts of the year's activities follow.

Mineral Dressing and Process Metallurgy Division

Mineral Dressing Investigations

Forty-seven reports were issued to companies which had submitted ore samples for investigation. The following table shows the nature of the samples and their regional origin.

Nature of Samples	N.W.T.	B.C.	Sask.	Ont.	Que.	N.B.	N.S.	Nfld.	Total
Copper-lead-zinc-tin		1							1
Silver-lead-zinc						1			1
Gold-silver-lead-zinc		2							2
Silver-copper-zinc		1							1
Copper-nickel			1	2					3
Gold-copper					1				1
Copper			2	1					3
Cobalt-copper				1					1
Iron	1		1	12	2				16
Lead-zinc-tungsten		1							1
Nickel					2				2
Silver		1							1
Tungsten		1						1	2
Manganese						1			1
Gold				5			1		6
Titanium					4				4
Zirconium				1					1
Total	1	7	4	22	9	2	1	1	47

Nearly all the base metal ores consisted of an intimate mixture of two or more minerals which had to be separated and concentrated to commercial grades with minimum losses. Some contained gold and silver, in which case provision for the economic recovery of these metals had to be made. One of the mining companies concerned is constructing a mill in New Brunswick, one plans to construct a mill in Quebec, and a mill in Ontario has been brought into operation.

The 16 samples of iron ores investigated were low grade. Methods for obtaining commercial grade concentrates at low cost and with good recoveries were worked out for nine of them. One contained considerable amounts of sulphur and copper, and by sintering the ore with small additions of calcium chloride it was shown that the sulphur and the copper can be reduced to acceptable percentages, and that the sulphur in the ore can be made to supply the necessary fuel. Two of the 6 gold ores were from new properties, and the rest from operating mines. In the latter, recommendations were made for increasing recoveries and reducing operating costs.

Eighteen companies used the facilities to carry out 21 investigations of their own. In all tests, assistance by the staff of the Division was given as requested. The amounts of ore treated varied from one ton to nearly 300 tons.

Samples of flotation agents manufactured by a Canadian chemical company were tested at the request of the company and were found to compare favourably with those now imported. Reports were issued to the distributors of crushing machinery on the performance of a gyratory crusher of new design, and to a pulp and paper company on the drying of one of its by-products.

Research

In further laboratory-scale research on ore grinding it was shown that by conserving within the grinding mill the heat generated by the grinding process the efficiency of the grinding operation can be increased. This is of considerable potential value to industry as grinding is often the most expensive operation in milling.

Research on the extraction of gold dealt chiefly with the possible application of the new pressure leaching techniques to the treatment of complex gold-bearing concentrates, and with the precipitation of gold from cyanide solutions. Pressure leaching of complex concentrates was shown in some cases to permit almost complete extraction of the gold, but the work also indicated that, in practice, the use of such a process would raise other problems, particularly with reference to the disposal of waste materials, that would be difficult to solve. However, the knowledge gained of some of the fundamentals of the precipitation process makes it possible to formulate some practical suggestions to operators where difficulties are being experienced.

Investigations were continued on a method for recovering elemental sulphur from pyrite and pyrrhotite by a procedure devised in the Division, with four major companies taking a direct interest in the process. It has been shown experimentally that elemental sulphur can be recovered in good yield from the nickeliferous pyrrhotites occurring in large quantities in the Sudbury area, and that the nickel can be separated simultaneously from the iron and sulphur. Thus the way appears to be open for the treatment of the pyrrhotite from these deposits for its sulphur and iron content, and also of the pyrite and pyrrhotite occurring in dumps or deposits in various parts of Canada.

Attention was again given to problems arising in the present treatment and utilization of ilmenite (iron-titanium) ore from the extensive deposits in Quebec, which comprise an important source of raw material for titanium pigment and a potential source of titanium metal. In work done at the request of industry the Division showed, on a pilot plant scale, that some of these ores can be desulphurized by flotation. This desulphurization is of importance where the ores are to be treated by smelting, as it makes possible the direct production of an iron of lower and more acceptable sulphur content. Studies were continued on the constitution and nature of the crystalline compounds in titania slags.

Work was continued on a larger scale on a process developed in the Division for producing a concentrate containing 94 per cent titanium dioxide by means of a pressurized sulphuric acid leach. Modifications that will make the process more attractive economically were introduced by reducing the pressures required and by improving the iron sulphate separation.

Some headway was made in research on the difficult problem of producing titanium metal of high purity at costs which would promote its much wider use as an industrial metal. Assistance was given to two Canadian companies that are studying methods of producing the metal.

In order to develop the application of electric smelting to Canadian ores, a 250 KVA electric arc furnace was installed in the laboratories. A program of investigation was commenced and already, in cooperation with industry,

two different commercially acceptable types of ferro-alloy have been produced on a semi-pilot plant scale. Use of the furnace has been made available to responsible Canadian industries with the object of encouraging them to establish facilities for processing their concentrates in Canada rather than shipping them abroad for treatment.

An investigation of methods of refining bismuth metal carried out at the request of a Canadian producer showed that the purity of the metal can be raised from about 95·0% to 99·98% by a combination of distillation and chlorination procedures. Metal of this purity commands a considerably higher price. During the experiments a convenient method for preparing bismuth trichloride in high purity was disclosed.

In another investigation the effect of including an indium compound in chromium plating baths was investigated at the request of a Canadian producer of indium interested in developing new uses and thus wider markets for the metal. The addition of indium improved a number of the more important properties of the chromium plate.

In the hope of recovering valuable materials from waste industrial by-products, programs were initiated to investigate the possibility of producing elementary arsenic from certain arsenic compounds produced during the treatment of arsenical ores and of producing useful phosphorus and iron compounds from ferrophosphorus, a by-product obtained in large amounts in the manufacture of phosphorus. The two projects were undertaken at the request of Canadian companies which desire to increase the efficiency of their processes.

A number of investigations on corrosion and its prevention in metals were undertaken for the Department of National Defence, Atomic Energy of Canada Limited, and for various Canadian industries. A wide variety of metallic and non-metallic coatings and other methods of preventing corrosion were investigated.

The Division has made much progress in its studies of the high temperature chemistry involved in the making of bone china, the object of which is to substitute scientific control for the Old World art which has traditionally been used in this field and so stimulate a domestic industry. The chief ingredient of this type of china is animal bone, of which Canada has an ample supply.

Some of the problems dealt with by the Division are of a highly specialized nature, involving the use of modern techniques such as X-ray diffraction and differential thermal analysis. These were applied, for example, in the identification of shales associated with the Quebec-Labrador iron ore deposits, and of carbonate minerals associated with Steep Rock iron ore deposits in Ontario. Positive identification of these shales and carbonate minerals is useful in working out the stratigraphy of the areas, which in turn is essential in the scientific search for orebodies. The same techniques were used in aiding a large Canadian iron ore producer to develop a process for beneficiating the ore, and in assisting a company in the manufacture of certain complex phosphorus compounds formed from Canadian-made phosphorus and used in making detergents. At the request of a British Columbia mining company, an attempt is being made to extend these techniques to aid in the search for sulphide orebodies underground.

Other scientific aids to the mining industry in the exploration and development of ore deposits were under investigation. One such device beginning to show promise is an electronic instrument for determining the temperatures at which the minerals in an orebody were deposited. This information can be of value in working out the geological history of a deposit, which knowledge in turn aids the operators in developing the mine and in the search for new

ore. It will be some time before the possibilities of this device can be fully assessed. Improvements in the instrument are planned to increase its sensitivity.

Developments in the metallurgical industries and the requirements of metallurgical research give rise to new problems in the accurate analysis of products, and the Division is continually devising new and improved methods for dealing with the wide range of samples involved. In spectrographic analysis, the semi-quantitative treatment of powder samples was advanced to the point where for some purposes, it is fully quantitative. Still further improvements are planned and an electronic device is being built by means of which the spectra of standard and unknown samples can be scanned simultaneously. This is expected to increase the speed and possibly the accuracy of the spectrographic method.

In all, 13,823 determinations on 1,492 samples were completed in the spectrographic laboratory during the fiscal year.

In the chemistry laboratory, 22,837 determinations were made on 5,878 samples. New developments were based chiefly on the use of modern electrical and optical methods. For example, polarographic procedures were devised for the determination of nickel as an impurity in cobalt metal, tin in steel, and lead, indium and cadmium in zinc base die-casting alloys. Photometric methods were developed for determining small quantities of tungsten in molybdenum ores. An entirely new method was worked out for the determination of manganese, which is applicable to manganese ores, ferromanganese ores, ferromanganese and steels. A new development was the determination of small amounts of sodium, potassium, lithium and calcium in titanium compounds by using flame photometers.

The Division was represented at the meetings of 24 scientific societies and technical committees. Nine technical papers by its officers were published during the fiscal year.

Radioactivity Division

The Division since its inception has been engaged in the development of methods for treatment of radioactive ores. At the same time, as a service to industry, it has carried out concentration and extraction investigations on specific ores. Up to 1953 the Crown-owned Eldorado Mining and Refining Limited, was the only producer of uranium in Canada. In its early work, the Division was called on to develop leaching and recovery processes low enough in cost to be specifically suitable for treating low grade Eldorado ore directly. Canadian uranium production has been increased through full scale installation of these processes by Eldorado. With the experience gained in developing these successful methods, the Division was ready to undertake similar work on other ores as required by industry in the fiscal year. It also worked with Eldorado in developing further a carbonate leach process on a larger pilot plant scale in preparation for full plant-scale operation.

With the extended service program carried out, staff and space shortage caused curtailment of primary research work. However, the Division continued to exchange technical information with similar groups working on radioactive ores in the United Kingdom, United States, South Africa and Australia, within the limits of security regulations. In addition, technical personnel from all the above groups have visited the Division to obtain first-hand information on the work under way. Similarly, representatives of the Division met a United States group to discuss further various aspects of the research into uranium ore treatment.

The Division continued to furnish services to and exchange information with the university research groups working on radioactive ore problems at the Universities of Alberta, British Columbia, Saskatchewan and at Queen's University, Kingston, Ontario.

Ninety-one classified and 23 unclassified reports were prepared by the Division during the fiscal year. Forty-one of these covered work carried out for private companies.

Ore Dressing and Extractive Metallurgy

The high level of interest in uranium mining by private industry and the development of some of the uranium properties to near production stage resulted in the need for considerable laboratory and pilot plant investigational work on uranium ores. The Division, with its experience on Eldorado ores, together with its present laboratory facilities and pilot plant equipment, was prepared to provide much assistance in this field. Two companies required extensive pilot plant programs and a number of others requested laboratory scale investigations on their ores.

The pilot leach plant programs in the Division's laboratory extended over 5 months in 1953 and are continuing into 1954. One series concerned an ore from a private company operating in the Lake Athabasca area. The investigations covered mineralogical examinations and preliminary physical and chemical concentration work. This was followed by pilot plant operations based on the results of the preliminary test work, including the acid leaching process developed in 1948-49 by the Division, and several methods of recovering the uranium from the leach liquors. With the results obtained from the pilot plant operations the company is designing its plant based on the process investigated. A full scale plant operation is scheduled to start in 1955.

The other pilot plant series dealt with an ore from a company operating in the Blind River area, Ontario. Here again the preliminary investigations were carried out to select a suitable process. A pilot acid leach plant, based on the preliminary test work, was then set up. Operations to determine the various factors in leaching and to select a suitable process for uranium recovery from solution are proceeding.

The atmospheric pressure alkaline carbonate leach process, which appears particularly suitable for treating the high acid-consuming low grade uranium ores of a type found in the Lake Athabasca region, was developed on a small pilot plant scale by the Division in 1952 and in 1953 Eldorado Mining and Refining Limited built a larger scale pilot plant to test the process further. In line with policy of closely integrated operations with Eldorado the Division shared in this project during its 5 months of operation by assisting in the design, supplying technical supervisory assistance, and by providing the analytical services. In the pilot plant scale the process was shown to be economically feasible, and after the close of the experimental plant full scale equipment was designed for an addition to the company's plant in the Beaverlodge area in northern Saskatchewan.

After the close of the pilot plant operations Eldorado transferred its technical personnel to the Radioactivity Division where they are continuing to evaluate factors in the atmospheric pressure leach process using the facilities of the Division and with guidance of its staff. Other work relating to Eldorado is being carried out by this group under similar arrangements.

In further assistance to Eldorado the Division carried out a number of investigations on ore dressing and chemical problems. In addition, staff members made field trips to the company's Port Radium and Beaverlodge plants to study operations and carry out experimental work.

With the restrictions placed by security regulations on dissemination of information on uranium leach processes, private companies found it expedient to take advantage of special arrangements which can be made to assign their own engineering personnel to work in the Division's laboratories, to study applicable leach processes and to assist in the laboratory and pilot plant investigations of their ores in cooperation with the Division.

In its services to private companies and individuals, the Division carried out 29 investigations on the treatment of radioactive ores from various properties. At the end of the fiscal year work had been completed on 25 of these. Twelve samples of ore and plant products were received from the Eldorado company for investigation during the fiscal year.

Analytical Chemistry

The extensive laboratory and pilot plant investigations carried out during the year, caused a proportionate increase in the analytical requirements. Over 12,000 samples were handled, requiring 25,000 assays, more than double the number in the previous year.

The Division continued to function to an increased extent as umpire in connection with samples from Eldorado's metallurgical plants. The company assisted by providing extra staff, who thus gain training in analyses of the type required for uranium plants. Similarly, private companies have been able to arrange for training of their key analytical laboratory personnel in the Division's laboratories.

A number of useful new methods were developed and current methods improved. Two new methods for uranium analyses were adopted. The first, the high-grade fluorimetric method, is almost entirely free from interference by other elements but is limited in its basic precision; the other, the ethyl acetate colorimetric method, may be occasionally subject to interference but has a higher inherent precision. The two methods complement each other and are both used in the umpire work.

An improved method for determining niobium and tantalum based on the spectrographic determination of the tantalum-niobium ratio was developed. An improved method for the solution of refractory samples was adopted, based on fusion with a sodium peroxide-carbon mixture. Methods of fluorine analyses were investigated and although a simple method was not found a colorimetric method for trace amounts was worked out.

A rapid polarographic method for the simultaneous determination of nickel, copper and cobalt appears promising.

A number of papers on these methods were published in technical journals.

Mineralogy

Detailed investigations were carried out on uranium ore samples submitted by private companies for the purpose of obtaining such mineralogical data as would indicate the particular type of treatment that would be most effective in concentrating the ore minerals.

To provide preliminary information of help in evaluating new showings, reconnaissance mineralogical examinations were made on 15 grab samples submitted by private individuals and companies.

Detailed mineralogical studies were made on 3 ore samples from the Eldorado operations in the Beaverlodge area and various products of the company's mill and refinery were investigated.

Physics and Electronics

Approximately 2,100 radiometric analyses were made during the fiscal year.

Considerable interest was taken by other organizations in the equilibrium counter method of radiometric analysis and there were many enquiries regarding it. The counter is being produced commercially as a complete unit. Personnel from outside organizations and private companies have trained in the Division in the use of radiometric methods.

The study of liquid and plastic phosphors for scintillation counters was continued, including work on the development of phosphors, and on the applications of these detectors. A bag assay unit which utilizes a liquid phosphor as a gamma detector was completed and put into use on checking incoming samples, giving preliminary assays of the unopened sacks of ore as received. Another application of the liquid scintillation counter is a unit for assaying waste rock from hand-sorting operations in an operating plant. The waste is assayed continuously on a moving conveyor belt. To give the unit a satisfactory operating time between readings it was necessary to develop a dekatron scale of 1,000 circuit to enable a large total count to be stored.

In uranium mining as in other types of mining it is sometimes difficult to see the outlines of the ore in place because of the similarity of host rocks and also the dissemination of the ore minerals, and it is necessary to rely on detailed sampling and assaying as the mining guide. To assist in overcoming this difficulty an underground directional probe counter was developed. A very compact unit was designed which requires only 2 flashlight batteries for a power supply and uses a directional geiger tube, all suitably waterproofed for underground service. Several units are under test at the Eldorado operation in the Beaverlodge area.

Experiments were carried out with radioactive tracers to determine the diffusion of activated silver at various temperatures, the inverse separation of zinc in magnesium anodes, and the distribution of zirconium in magnesium zirconium alloys. Radioactive tracers are being used in experiments to determine the viscosities of molten metals.

Industrial Minerals Division

To aid in the development and utilization of Canadian resources of industrial minerals, field work was done in 9 of the 10 provinces and laboratory research was undertaken on these minerals from all provinces. Field work included the examination and sampling of deposits of non-metallic minerals, rocks, clays, sands, gravels, and also the sampling of industrial waters. In the course of this work, industries using these materials were also visited in order to keep abreast of new developments in their utilization. Laboratory research was directed mainly toward the up-grading of industrial mineral products and toward finding new uses for minerals and mineral substances. The Division's work consists largely of the examination and evaluation of mineral samples submitted by industry and individuals in all parts of Canada. During the fiscal year 878 such samples were received and studied and opinions given as to their economic value. In addition to these small samples, and

exclusive of samples of industrial waters, 354 mineral samples, ranging in weight from a few pounds to several tons, were processed to obtain useful products therefrom. The regional distribution of these samples follows.

Samples	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Total
Anhydrite			2	1					1		4
Apatite					1						1
Asbestos	1				1					3	5
Barite			2			1					3
Bentonite							1	2			3
Corundum						1					1
Dolomite						4					4
Diatomite			1								1
Diopside					1		1				2
Feldspar			1								1
Fluorspar										1	1
Graphite					1	1	1				3
Gypsum			3								3
Kyanite						3				2	5
Limestone				3	1	5			3	2	14
Magnesia					3						3
Magnesite					5						5
Manganese				1							1
Mica			2		2	1					5
Nepheline syenite						7					7
Roofing granules						1				2	3
Silica		6		3	4	2		2			17
Sodium sulphate								4			4
Talc					3						3
Vermiculite					2	1					3
Witherite										1	1
Lightweight aggregate:											
(a) Clay and shale				4	6	5		2	23	28	68
(b) Perlite										8	8
Concrete aggregate					15	8					23
Sand and gravel					3	3					6
Carborundum residue					1						1
Ceramic clays, shales and products	3		13	33	24	28	1	2	24	17	145
Totals	4	6	24	45	73	71	4	12	51	64	354

The survey of the industrial water resources of Canada was continued and reports were issued dealing with the Columbia River and the rivers of Vancouver Island and of the coastal areas of British Columbia. Sampling of the waters of the Mackenzie River drainage basin and of the Canadian section of the Mississippi River basin was completed, and sampling was begun of the waters of the Churchill and Nelson River basins, which include the rivers of southern Manitoba. Suitable sites for sampling stations were chosen in the Maritime Provinces and in Newfoundland in preparation for the surveys of the waters of those provinces in 1954. The Division analysed 539 samples of water in its industrial waters laboratory.

A one-ton sample of what appears to be a very large deposit of intermixed fluorspar, witherite and barite discovered by prospectors during the year in northern British Columbia adjacent to the Alaska Highway near Lower Liard Crossing, was shipped to the Division where work was undertaken on the problem of making a satisfactory separation of the three minerals. In the

sample submitted these occur in the proportions of 50 per cent fluorspar, 35 per cent witherite, and 7 per cent barite, and the balance mostly quartz. Efforts are being directed toward finding specialized uses for the witherite. The discovery is the first major find of witherite on this continent. Witherite is the carbonate of barium, and because of its solubility in acids is a favoured raw material in making barium salts for various uses. It is also used in the case-hardening of steel and in the ceramics industry. Present supplies of witherite are imported. The fluorspar associated with the witherite is used in making aluminum fluoride for the aluminum industry; as a flux in the steel industry; in making heavy chemicals; and in the ceramic industry.

The investigation into the economic possibilities of Canadian kyanite deposits was continued in cooperation with the companies owning the deposits, who have carried out considerable exploration work, including diamond drilling. The Division has developed a satisfactory flowsheet for the recovery in marketable form of the kyanite and its associated muscovite and garnet from deposits in the vicinities of Mattawa and Sudbury in Ontario, and in the Big Bend of the Columbia River in British Columbia. Its work has shown the Canadian kyanite to be of high quality and apparently well suited for making mullite refractories, so vital to the metallurgical and glass industries. Development of the Canadian deposits would make Canada independent of present foreign sources and would provide a basis for new ceramic industries.

Successful research was undertaken into the production of white anhydrous sodium sulphate (salt cake) from the extensive deposits of natural sodium sulphate in Saskatchewan. The salt cake at present produced from these deposits is dark grey in colour and unsuited for use in synthetic detergents that would provide a new market for the Saskatchewan production. The cause of the dark colour was ascertained and then, by using continuous precipitation during thermal cycling, and by using a submerged combustion method to evaporate the water of crystallization, a very white anhydrous product was obtained in each case. The economics of these processes are being investigated by a prospective producer.

Research was continued into finding ways of using anhydrite from the huge deposits in Nova Scotia, New Brunswick, and Newfoundland. The only use being made of this anhydrite at present is for spreading on land used for raising peanuts, and this accounts for only a small tonnage. Large samples of anhydrate from different deposits were obtained through the cooperation of gypsum quarry operators. The results to date of efforts to convert the anhydrite into the more valuable gypsum have been encouraging, and progress was also made in developing cements from the anhydrite.

To obtain data on the feasibility of making pharmaceutical grades of magnesia in Canada, research was undertaken on various raw materials that appear to be suitable for the purpose. It was found that waste products resulting from the working of brucitic limestone deposits have excellent promise as raw materials from which to recover pure magnesia by reaction with carbon dioxide solution, particularly when the brucitic limestone was first calcined at a temperature of 1000°F.

A survey of the granite industry in Canada was completed and a report is now in press.

An investigation of the cause and prevention of efflorescence on masonry structures showed that the mortar in such structures is the chief source of efflorescence and that it can be reduced considerably by adding calcium chloride in the proportion of approximately 4 per cent of the cement used.

A bibliography of published and unpublished reports dealing with the treatment of industrial minerals from Canadian deposits was completed.

With the completion during the fiscal year of the field work on clays and shales in British Columbia, the preliminary survey of resources of materials suitable for making lightweight aggregates has been completed in most parts of Canada. This survey was limited to clays and shales that possess natural bloating properties, and for the most part, was restricted to areas adjacent to the larger centres of population. Publication of the results has aroused a great deal of interest among companies producing structural materials, and four new plants for the production of lightweight aggregates have been built or are under construction.

The research program into the making of sand from quarried rock was expanded greatly at the request of The Hydro-Electric Power Commission of Ontario and the federal Department of Transport in order to study the economics of producing manufactured sand for use in the concrete work of the St. Lawrence Seaway and Power project. Natural sand of good quality is not available in sufficient quantity within economic trucking distance of the places where it will be required. With the use of a centre peripheral discharge rod mill it has been demonstrated that a suitable sand can be produced at relatively low cost from several varieties of limestone found in the area where the sand is required.

In its work on the development of piezo-electric ceramics for use in ultrasonic equipment the Division found methods of making these materials in a variety of sizes and shapes. It supplied numerous specimens processed in accordance with these methods to the Navy Research Establishment for further research and evaluation.

In its extensive series of tests on all types of refractory products used in Canada the Division made tests on 58 brands of firebrick, mortars, plastics, castables, and insulating firebrick. The Royal Canadian Navy now stipulates that all refractories used in its installations must pass these tests.

An investigation was completed into the possibility of making a satisfactory acid-resisting brick, using ordinary brick-making shale as a major constituent. A brick that meets the required specifications was produced and its manufacture is being considered by a Canadian company. Other investigations are being made into: methods of improving the bonds of refractory cements; the possibilities of using Canadian fireclays together with imported materials in the making of super duty and high-alumina firebrick; and the development of super-refractories from Canadian kyanite.

Additions to the Division's laboratory facilities during the fiscal year included some highly specialized grinding and screening equipment; apparatus for measuring the thermal conductivity of various kinds of insulating products, including pipe covering; a Chevenard thermal balance for identifying and analysing minerals; equipment for making particle-size analyses of very fine powders; and submerged combustion equipment for the evaporating of liquids.

The Division issued 3 printed monographs, 1 multilithed memorandum series report, 7 technical papers, 79 reports on the results of laboratory investigations, 168 reports of laboratory tests, 8 special reports, and replied to about 1,700 enquiries for technical information on industrial minerals.

Fuels Division

The technical problems of the coal industry received chief attention in an attempt to help that industry maintain some of its markets in the face of competition from oil and natural gas. It has become increasingly difficult for coal dealers to maintain their former volume of sales, and coal production has decreased in consequence.

Deep Mining of Coal

The results being obtained in the cooperative study of rock pressures in coal mines in eastern and western Canada are being studied with interest by other mining companies who have to work at extreme depths. Part of the work in western Canada was interrupted by changes in the production program of some of the mining companies necessitated by adverse marketing conditions for coal. Additional and improved equipment was obtained and made available for this work. Laboratory studies on the physical properties of rock columns from McGillivray and International mines in Alberta were carried out. Studies were continued on the permeability of coals by methane, on the capacity of bituminous coals to absorb gas, and on the effect of these characteristics on the outbursts hazard.

Electric Equipment Certification

An electrical engineer with experience in construction and maintenance was appointed for assignment to the certification of electric equipment for use in coal mines and other hazardous places. Following an extensive course of training he made visits of inspection and consultation to electric manufacturers works, to mechanized coal mines, and to government laboratories and institutions where such equipment is tested. The visits covered organizations in Canada, United States, Great Britain, France, Belgium, Germany and Holland.

Testing Mine Airs

The Division cooperated with the provincial mining inspectors in the periodic testing of mine airs to ensure adequate ventilation of the works. Sixty-six samples were received from Alberta and British Columbia, and were analysed and reported upon.

Coal Preparation

Progress was made in equipping a coal-clearing laboratory in Calgary established to aid coal operators in western Canada in solving their coal preparation problems. Experimental work in the laboratory combining centrifugal and vibrating forces in specially designed equipment gave results which indicate the potentialities of cleaning coal fines by the use of such equipment.

Briquetting

An improved method of adding asphalt binder, resulting in stronger briquettes for railway use without increasing the proportion of binder was developed in the Calgary laboratory and tested commercially.

In the Division's laboratories in Ottawa an extensive investigation concerning the production of railway briquettes from certain bituminous coals from western Canada having widely varying moisture contents was completed. As a result a plant has been established in British Columbia for the production of about 180,000 tons of briquettes a year, using the method developed.

A study was initiated on the utilization of Canadian coal fines for the preparation of small stoker-sized briquettes with a view to improving the overall economy of the mine products and extending the markets for fines.

Experiments were carried out on the briquetting of other materials, such as: dolomite-type fines to produce a better refractory brick for furnace linings; mixtures of calcined bauxite, iron borings and petroleum coke for the utilization of bauxite fines in making artificial corundum; mixtures of ilmenite and anthracite to produce a suitable material for reduction in electrical furnaces; and mixtures of silver-cobalt ores in order to utilize materials which, because of their fineness, were not suitable for processing in the regular way.

Coking Tests

Carbonization tests were continued on blends of Nova Scotia coal of varying volatile content and coking properties. The favourable results obtained in the laboratory tests encouraged trials on a commercial scale at Montreal, the results of which are not yet available.

Combustion Engineering

An investigation was undertaken to evaluate the important factors affecting the suitability of Canadian fuels in automatic domestic heating equipment. The first series of tests completed employed a cross-feed worm ash-removal anthracite type conversion stoker which indicated the suitability of certain western Canadian high ash fusion, low volatile coals bordering semi-anthracite rank.

Burning tests of Canadian coals were continued, using a 24-inch cyclone combustor. The combustion system was modified to incorporate an adequate heat exchanger. In addition to preliminary tests, 27 Canadian coals were burned, the results of which will be of importance in connection with the coal-fired gas turbine project, mentioned below.

In connection with a power investigation sponsored by the Dominion Coal Board, a study was commenced to evaluate the Canadian power industry and to determine the need for steam-generated power using Canadian fuels. The major power utilities in the Maritime Provinces were the first to be visited and a preliminary report was prepared.

Coal-Fired Gas Turbine Project

Erection of the 500 h.p. prototype engine was completed at Ste. Anne de Bellevue, Quebec. Engine test operations on eastern Canadian coal and on light oil were commenced. A major modification is being made by adding a dust separator which will remove fly ash from exhaust gases. Advantage is being taken of the engine operation to test a number of high temperature alloys in the hot cyclone combustor gases to estimate their ability to withstand erosive and corrosive effects at extreme temperatures.

Cyclone Smelting

A small test unit was set up to experiment with the smelting of iron ore in a furnace of the cyclone combustor type. It was found possible to produce pig-iron from iron ore, using coal as fuel. Small quantities of mild steel and powdered iron were also produced. The test unit was too small to obtain data on the economics of the process and it is proposed to continue the investigation with a larger unit.

Reconversion of Hydrogenation Plant

Little headway was made on the conversion of the high pressure hydrogenation plant, due largely to the difficulty of obtaining the special apparatus and equipment required. However, it is possible that part of the equipment will be put into operation next fiscal year. Meantime, contact is being maintained with the work of the United States Bureau of Mines and a careful survey was made of the Bureau's plant at Louisiana, Missouri, before it was closed. The survey supplied information on operation and on the interpretation of results.

Analysis Directory of Canadian Coals

A completely revised edition of the analysis directory of Canadian coals was published.

Physical and Chemical Survey of Canadian Coals

This work was continued as part of the study of the basic properties and characteristics of Canadian coals. Samples were examined from the mines listed below and comprehensive reports were issued as soon as possible after completion of the analytical work.

Name of Company	Mine	Seam	Location of Mine
Dominion Coal Company	No. 18	Harbour	New Waterford, N.S.
Four Star Collieries	Four Star	Tracey	Broughton, N.S.
Margaree Steamship Co.		34-inch	Inverness, N.S.
Margaree Steamship Co.	Harbour View	6-foot	Port Hood, N.S.
Acadia Coal Co.	McBean		Thorburn, N.S
Bras d'Or Coal Co.	Franklin	Franklin	Little Bras d'Or, N.S.
Indian Cove Coal Co.	Greener	Greener No. 3	Sydney, N.S.
Indian Cove Coal Co.	Tomson	Greener No. 3	Sydney, N.S.
Canmore Mines Ltd.	New Mine	Cairnes	Canmore, Alta.
Canmore Mines Ltd.	New Mine	No. 4	Canmore, Alta.
Canmore Mines Ltd.	New Mine	Upper Marsh	Canmore, Alta.

Athabasca Bituminous Sands, Alberta

Work on this project was limited mainly to fundamental laboratory-scale research on hydrogenation at a pressure of 1,000 pounds per square inch. In this connection it should be noted that the specialized techniques required to solve the problems relating to the economic development of the bitumen can only be developed through the medium of a small scale pilot plant of a design permitting the study of every phase of the refining problem, from the raw bitumen to the finished product. The aforementioned research indicated that:

the resultant crude is essentially naphthenic in character;
the sulphur content of coker distillate can be reduced to about 0·5 per cent, yielding a distillate which would make a satisfactory fuel oil with a high heating value per pound;
the diesel fuel oil fraction has a cetane number lower than the average fuel in common use, presumably due to the presence of unsaturated components;
the rate of coke formation on the catalyst was comparatively rapid at 1,000 lb. pressure, indicating that higher pressures may be desirable.

Chemical Constitution of Bitumen

Fundamental research was carried out on fractions of Alberta bitumen in an effort to develop a suitable technique for measuring the molecular weight of asphaltenes and on the chemical reactions of some of the sulphur compounds. The work will place the chemistry of the asphalts upon a much firmer footing and should be of considerable interest to many industries using this type of material.

An extensive survey was made of the infrared spectrum of approximately 1,000 compounds in an effort to classify the infrared spectra of the bitumen fractions. It was found that a striking resemblance exists between the terpenes and some bituminous fractions, which information may cast important light on the origin of the bitumen as compared to that of other crude oils.

The infrared spectrometer was used a great deal and it is believed this instrument will greatly simplify the classification of very small samples of oil, of bituminous material and of coal.

Committee and Conference Work

The Division continued cooperation 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 Committee on Atmospheric Pollution in Canada; the Canadian Government Specifications Board; the Interdepartmental Fuel Committee; the Thermal Committee of the Canadian Electrical Association; the International Conference on Briquetting; and the Research and Mining Methods Committee of the Coal Division, Canadian Institute of Mining and Metallurgy.

Physical Metallurgy Division

The researches, developments, and investigations recorded below comprised the more important activities during the fiscal year.

Low temperature brittleness of some structural steels in applications such as shell plate for anti-submarine escort vessels, dock piling, and bridge girders, poses serious problems of inspection and design which the Division was asked to investigate. Testing procedures were studied and a method developed by which steels susceptible to embrittlement can be detected prior to fabrication. At the same time, the type of grain structure which resists low temperature embrittlement was identified. Features of design which minimize the danger of damage from embrittlement were noted. Recommendations based on the results of the investigation have facilitated construction and increased the life expectancy of such structures as those mentioned.

Non-destructive testing methods received special attention. Such work is of great importance, since the difficulty of ensuring freedom from internal flaws in machine parts without destroying the parts has always been one of the most troublesome problems of inspection. Magnetic, electrical, and ultrasonic techniques have been developed and successfully applied to the separation of satisfactory from unsatisfactory material in such examples as 40mm. shells, tracer-igniters, and steam turbine rotor forgings.

Mechanical tests were carried out on a considerable number of hand tools for the Department of National Defence. These provided data which can be used to establish the relative merits of different lots for the purchase of large quantities on tender. These data also provided essential criteria for the preparation of a much-needed Canadian specification for such tools.

The highly creep-resistant nickel-aluminum-molybdenum alloy, "Kinsalloy" developed in the Division for gas turbine engine parts, has been used very successfully as dieblock material in the forging of gas turbine rotor blades. This is a very severe forging service and Kinsalloy has outlasted other dieblock materials by a factor of five.

A number of prototype castings were made for light alloy components of armour-piercing shot and for parts for newly designed guided missiles. A prototype forged aluminum alloy base-plate for a lightweight mortar was accepted by the Army after extensive field trials. Prototype castings are being prepared for a transportation sled newly designed for defence use in the Arctic. Dies for prototype arctic gas mask have been produced, as have magnesium alloy axe handles to replace wooden handles which dry out and become loose under arctic conditions of humidity and temperature.

To ensure that castings for R.C.A.F. aircraft meet the necessary high quality requirements a system of radiographic control has been developed and is in operation. It involves two main features, namely, the development of radiographic procedures for critical castings and the inspection of industrial

X-ray laboratories. When such laboratories are found to be adequately equipped and the operating staff properly trained, the Division certifies the laboratories as being competent to conduct radiographic inspection of castings for the R.C.A.F.

The Division continued to assist the Royal Canadian Navy in controlling the quality of welding on the steam lines of naval vessels. The governing specification was improved and kept up to date by continued study and research on the welding problems involved. Shipyard welding procedures were examined to ensure compliance with the requirements of the specification.

Rapid corrosion of chemical reaction vessels in a mineral processing mill had severely curtailed production. A program of salvage by welding was devised for 6 of the 18 vessels and the repair operation was supervised. Subsequent production experience showed that the corrosion resisting metal applied would not be satisfactory in these unusual service conditions. A plastic material is being applied as a temporary measure while a more suitable metal is being selected on the basis of service corrosion tests.

Inadequate ductility in plain carbon, low alloy and austenitic manganese cast steels presents a constantly recurring problem to steel foundrymen. During 1953 the Division investigated 11 such cases for Canadian industry and its recommendations enabled the producer to meet the specified ductility requirements.

Increasingly exacting demands on the service performance of steel castings has indicated the need for improved impact resistance when tested at sub-zero temperatures. As a result of investigations it has been established that controlled additions of a rare earth mixture containing lanthanum and cerium as the principal ingredients substantially increase the impact strength at room temperature and at −40° F.

In the constant endeavour to develop more efficient aircraft, the R.C.A.F. and Canadian industry have recognized that a plant for the production of medium and high tensile steel castings was urgently required. Such castings can eliminate the use of multiple forgings or wrought products and can result in simplification of design, weight saving, and lower fabrication costs. The extremely high calibre of casting required makes a rigorous and lengthy testing process mandatory before a foundry can be approved as a supplier. One Canadian foundry, with the technical assistance of the Mines Branch, has successfully passed all requirements and is now the one facility of this kind on this continent.

An extensive program of investigation was inaugurated in the Division's foundry to determine the maximum yield that can be obtained from nodular iron castings without sacrificing soundness. The first part of the program was completed and the findings indicate that sound castings can be produced by the use of much smaller risers than those commonly employed, the net result being a substantial saving in metal and a greater yield of sound castings per ton of metal produced.

To obtain a better understanding of the flow of molten metal into moulds a project was undertaken to study the effects of temperature and alloy composition on some physical properties of molten alloys that affect their fluid performance during casting. The first phase of this work—including construction of special laboratory equipment and determinations of liquid density, viscosity and metal fluidity of high purity, binary lead-tin and antimony-cadmium alloys—was completed and the results are being made available to those concerned.

Considerable time was spent in studying fundamental problems of the centrifugal casting process being used increasingly in industry. Works scale tests showed that the effect of turbulence in the mould was obscuring other phenomena, and more precise laboratory studies were necessary. These showed several effects that had not been noted previously and tentative explanations for them were deduced. This work was carried out in cooperation with the American Foundrymen's Society and results of the first phase of the project were submitted to the Society for publication.

At the request of Atomic Energy of Canada Limited the orientation textures produced in uranium during rolling and recrystallization were investigated. Textures were found to change with different rolling temperatures and recrystallization heat treatments and the behavior at various temperatures was determined. A theory of the deformation process based on single crystal slip mechanisms was evolved which agrees with the experimental evidence. It has been possible to predict directional physical properties from observation of orientation textures and a program was initiated to develop a general theory for predicting properties of all oriented materials.

Quantitative methods were established by means of which the interdiffusion of two dissimilar alloys at high temperatures can be studied; and the extent of segregation in alloys can be determined. One method is an autoradiographic procedure for use with radioactive tracers; the other involves a spectrographic technique for the rapid analysis of highly localized areas. The spectrographic method has the advantage that data concerning the simultaneous diffusion of several elements may be obtained. This procedure was applied to the study of segregation in forged aluminum alloys submitted by a manufacturer of compressor rotor blades for jet engines.

Laboratory tests on a new method of cold working the surface of mining drill rods, drill rod attachments, and oil drill pipes devised in the Division indicate that the use of this treatment confers marked improvement of endurance properties to the treated parts. Field trials are being arranged.

The Division has perfected delicate techniques essential for the examination of metals at extremely high magnifications, using the electron microscope. It is now possible to study microstructures at magnifications up to 50,000 diameters. This instrument and mastery of the techniques involved in its efficient utilization have become essential tools in modern physical metallurgy.

With such tools as the electron microscope and radioactive tracers available new horizons of research in connection with the structural and phase changes that occur in ferrous alloys during forming and heat treatments have been established. With the use of such new facilities, the Division has extended the study of carbon precipitation in iron and steel into a new order of dimension. The first stage of this program, an investigation of changes occurring during tempering of carbon steel, is nearing completion. The main facts have been ascertained and it has been found that previously accepted theory is only partly consistent with the new evidence. This evidence sheds new light on the problems of temper brittleness.

The Division issued 8 research reports, 33 reports of investigations, 274 test reports; and answered 79 Technical Information Service enquiries.

Officers of the Division presented 29 lectures before metallurgical societies. A number of their articles and discussions were published in the technical press.

Mineral Resources Division

The marked advance of the Canadian mineral industry over the past few years has intensified the interest in Canada and abroad in the development of the country's mineral resources. The services of the Division, whose functions are primarily of an economic nature pertaining to the development, utilization, and conservation of Canada's metallic mineral resources, were made available to other government departments, and to industry and individuals. Many enquiries were received from the United States and other countries requesting information relating to the conditions of exploration and to conducting mining operations in Canada.

In all, more than 3,400 enquiries were received, the replies in many cases entailing the preparation of lengthy reports.

Numerous additions were made to the Division's mineral occurrences. The condensed information on mining properties and deposits in the index was utilized extensively by representatives of the mining industry.

At the request of the Inter-departmental Committee on Supplies of Selected Materials brief reviews and extensive statistical data were prepared on 37 mineral commodities for use of the Committee on Interior and Insular Affairs, United States Senate.

A comprehensive report on cobalt, one of the essential metals in the development of alloys for jet aircraft engines was prepared for publication.

In cooperation with other Divisions of the Branch and with the Geological Survey of Canada, reviews for 1952 were issued on each of the metals and minerals produced or used extensively in Canada in that year.

Field work included visits to base metal operations in Nova Scotia, New Brunswick, Quebec and British Columbia; to the nickel mines in the Sudbury area, Ontario; to oil and natural gas developments in Alberta; to iron ore mines and developments in Newfoundland, Quebec-Labrador, and Ontario; and to titanium developments in Quebec.

Two engineers assisted the Director General of Scientific Services in the administration of the Emergency Gold Mining Assistance Act. One was responsible, in cooperation with the Cost Inspection and Audit Division of the Office of the Comptroller of the Treasury, for processing applications under the Act, and the other carried out the 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. Twenty-three 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 based on 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. In addition four companies submitted applications for accelerated depreciation as provided for by legislation respecting oil or natural gas pipe lines.

The chief of the Division attended the United Nations Committee on Iron Ore Resources of the World at New York, June 13 to 20; the International Tin Conference at Geneva, Switzerland, November 6 to December 9; and on January 1, 1954 was granted six months leave of absence to act as mining adviser to the International Bank of Reconstruction and Developments' Economic Survey Mission to the Federation of Malaya.

During the fiscal year 66,856 copies of publications were distributed by the distribution office of the Division.

Library

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

The following acquisitions were recorded.

Publications received:	
Canadian Government	1,934
British, United States, and Foreign governments	2,621
Scientific societies	1,456
Periodicals	5,820
Books and pamphlets by purchase	650
	12,481
Recorded loans of books, pamphlets and periodicals, including inter-library loans of 976	23,941
Volumes bound	372
Volumes accessioned	1,057
Periodicals and annuals subscribed for	409
Cards added to general catalogue	3,143
Reference cards prepared and filed in Research section	12,544

Library

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

The following acquisitions were recorded.

Publications received:	
Canadian Government	1,324
British, United States, and Foreign governments	2,851
Scientific societies	1,256
Periodicals	5,820
Books and pamphlets by purchase	650
	12,481
Recorded loans of books, pamphlets and periodicals, including inter-library loans of 376	23,941
Volumes bound	372
Volumes accessioned	1,057
Periodicals and annuals subscribed for	149
Cards added to general catalogue	3,145
Reference cards prepared and filed in Research section	12,344

DOMINION OBSERVATORIES

C. S. Beals, Dominion Astronomer

The Observatories continued to provide a time service for Canada and to distribute by radio and other methods accurate time based on daily astronomical observations. Studies were made of the radiation from the sun and its effect on earthly conditions, and the chemical constitution and density of the high upper atmosphere were investigated by the methods of meteoric astronomy. The Astrophysical Observatory at Victoria continued its studies of the motions and physical characteristics of the stars, on the structure of the galaxy, and on the sources of stellar energy and the nature of interstellar material.

An important part of the geophysical work was concerned with magnetic mapping for navigation and other purposes, some of the work being done by airborne methods. Earthquake hazards on the west coast and in the St. Lawrence valley were studied and calculations were made of the depth and directions of the motions responsible for earthquakes. The variations in density of the earth's crust over large areas of the Canadian Shield were investigated by gravity methods.

The Dominion Observatory, Ottawa

POSITIONAL ASTRONOMY

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

Star Positions.—A program of observations of 1,200 stars used for precise time and variation of latitude determinations was completed with the Ottawa meridian circle on December 31. A new program of observation on 3,000 stars began January 1954. The stars are chosen from recommendations made by the Astrometric Committee of the International Astronomical Union.

During the fiscal year 124 nights were devoted to this work and 5,800 star observations were made. The computations of these stars are well up-to-date and are prepared for completion at the Computing Centre at the University of Toronto.

Purchase of a new mirror instrument to replace the Meridian Circle has been under consideration and requests have been sent to firms in England and the United States for suggestions and estimates of cost.

A catalogue of 1,589 stars resulting from observations with the Meridian Circle, taken 1935 to 1950, was completed and is ready for printing. This brings up to date publication of the arrears of several decades of observations and will make possible the prompt publication of current results.

Determination of Time and Latitude Variation—Time and latitude determinations, by observing 3,606 stars, were made with the photographic zenith telescope on 176 nights. Star positions for 150 stars were revised from the zenith telescope results and preliminary values of the meridian circle observations. As a consequence of the revisions future observations of time and

latitude should be smoother from star to star and from night to night. The probable error for a single star observation is $\pm^{s}.020$ for a clock correction and $\pm 0''.20$ for a latitude value.

A new measuring engine for scaling the photographs of time stars, designed by the Division and constructed in its machine shop was put into service. This instrument is a new type in which enlarged star images and the two micrometer readings are projected onto a ground glass screen on which are ruled suitable index marks. This dispenses with the use of a microscope with a great reduction in eye strain and fatigue for the measurer.

The computations for time are normally carried out on the morning following the night's observation and provide data for correcting the clocks. This work has been greatly speeded up by having the apparent places for the stars computed in advance for each day by the Computing Centre of the University of Toronto. A report on latitude variation results for 1952 and 1953 is being prepared.

During the fiscal year the Division devoted considerable time to developing methods of comparing the rates of crystal clocks, a process on which much of the accuracy of the time service depends. Comparisons with foreign time signals were made daily and a careful watch was kept on the accuracy of the broadcast time signals.

Distribution of Time—For the most part distribution of time is accomplished by means of radio time signals. For the more populated regions, time is made available for reception on ordinary radio sets by the daily CBC broadcast at one o'clock eastern standard time. (EDT in summer). For surveyors, aerial navigators, ships at sea and persons stationed in remote or isolated areas of the country, short wave radio broadcasts of time signals are maintained on a 24-hour basis, the broadcast frequencies being 3,330, 7,335 and 14,670 kilocycles. A new transmitter put into operation recently radiates the 7,335 frequency at a power of 3,000 watts. A speaking clock has been ordered which will broadcast the time by a voice announcement once each minute throughout the 24 hours. The two main railway and telegraph companies and Bell Telephone Company also receive signals by wire for transmission over their own networks.

Synchronized time impulses from the Observatory control master clocks in a number of the main government buildings. The general tendency, however, is for new buildings or new clock systems to operate by synchronous motor control which is related to the Observatory time service by indirect methods.

STELLAR PHYSICS

Studies of Meteors—The physics of meteors and the relation of meteors to the earth's upper atmosphere were investigated observationally at the pair of meteor observatories at Meanook and Newbrook, about 80 miles north of Edmonton; and in the Ottawa neighbourhood. Photographic and visual observations are carried out at both locations, and radio meteor investigations are conducted at Ottawa in cooperation with the National Research Council.

Much construction work was done at the Meanook and Newbrook meteor observatories to make them more efficient in the observational program. The two Super-Schmidt meteor cameras, instruments of large field and exceptional light-gathering power, were placed in routine operation during the dark-of-the-moon periods. These cameras are mounted to photograph meteors simultaneously from either end of a base line 26 miles long, the distance between the two observatories.

Altogether, 1,321 exposures were made with the meteor cameras at the Alberta and Ottawa stations and 1,812 meteors were recorded visually. Five new meteor spectra were photographed, one being taken with fast infrared

film. This is the first time the light of meteors has been photographed successfully in the infrared. From this observational result the atmospheric lines of the oxygen and nitrogen atoms have been identified in the infrared light of meteors. From a study of other spectra taken with panchromatic emulsions there seems to be evidence of the presence of the bands of the nitrogen molecule in the light of fast meteors.

In cooperation with the National Research Council a special study was made of all meteor heights determined by radio methods at Ottawa since 1948.

The numbers of visual meteors observed per hour and their size distribution are being studied statistically, making use of the records of over 15,500 visual observations made at the Dominion Observatory in the period 1947 to 1953.

A study was commenced of upper atmosphere winds, using the published records of long-enduring visual meteor trains. Preliminary results show the existence of winds in the high upper atmosphere of turbulent character of the order of thirty metres per second.

With the assistance of the daily press and local radio stations over 100 eye-witness accounts of the brilliant fireball of January 13, 1954, were collected. This object disappeared north of Parry Sound and was observed over a wide area. Loud detonations were heard near the end point but positive evidence of the fall of meteorites was not obtained.

A catalogue of all Canadian meteorite falls was completed and published.

In connection with a general study of the nature and formation of explosion craters, material was collected concerning the physical form of existing meteor craters on the earth's surface. At the request of the Dominion Observatory the R.C.A.F. carried out an air photo survey of the Ungava crater. An analysis of the profiles indicates that the crater is similar in general characteristics to other explosion craters. This strengthens the hypothesis of its meteoric origin.

Solar Physics—Numerous infrared solar spectra of high resolution were obtained with the solar spectrograph, using lead sulphide and lead telluride detectors, in a program of identification of molecules in the atmosphere of the sun.

An investigation was made of the accuracy of wavelength calibration in the infrared by an examination of the internal consistency of absorption bands produced in the laboratory. It is proposed eventually to use these methods for the measurement of lines in the spectrum of the sun.

Plans were made and equipment constructed for observing the total eclipse of the sun of June 30, 1954, from Smoky Falls, Ontario. A 10-inch coelostat was purchased to be used in conjunction with the large grating spectrograph which has been modified for eclipse purposes. Two small interferometric spectrographs are under construction and a medium quartz spectrograph has been fitted with automatic film-change mechanism. The latter will be used as airborne equipment.

Theoretical Astrophysics—The dynamics of the formation of a crater as a result of a large meteorite striking the ground was studied from several aspects. The problem narrowed down to consideration of the behaviour of materials at high impact velocities and to non-linear wave propagation. Research in both phases is continuing.

TERRESTRIAL MAGNETISM

Magnetic Surveys—The magnetic survey of Canada was continued by parties operating on the ground and in the air. Ground parties engaged in re-occupying previously established magnetic stations to determine the rate of change in the various components of the earth's magnetic field and in

establishing stations in areas not hitherto covered by the survey, operated in New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, and Northwest Territories. Observations of magnetic declination, inclination, and intensity were made at 20 repeat and 37 new stations. An average of 40 complete sets of observations extending over a two-day period was made at each station. Two ground parties measuring vertical intensity only were in the field. One surveyed the suspected meteor crater near Brent, Ontario and occupied two base and 123 field stations. The other commenced an intensive survey of the municipal district of Athabasca, Alberta, radiating from Meanook magnetic observatory and occupied one base and 248 field stations. This latter survey will be continued to obtain a precise knowledge of the magnetic field within a 50-mile radius of Meanook observatory for various purposes, one being to provide information necessary to the standardization of airborne magnetic instruments while in flight.

The Dominion Observatory's universal airborne magnetometer was used for the first time on magnetic survey operations, and continuous records of declination and of horizontal and vertical intensity were made on flights totalling 15,000 miles over all provinces, and Yukon, Northwest Territories, part of Alaska and the French islands of St. Pierre and Miquelon off Newfoundland.

Magnetic Maps—Isomagnetic maps of Canada for the epoch of January 1, 1955, depicting lines of equal magnetic values and annual changes were completed for inclination and horizontal intensity. All data for the maps depicting vertical intensity, total intensity, and the north and east components of the magnetic field were made ready for final draughting and work on the remaining declination map was well advanced. Discussions with officers of the United States Coast and Geodetic Survey were held in Ottawa and agreement was reached relative to the configuration of the isomagnetic lines in boundary areas. The result of this agreement will mean continuity of all lines on United States and world charts with those of Canada in border areas.

Magnetic data required for new and revised topographical map sheets and marine and air navigation charts were supplied for 1,670 items, an increase of 78 per cent over 1952-53. The items comprised 746 for the Surveys and Mapping Branch, 47 for the Geological Survey of Canada, 686 for the Department of National Defence, and 191 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 carried on by a member of the staff on educational leave in Cambridge University, England.

Magnetic Laboratory—The chief project was the completion and testing of the universal airborne magnetometer designed and developed by the Dominion Observatory. Test flights were made between August 30 and September 17, inclusive. The magnetometer was installed in the National Research Council's de-icing research North Star aircraft and flown by the Experimental and Proving Establishment, R.C.A.F. The aircraft was swung over Agincourt and Meanook magnetic observatories to determine the coefficients representing the induced and permanent fields of the aircraft. A swing consisted of eight flights over the magnetic observatory on different headings at a height of 2,500 feet. From the coefficients thus determined, correction curves were computed and used to correct the measured values of the direction and intensity of the earth's field in all parts of Canada. Following test flights, regular survey flights were made at an average height of 8,000 feet. During the 77 hours and 15 minutes of flying the magnetometer was in satisfactory operation for 96 per cent of the time, a highly satisfactory performance considering the complex nature of the instrument. The stabilized platform supporting the magnetometer head was steady to three minutes of arc under good flying conditions which was about 75 per cent of the flying time.

Following the flights the mechanism of the stabilized platform was modified to facilitate the exchange of gyroscopes, and changes were made in the magnetometer circuits to allow operation in all parts of the world. A detailed report on the development and construction of the magnetometer is nearing completion.

A revised model of a three-axes recording variometer was constructed and placed in operation at the laboratory for continuous recordings of the changes in direction and intensity of the earth's magnetic field. Construction of two similar variometers for use at the two Arctic observatories was in progress.

A new electrical absolute magnetometer whereby values of declination, inclination, total intensity and the horizontal and vertical components of the magnetic field may be measured independently was completed for use at Meanook magnetic observatory.

Magnetic Observatories—The magnetic observatories at Agincourt, Ontario, Meanook, Alberta, Baker Lake, N.W.T., 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. The congestion of unpublished magnetic observatory results was somewhat relieved by making the results of ten years available for publication. Photostats of observatory magnetic records were made available to all major commercial geophysical prospecting agencies operating in Canada. Magnetic results from the Canadian magnetic observatories were made available to the University of Toronto for analyses requested on contract by the Air Force Research Center, Cambridge, Massachusetts.

The instrumentation at the magnetic observatories was improved by the installation at Meanook of a newly constructed universal electric absolute magnetometer and at Baker Lake and Resolute of less comprehensive electrical magnetometers. Also, a complete set of Ruska photographic recording variometers was installed at Resolute Bay and a similar set was purchased for installation at Agincourt to replace obsolete equipment. Three horizontal intensity magnetometers were purchased from the Danish Meteorological Institute to be used mainly as travelling standards for inter-comparison of absolute magnetometers employed at the magnetic observatories.

GRAVITY

The chief function of this Division is to make precise measurements of gravity over the land mass and coastal waters of Canada. Such regional measurements at intervals of 5 to 20 miles find direct application in an international program of determining an accurate shape of the earth, which in turn is fundamental to the adjustment of precise geodetic surveys and in the construction of accurate maps. Gravity data are used also in structural studies of the earth's crust and are of value to commercial geophysical companies who use the data for reference and for control of their more detailed gravity surveys in the search for petroleum and other minerals.

Pendulum Work—During the fiscal year, apparatus on loan from Cambridge University was used to establish ten pendulum stations between Lethbridge, Alberta and Fairbanks, Alaska. These measurements complete the program initiated in 1952 to establish a line of precise pendulum stations over a wide latitude range in North America from Mexico to Alaska for the purpose of providing an accurate base line to calibrate gravimeters and to ensure homogeneity within the national gravity networks of the continent. These objectives have been accomplished; the total change in gravity measured between Mexico City and Fairbanks is 4,300 milligals and the uncertainty of each determination is less than half a milligal.

The Cambridge pendulum apparatus was used also to strengthen the connection between the North American and European gravity networks. The results of careful measurements made in turn at Teddington, England, Washington, D.C., and Ottawa suggest that 980·622 cm. per sec.^{2}, previously adopted as the value of gravity for the Ottawa base station should be decreased by about three milligals.

In another pendulum project the reconstruction of the Mendenhall apparatus, which has been in use by the Observatory since 1902, was undertaken. The object is to improve the performance of the instrument by eliminating undesirable effects of sway and temperature and by incorporating up to date methods of timing the swing. It is hoped to have the instrument ready for field tests shortly.

Regional Gravimeter Work—The objectives of the 1953 field work were to further extend the network of well-connected gravimeter bases in Canada and to complete connections between the principal bases of previous surveys.

Three field parties were engaged in this work. One party, using aircraft transportation, continued the program of making regional measurements throughout the Canadian Shield. It observed 115 stations in the area west of Hudson Bay, between the northern boundary of Manitoba and Chesterfield Inlet and 25 base stations were interconnected and tied to previously established network of northern Canada. Another party, using automobile transportation, established a series of well-connected bases and made detailed traverses between Lethbridge, Alberta and Fairbanks, Alaska. It made magnetometer observations and collected numerous rock samples for density determinations. The third party obtained a similar set of measurements along the Trans-Canada Highway between Cochrane, Ontario and Winnipeg, Manitoba.

These results provide an important link between the networks of eastern and western Canada, which had been lacking.

Other Gravimeter Surveys—At the request of and in cooperation with the Nova Scotia Department of Mines the Division carried out a gravity investigation of that section of the Cumberland basin between Springhill and Malagash, Nova Scotia. The purpose of the survey was to delineate underground structure which might facilitate the direction of drilling operations in the attempt to locate salt. The results were of definite value in delimiting the extensions to the known salt deposit at Malagash, and indicate two areas, lying to the east, structurally favourable to salt deposition. These are being investigated through a drilling program of the Nova Scotia Department of Mines and Malagash Salt Company.

About 200 gravity measurements were made over a 16-square mile area north of Brent in Algonquin Park, Ontario for the purpose of studying a possible meteor crater in the area. The results show a circular gravity minimum of about 5 milligals at the centre of the feature, which suggests that its undisturbed floor, now filled with sedimentary deposits and glacial debris, lies between 1,500 and 3,600 feet below the surface. The negative gravity anomaly indicates that the feature is not of a volcanic origin.

SEISMOLOGY

The ten seismograph stations in regular operation are at Halifax, Nova Scotia; Seven Falls and Shawinigan Falls, Quebec; Ottawa and Kirkland Lake, Ontario; Resolute Bay, Northwest Territories; Saskatoon, Saskatchewan; and Victoria, Horseshoe Bay, and Alberni, British Columbia. During the fiscal year improvements were made to the installations at Seven Falls, Shawinigan Falls, and Victoria and a temporary network was set up with stations at Fernie, British Columbia, and at Blairmore and Turner Valley, Alberta, to assist the Mines Branch in its studies of the rockbursts in the mines of the area.

The concentration of regular stations in the St. Lawrence valley and on the Pacific coast reflects the high seismicity of these areas. Two annual reports

have been published listing the earthquakes of southwestern British Columbia, and it is hoped that eventually it will be possible to outline the areas of major earthquake hazard. A seismic history of eastern Canada is being prepared with the same general object in view.

Related to the study of local seismicity are the seismic studies the Division has made in the past on crustal structure. More advanced studies are to be made in this field. New seismographs to be used for this purpose and to study large scale local features are being constructed and will be ready for use during the 1954 field season.

Two small field surveys were carried out. One of these, made in cooperation with the Nova Scotia Research Foundation, investigated the value of the seismic methods in determining the extent and thickness of gypsum deposits. It was concluded that when some auxiliary borehole data were available, the methods have definite value. The other was a seismic investigation of a crater near Brent, Ontario. A profile which would be in accordance with a theory of meteoric origin for the crater was obtained across the feature.

Considerable research was done on what is known as the fault-plane project. By studying the direction of initial motion of seismograms it is possible to learn much about the mechanism of earthquakes and thus about the forces that cause them. These studies have a basic scientific value but the results should eventually prove of practical importance also, for only when the forces causing earthquakes are understood can proper appraisal of earthquake risks be made.

The matter of earthquake risks is of increasing interest in Canada, particularly in British Columbia where there has been so much new construction. During the fiscal year, for the first time, the Division prepared an earthquake probability map, in cooperation with the Division of Building Research, National Research Council. This map is still less detailed than might be desired but will be revised from time to time as increasing knowledge warrants change.

Dominion Astrophysical Observatory, Victoria, B.C.

RESEARCH

Activities were directed mainly towards the solution of astronomical problems by photographing and studying the spectra of stars.

Observing weather for the year was rather below average; the 73-inch telescope was in operation on 174 nights for a total time of 973 hours. Thirty-four-year averages for these figures are 193 nights and 1,272 hours, respectively.

Stellar Spectroscopy—Two studies of particularly interesting stars were completed. One, a detailed examination of the spectrum of the bright double star, Capella, showed that, contrary to conclusions reached elsewhere recently, the component stars of the system are probably normal giant stars. The other was an extensive study of over 400 spectrum photographs of the star H.D. 199140 obtained at Victoria over a 25-year period. Its results should be of much aid and importance in solving the perplexing problem of the nature of a type of star that varies in brightness and probably also pulsates in a period of about one-fifth of a day. An additional advance has been made in obtaining slit-spectrograms of stars farther into the infrared than has heretofore been possible.

Preparations were started for an expedition to photograph the flash-spectrum of the sun, our nearest star, at its total eclipse, June 30, 1954. A total eclipse of the sun is seldom visible from Canada and the occasion will afford Canadian scientists an opportunity to share in and contribute to the special investigations of the physics of the sun's atmosphere that can only be carried out at an eclipse. One of three principal Canadian groups, the Victoria party, plans to carry out its photographic program at Hansen, Ontario.

Other contributions during the fiscal year include: the study of the atmospheres of stars with equatorial atmospheric bulges or shells; a spectroscopic examination of the atmosphere of the planet Jupiter; and the continuation of the problem on calculating models of stellar atmospheres, using an electronic computing machine.

Stellar Motions—Studies of the line-of-sight motions of the stars from measurements of the displacements of their spectrum lines continued to occupy a prominent part in the work of the Observatory. Over 800 spectrum photographs were measured for velocity-determination. These spectra are divided among: (1) the large program of distant luminous stars, to be utilized for the study of large-scale motion in the galactic plane; (2) the more restricted program for investigation of motions toward the galactic pole; and (3) the investigations of the orbits of spectroscopic double stars.

The evidence that has accumulated from various sources during the past two years, pointing to the fact that our galaxy has recognizable spiral arms, makes the prospect of utilizing the radial velocities found under (1) above even more interesting and important than had been anticipated when the program was begun several years ago.

The research on double stars has yielded orbits and stellar dimensions for three new systems and revised orbits for four others.

Seismology—The seismographs were set up early in the fiscal year in the newly constructed addition to the Observatory's office building, and some excellent new equipment was added. The six stations of the western Canadian network were kept operating, and recorded about 300 earthquakes, 80 being of local and 220 of distant origin.

The program of cooperation with the Royal Canadian Navy involving the recording of timed depth-charge explosions was continued to advantage. One excellent run enabled accurate determination of the velocity of seismic waves through the earth's crust in the region of Victoria, the resulting value being 6·392 kilometers per second. This figure should enable the more precise determination of the epicentres of local earthquakes.

Information on the occurrence and likelihood of earthquakes in western Canada was provided on request to the public, the press, interested industrial organizations, and to insurance companies.

INSTRUMENTATION

Several important additions were made to the new stellar spectrograph. Two long-focus lenses make it possible to photograph stellar spectra with the highest practicable power, a power exceeded at perhaps only two other observatories. Also, the addition of quartz optical parts makes it possible to photograph the ultraviolet region of stellar spectra.

The modification of the viewing eyepiece of the large telescope is of advantage in enabling visitors to view objects on the regular Saturday evening public periods. In addition, a novel eyepiece and control box arrangement was added that contributes greatly to the convenience of the regular observers.

GENERAL

The new section of the office building was completed and provides not only much-needed office space but 3 laboratory rooms, a seismographic section, and additional space for the Observatory library.

An estimated 23,000 general visitors toured the dome of the Observatory during the fiscal year. Over 20 lectures were given on request by members of the staff to various organizations.

The Observatory was represented at 6 scientific meetings, and contributed 9 papers to the programs of these meetings.

GEOGRAPHICAL BRANCH

J. W. Watson, Director

During the 1953 season field parties conducted intensive surveys of representative areas at Mould Bay on Prince Patrick Island in the northwestern Arctic and Spence Bay on Boothia Peninsula. These studies are to be used in preparing ground-photo keys, by means of which surface conditions in other areas having a similar topography may be interpreted readily from air photographs. The work is being done primarily for the Department of National Defence but will be of value also to the Department of Northern Affairs and National Resources and the Department of Transport.

A team of engineers, town planners, and geographers examined fourteen sites along the northeast and southeast coasts of the island of Newfoundland that had been selected by a joint Provincial-Federal committee. The object was to determine the possibility of establishing settlements that would afford opportunity for land, as well as sea, activity, and thus provide the very scattered fishing population with better and more stable living conditions.

A study of the Annapolis Valley, Nova Scotia, was part of a general survey of changes in land use and settlement in the province during the past 10 years. The effects of topography, drainage, climate, soil, vegetation, transportation, competing economic demands, and changing urban markets were plotted in relation to the changes in land use and settlement.

The Branch, at the request of the Civil Defence Division, Department of National Health and Welfare, began in 1952 a study of Saint John, New Brunswick. The work was continued in 1953, with studies chiefly concerning the harbour, its limitations and possibilities, and its relation to the city. The survey also involved detailed studies of the industrial, commercial, and residential areas, the coastal and overseas traffic, traffic with other provinces, and their relationship to the geographic and economic factors.

In connection with the Unesco Arid Zone project for the study of dry areas, the drought area of southern Alberta was examined. The survey included: the determination of the boundaries of the arid and semi-arid zones; the study of the adaptations of agriculture, transportation, industry, and related activities to conditions of topography, soil, water supply, and climate; and the determination of the main problems affecting settlement and development of the area. The data obtained were made available to Unesco.

SYSTEMATIC GEOGRAPHY

A major project is the production of a new Atlas of Canada. Pressure of more urgent work and requests from other departments slowed down work on this project. To date, the base maps have been designed, and four plates of historical and political maps, two of urban settlement, two geological, two mineral, and four agricultural maps have been prepared.

Ice conditions at various coastal points during the freeze-up and break-up periods are of considerable importance to navigation. These conditions are being studied and mapped on a 1 inch to 8 mile basis in the Gulf of St. Lawrence, in Hamilton Inlet on the coast of Labrador, and in Ungava Bay and Hudson Strait. A report on the gulf is in press and a similar report was prepared for use at a special conference of iron mining and shipping companies interested in the iron ore deposits recently discovered west of Ungava Bay.

At the request of the Department of National Defence, the Branch continued the mapping on an 8-mile basis of surface conditions in Ungava-Labrador. The maps will show exposures of bedrock, extent and nature of surface deposits, types of land form, drainage, and vegetation.

In continuation of a project undertaken at the request of the Civil Defence Division, Department of National Health and Welfare, urban surveys were carried out at Winnipeg, Sault Ste. Marie, and Montreal. In the last named the work was confined to contiguous municipalities, as the metropolitan area had already been surveyed by the city authorities. Detailed maps showing such factors as industrial, commercial, and residential areas, night and day distribution of population, nature and density of housing, and fire hazards were prepared. Surveys of a similar nature have previously covered Toronto, Hamilton, London, Windsor, Saint John, and Halifax.

DRAUGHTING

The Branch turned out 26 sketches and diagrams for the Department of Fisheries, and 47 maps for various other departments and agencies. A pictorial wall map of Canada was prepared for the Department of Northern Affairs and National Resources.

LIBRARY

During the fiscal year, 1,415 books and pamphlets were added to the library, bringing the total of volumes up to 12,675. Loans, exclusive of periodicals, totalled 3,614.

The library received an important addition in the shape of a collection of 800 volumes of geographical periodicals from the library of the late Professor Wilhelm Meinardus of Germany.

The map collection increased by 5,000, mainly as a result of exchanges with fifteen countries. New exchanges were arranged with Italy and Sweden. About 175,000 maps are now on file. Over 5,000 loans of maps were made, including over 1,000 items from the Japanese section, which were borrowed by the Department of National Defence. A list of the chief maps published in Canada in 1951-53 was compiled for the *Bibliographie Cartographique Internationale*, being published in Paris for Unesco.

PUBLICATIONS

ADMINISTRATIVE

English Publications

Report No.

Summary of Activities 1953. (Offset).
Report of the Explosives Division (Calendar Years 1944-51).
Report on the Administration of the Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31, 1953.
Annual Report for the Fiscal Year ended March 31, 1953.

French Translations

Summary of Activities 1953. (Offset).
Annual Report for the Fiscal Year ended March 31, 1952.
Annual Report for the Fiscal Year ended March 31, 1953.
Report on the Administration of the Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31, 1953.

SURVEYS AND MAPPING BRANCH

Hydrographic Service

English Publications

Great Lakes Pilot, Vol. 1 (Third Edition).
St. Lawrence River Pilot—Quebec Harbour to Kingston Harbour (First Edition).
Supplement No. 2 to the 1944 edition of Nova Scotia Southeast Coast and Bay of Fundy Pilot.
Newfoundland Pilot (First Edition).
British Columbia Pilot, Volume 1 (Fifth Edition)
Cover, *Tidal Current Charts—Vancouver Harbour.*

1. Tide Tables, 1954. *Atlantic Coast.*
2. Tide Tables, 1954. *St. Lawrence and Saguenay Rivers.*
3. Tide Tables, 1954. *Prince Edward Island and Adjacent Waters.*
4. Tide Tables, 1954. *Nova Scotia, Atlantic Coast.*
5. Tide Tables, 1954. *Bay of Fundy.*
6. Tide Tables, 1954. *Newfoundland, East and South Coasts.*
10. Tide Tables, 1954. *Pacific Coast.*
11. Tide Tables, 1954. *Strait of Georgia.*
12. Tide Tables, 1954. *British Columbia, Northern Waters.*
13. Tide Tables, 1954. *Vancouver Island, Southwest Coast.*

Geodetic Survey

English Publications

Geodetic Operations in Canada, January 1, 1951-December 31, 1953.

21. *Precise and Secondary Levelling in Manitoba,* by David McMillan.
70. *Triangulation in New Brunswick and Prince Edward Island,* by W. H. MacTavish.
71. *Triangulation along the Coast of British Columbia,* by W. H. MacTavish.

Legal Surveys

English Publications

Supplement to the Manual of Instructions for the Survey of Canada Lands. (Offset).

GEOLOGICAL SURVEY OF CANADA

English Publications

Memoir 239: *Mesozoic Stratigraphy of the Eastern Plains, Manitoba and Saskatchewan*, by R. T. D. Wickenden. (Reprint.)
Memoir 268: *Dezadeash Map-area, Yukon Territory*, by E. D. Kindle.
Memoir 269: *Goldfields-Martin Lake Map-area, Saskatchewan*, by A. M. Christie.
Memoir 270: *Weldon Bay Map-area, Manitoba*, by J. Kalliokoski.
Memoir 271: *Batty Lake Map-area, Manitoba*, by D. S. Robertson.

Bulletin 25: *Interpretations of the Structural Geology of the Sherridon-Flin Flon Region, Manitoba*, by J. Kalliokoski.
Bulletin 26: *Bedrock Geology of the Seaboard of Labrador between Domino Run and Hopedale, Newfoundland*, by E. H. Kranck.

Water Supply Paper No. 311: *Ground-water Resources of Townships 31 to 34, Ranges 21 to 24, West of 4th Meridian, Alberta (Three Hills Area)*, by A. MacS. Stalker.
Water Supply Paper No. 314: *Ground-water Resources of Townships 31 to 34, Ranges 25 to 29, West of 4th Meridian, Alberta (Wimborne Area)*, by A. MacS. Stalker.
Water Supply Paper No. 315: *Ground-water Resources of Townships 11 to 14, Ranges 22 to 25, West of Principal Meridian, Manitoba (Hamiota Area)*, by E. C. Halstead.
Water Supply Paper No. 317: *Ground-water Resources of Townships 35 to 38, Ranges 1 to 4, West of 5th Meridian, Alberta (Markerville Area)*, by A. MacS. Stalker.
Water Supply Paper No. 318: *Ground-water Resources of Williamsburgh Township, Dundas County, Ontario*, by E. B. Owen.
Water Supply Paper No. 319: *Ground-water Resources of Townships 11 to 14, Ranges 26 to 29, West of Principal Meridian, Manitoba (Elkhorne Area)*, by E. C. Halstead.
Water Supply Paper No. 321: *Ground-water Resources of Malpeque Map-area, Prince and Queens Counties, Prince Edward Island*, by E. I. K. Pollitt.
Water Supply Paper No. 322: *Ground-water Resources of Surrey Municipality, British Columbia*, by J. E. Armstrong and W. L. Brown.

Paper 52-10: *Waterton Area, Alberta*, by R. J. W. Douglas. (Preliminary map.)
Paper 52-24: *Yellowknife, Northwest Territories*, by J. F. Henderson and I. C. Brown. (Preliminary map.)
Paper 52-27: *Notes on the Devonian System of the North-central Plains of Alberta*, by H. R. Belyea.
Paper 52-28: *The Yellowknife Greenstone Belt, Northwest Territories*, by J. F. Henderson and I. C. Brown.
Paper 52-30: *Geology and Mineral Deposits of Whitehorse Map-area, Yukon Territory*, by J. O. Wheeler.
Paper 52-31: *Fenelon Falls, Victoria, Peterborough, and Haliburton Counties, Ontario*, by J. F. Caley and B. A. Liberty. (Map and descriptive notes.)
Paper 52-32: *Notes on the Geology of Parts of Ellesmere and Devon Islands, Northwest Territories*, by V. K. Prest.
Paper 52-33: *Lindsay, Victoria, Durham, Ontario, and Peterborough Counties, Ontario*, by B. A. Liberty. (Map and descriptive notes.)
Paper 53-1 : *Notes on Localities Visited on the Labrador Coast in 1946 and 1947*, by G. Vibert Douglas.
Paper 53-2 : *Newmarket, Ontario and York Counties, Ontario*, by B. A. Liberty.
Paper 53-3 : *Pegmatitic Beryllium and Lithium Deposits, Preissac-Lacorne Region, Abitibi County, Quebec*, by R. C. Rowe.
Paper 53-4 : *Structural Features of the Preissac-Lacorne Batholith, Abitibi County, Quebec*, by K. R. Dawson.

Paper 53-5 : *Springdale, Newfoundland,* by J. Kalliokoski. (Preliminary map.)
Paper 53-6 : *Elgin County and Parts of Middlesex County, Ontario, Showing Drift-Thickness and Bedrock Contours,* by B. V. Sanford. (Preliminary maps.)
Paper 53-9 : *Alliston, Simcoe, York, and Dufferin Counties, Ontario,* by B. A. Liberty. (Preliminary maps.)
Paper 53-11: *Rice Lake, Northumberland, Durham, and Peterborough Counties, Ontario,* by C. P. Gravenor. (Preliminary map.)
Paper 53-12: *Uhlman Lake Map-area, Manitoba,* by G. M. Wright.
Paper 53-13: *Barrie, Simcoe County, Ontario,* by B. A. Liberty. (Preliminary map.)
Paper 53-14: *Central Labrador Coast, Newfoundland,* by A. M. Christie, S. M. Roscoe, and W. F. Fahrig. (Preliminary map.)
Paper 53-15: *Black Bay Map-area, Saskatchewan,* by W. E. Hale.
Paper 53-16: *Orr Lake, Simcoe County, Ontario,* by B. A. Liberty. (Preliminary map.)
Paper 53-18: *Oshawa, Ontario and Durham Counties, Ontario,* by B. A. Liberty. (Preliminary map.)
Paper 53-19: *Scugog, Durham, Ontario, and Victoria Counties, Ontario,* by B. A. Liberty. (Preliminary map and notes.)
Paper 53-20: *Kluane Lake (West Half), Yukon Territory,* by J. E. Muller.
Paper 53-21: *Notes on Triassic Ammonoids from Northeastern British Columbia,* by F. H. McLearn.
Paper 53-22: *Geological Notes on Southern District of Keewatin,* by C. S. Lord.
Paper 53-23: *Silurian Formations of the Niagara Escarpment in Ontario,* by T. E. Bolton.
Paper 53-24: *Report of Progress on the Geology of Cornwallis Island, Arctic Archipelago, Northwest Territories,* by R. Thorsteinsson and Y. O. Fortier.
Paper 53-25: *Dewar Creek, British Columbia,* by J. E. Reesor. (Preliminary map.)
Paper 53-26: *Scugog, Durham, Ontario, and Victoria Counties, Ontario,* by C. P. Gravenor. (Preliminary map, glacial geology.)
Paper 53-28: *Vancouver North, British Columbia,* by J. E. Armstrong. (Preliminary map.)
Paper 53-29: *Bathurst, Gloucester and Restigouche Counties, New Brunswick,* by R. Skinner. (Preliminary map.)
Paper 54-1 : *A List of Publications on Prospecting in Canada and Related Subjects (with Explanatory Notes),* by A. H. Lang.

Geophysics Paper 57 (Revised edition): *Bathurst, Gloucester and Restigouche Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 59 (Revised edition): *Tetagouche Lakes, Restigouche, Northumberland, and Gloucester Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 64 (Revised edition): *Nepisiguit Lake, Restigouche, Northumberland, and Victoria Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 66 (Revised edition): *California Lake, Northumberland, Gloucester, and Restigouche Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 113: *Orillia, Simcoe, Ontario, and Victoria Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 118: *Gravenhurst, Victoria, Simcoe, and Ontario Counties and Muskoka District, Ontario.* (Aeromagnetic map.)
Geophysics Paper 124: *Orr Lake, Simcoe County, Ontario.* (Aeromagnetic map.)
Geophysics Paper 125: *Grand Falls, Victoria and Madawaska Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 126: *Lake Joseph, Muskoka and Parry Sound Districts,* Ontario. (Aeromagnetic map.)

Geophysics Paper 127: *Seguin Falls, Parry Sound and Muskoka Districts, Ontario.* (Aeromagnetic map.)
Geophysics Paper 128: *Penetanguishene, Simcoe County and Muskoka District, Ontario.* (Aeromagnetic map.)
Geophysics Paper 129: *Tobique, Victoria County, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 130: *Florenceville, Carleton County, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 131: *Plaster Rock, Victoria County, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 132: *Andover, Victoria and Carleton Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 133: *Doaktown, Northumberland and York Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 134: *Aroostook, Victoria County, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 135: *Napadogan, York County, New Brunswick.* (Aeromagnetic map.)
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