CANADA

Department of Mines and Technical Surveys

Annual Report

Fiscal Year Ended

March 31, 1951

Price, 50 cents

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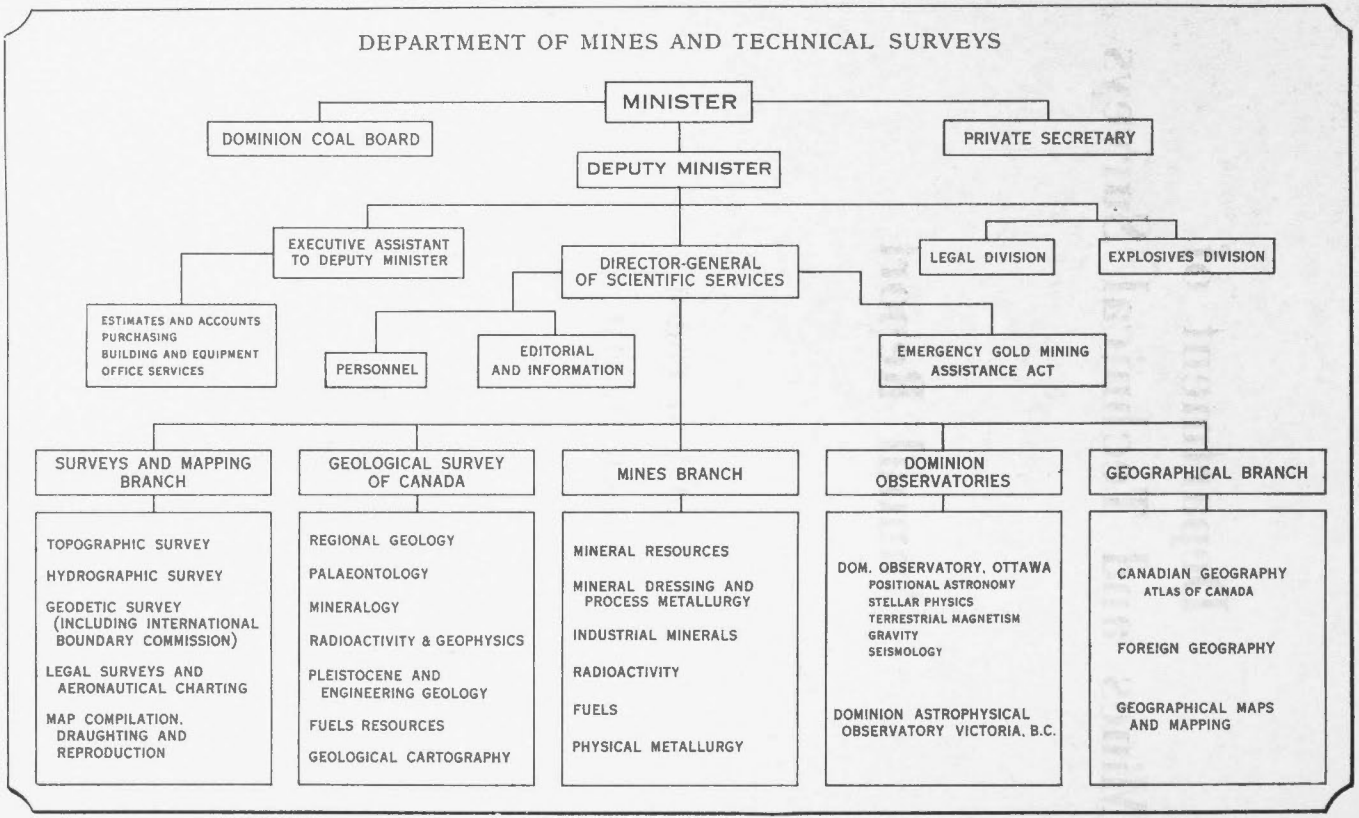

Organization Chart.

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To His Excellency Field Marshal the Right Honourable Viscount Alexander of Tunis, G.C.B., G.C.M.G., C.S.I., D.S.O., M.C., LL.D., A.D.C., Governor General and Commander-in-Chief of the Dominion of Canada.

MAY IT PLEASE 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, 1951.

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, 1951.

Your obedient servant,

MARC BOYER,
Deputy Minister.

REPORT OF THE DEPARTMENT OF MINES AND TECHNICAL SURVEYS FOR THE FISCAL YEAR 1950-51

It should be noted at the outset that a summarized account of the main activities of the Department during 1950 was made available to the public early in February 1951 in a mimeographed report issued under the title "Summary of Activities in 1950". The present report provides considerable additional information on the many projects of the five branches. A comprehensive statement on the establishment of the Department by Act of Parliament in December 1949 and on the functions of its branches appears in the introductory part of the report for the previous fiscal year. These functions have not undergone material change since then.

The mineral industry again established a production record, the sixth in succession. For the first time the value of output exceeded a billion dollars, the finally revised amount for 1950 being $1,045,712,000. The increase was general throughout the industry, the principal gains being in the outputs of crude petroleum, asbestos, gold, zinc, copper, and nickel. A record was also established in the physical volume of output, the index in 1950 being 148·6 compared with 133·6 in 1941, the previous peak year. Exports of mine products also reached peak levels, as did the domestic consumption of several of these products.

Completion of the 1,150-mile pipeline from Edmonton to Superior, Wisconsin, was a notable event of the year. Actually, movement of oil by tanker from Superior to refineries in Ontario was commenced shortly after the end of the fiscal year. Average daily production from wells in Alberta in 1950 was 75,605 barrels and potential production at the end of the year was 185,000 barrels, or the equivalent of about 50 per cent of Canadian requirements. Oil companies operating in western Canada made a record expenditure of approximately $150,000,000 on exploration and development in 1950, with the result that new peaks were set in footage drilled, in well completions, and in discoveries made. Total footage drilled for development and exploratory wells in the Prairies reached 4,600,000 feet, compared with 3,273,000 feet in 1949. A total of 117 geophysical parties was in action, of which at least 105 were in Alberta where the greatest exploratory activity was in the central and south-central areas.

The marked increase in productive potential of the Prairie Provinces has also led to the building of a refinery at Winnipeg at a cost of $10,000,000; construction of a 75-mile, 10-inch connecting pipeline from Gretna, Manitoba, to Winnipeg at a cost of $2,500,000; construction of a 30-mile, 16-inch pipeline from Redwater to Edmonton at a cost of $2,500,000; refinery construction and modernizing at several centres such as Edmonton, Ogden, Lloydminster, Moose Jaw, Regina, and Froomfield, near Sarnia, Ontario, at a total cost of approximately $75,000,000; and construction of additional storage capacity at Sarnia.

Natural gas continued to be found in almost every well drilled for oil in Alberta. Throughout most of 1950 markets available to the established gas fields in the plains areas were fully supplied and there was little incentive to prospect for further gas reserves. Despite this, several gas discoveries of commercial importance were made in areas in Alberta stretching from the

southeastern part of the province to the Peace River district. The matter of a policy regarding permission to export natural gas from the province was under review by the Government of Alberta.

Canadian output of coal reached a record of 19,139,100 tons. Output from Alberta was about 500,000 tons lower than in 1949, but that from Nova Scotia, Saskatchewan, and British Columbia was considerably higher.

Demand for the non-ferrous base metals was exceptionally strong throughout the year. A development of major importance was the disclosure of a large deposit of zinc-silver ore by Barvue Mines Limited in Barraute township, Quebec. Surface drilling on the property has indicated 17,000,000 tons of ore averaging over 3 per cent zinc and 1 ounce of silver a ton to a depth of 700 feet. Plans were formulated to bring the property into production at the rate of 4,000 tons a day.

Output of zinc in 1950 reached a new peak, but that of copper, nickel, and lead was considerably short of the peaks reached during the war, though in each case the value of output was much higher in 1950. Prices of the four metals rose sharply during the year. Nickel, for instance, advanced from 42·5 cents a pound in January to 51·75 cents at the close of the year; copper from 20·35 to 25·95 cents; lead from 13·25 to 17·95 cents; and zinc from 16·50 to 19·30 cents; the prices being in Canadian funds.

To an increasing extent during the fiscal year metal-consuming industries in Canada and elsewhere were encountering difficulties in obtaining needed supplies of the principal non-ferrous metals, and by the close of the year the shortage of supply in some cases was becoming acute. It is evident that, as defence production gains momentum diversion of supplies from less essential uses will become increasingly necessary. Meantime, although Canadian output, with the exception of zinc, is below peak wartime levels, the industry has been undergoing considerable enlargement through the expansion of productive facilities, the development of new deposits, and the discovery of others. Practically all of the main producers have been making large expenditures, broadly designed to improve metallurgical practices, to provide greater smelter and refinery capacity, and to handle larger ore tonnages. Some of this work is well advanced and is being reflected in the monthly output figures, but it will be a few years before a marked increase in production above the peak wartime levels will materialize, taking into account the gradual decline since the war in the average grade of the ores being mined by some of the leading producers.

Much the greater part of the lead and zinc exported in 1950 again went to the United States and most of the copper to Great Britain. The United States has been the chief importer of Canadian nickel for a number of years. Exports of the four metals in 1950 reached a total value of $285,626,000. Domestic consumption of nickel was still less than 3 per cent of the output, whereas consumption of zinc reached a record of 54,370 tons. Lead consumption at 57,300 tons was well below the peak of 1946, and copper consumption at 106,900 tons was the highest since the war, but was more than 76,000 tons below that of 1942, the peak year.

Although shipments of iron ore at 3,218,983 long tons was about the same as in 1949, developments in the industry give promise of a greatly increased output within the next few years. Considerable headway was made in carrying out the expansion program at the Steep Rock deposits in northwestern Ontario, which is aimed at a production of at least 3,000,000 long tons by 1955 and an eventual annual production of 10,000,000 tons. The Helen mine in the Michipicoten area reached its rated capacity of 1,000,000 tons of sinter a year. Construction was started on the railway from the port of Seven Islands on the Gulf of St. Lawrence to the Quebec-Labrador hematite deposits, and drilling of several magnetite deposits in eastern Ontario was commenced.

Shipments from the Wabana hematite deposits in Newfoundland to Do-

minion Steel and Coal Corporation's furnaces at Sydney were 12 per cent higher than in 1949, but owing to the shortage of foreign exchange, overseas shipments, particularly to the United Kingdom, were much lower. Contracts made at the end of 1950 ensure increased shipments to the United Kingdom in 1951.

Aside from the 318,000-ounce increase in production over 1949 there were few developments of exceptional interest in the gold industry. The increased output came mainly from Quebec, although output from Ontario and Manitoba was also higher. That from British Columbia continued to decline. Exploratory and development work was less active than in 1949, though there was a considerable heightening of activities in a few areas, more particularly in the Yellowknife area, Northwest Territories.

Much interest was centred in the Beaverlodge area, north of Lake Athabasca, in Saskatchewan, and particularly on the Ace property of Eldorado Mining and Refining (1944) Limited. This property shows promise of becoming a major source of supply of uranium ore, and its development toward production is actively under way. Next to Great Bear Lake the area is the most active uranium camp in Canada. The region is almost covered by claims and concessions, most of which are held privately. More than 2,300 occurrences are known in the area, including about 1,100 on claims held by Eldorado. Many of these occurrences seem to merit further exploratory work.

An event of significance was the commencement of shipments of titanium ore from the Allard Lake deposits north of Havre St. Pierre in eastern Quebec. A total of 100,000 tons of ore was mined and shipped to the smelter at Sorel, Quebec, where the first of five contemplated furnaces was put into experimental operation to produce iron ingots and titanium dioxide slag.

Output of the industrial minerals in 1950 reached a record value of $227,000,000, a 27 per cent gain over 1949. Volume records were established by asbestos, cement, sand and gravel, clay products, salt, and gypsum. The output of asbestos for the first time included a substantial quantity of chrysotile fibre from Ontario with the commencement of commercial milling at the Munro mine of Canadian Johns-Manville Company Limited, near Matheson. The year witnessed an active search for new deposits of the mineral and several companies carried out exploratory and development work in Quebec, Ontario, and British Columbia. Exploratory work on an occurrence of chrysotile discovered at McDame Mountain in British Columbia south of the Yukon border proved encouraging, and further examination of the commercial possibilities was planned in 1951.

Demand for asbestos fibre for all grades continued at an unprecedented level.

Capacities were expanded and equipment was improved in several of Canada's gypsum plants. Within the past few years the gypsum industry has shown a definite and increasing interest in the possibilities for beneficiation of the somewhat low-grade ores that constitute the greater part of the raw material now available from deposits in central and western Canada. The Department of Mines and Technical Surveys has been carrying out extensive tests on the beneficiation of gypsum from some of these deposits with considerable initial success.

In spite of a record output of cement and capacity operation of the plants it was necessary to import 1,386,200 barrels, 60 per cent of which came from the United Kingdom. Expansion planned by the industry is expected to increase total cement-making capacity to 22,500,000 barrels annually in the next 2 years compared with a capacity of 17,000,000 barrels at the end of 1950.

Difficulty was experienced by several countries in obtaining adequate supplies of elemental sulphur from the Frasch-mined domes of Texas and Louisiana. Actually, Canadian manufacturers of pulp and paper, heavy chemicals, explosives, and textiles experienced little difficulty obtaining their needs until the third quarter of 1950. By then, however, low producers' stocks and declin-

ing reserves threatened to reduce shipments, with the prospect of a continuing shortage for some time. The large reserves of natural gas in the Pincher Creek, Jumping Pound, and Turner Valley fields in Alberta are estimated to contain 8, 4, and 2 per cent, respectively, of hydrogen sulphide gas. In the case of the Pincher Creek field, for instance, it is estimated that 430 tons of elemental sulphur can be recovered from every 100,000,000 cubic feet of natural gas. In the plant it is erecting in the Jumping Pound field, Shell Oil Company of Canada expects to recover 10,000 tons of elemental sulphur a year and hopes to have the plant in operation by the end of 1951. Royalite Oil Company, Limited, plans to erect a plant at Turner Valley for the recovery of sulphur from the natural gas of that field. Output from these plants, however, will be sufficient to meet only a part of the Canadian requirements, and unless the supply situation improves increased attention will possibly be given to the development of pyrite deposits, some of which in Canada are known to contain large tonnages of this mineral.

Clay products made from Canadian clays reached a value of $21,790,900 in 1950 and those made from imported clays a value of $15,095,500. Expansion and modernization of plants have been fairly general in recent years and several new plants have been established. The defence program has caused a heightened demand for refractories and for special electrical porcelains.

ACTIVITIES OF THE DEPARTMENT

The many and varied activities of the Department during the fiscal year largely reflected the quickening pace of mineral development throughout the country and the increasing impact of the defence program on the Canadian economy. Most of the work in some units of the Department had a direct bearing on this program.

The increasing need for basic maps for use in natural resources development, for defence purposes, and in engineering projects caused the Surveys and Mapping Branch to carry out the largest field program in its history. Mainly to meet the requirements for defence, it also had a larger number of vessels of its Hydrographic Service engaged in the charting of coastal and inland waters than ever before. Oil and natural gas developments in Alberta and increasing mining activity in Yukon and the Northwest Territories resulted in a greater demand on the services of its Legal Surveys Division for the location of interprovincial boundaries in the regions concerned and for the survey of lots, claims, and townsites in those parts of Canada under administrative control of the Government of Canada. The Branch distributed approximately 700,000 maps and other publications during the fiscal year; printed 568 separate maps and charts, of which over a million copies were produced; distributed more than 18,000 advance information prints to federal and provincial authorities and to the public; added close to 200,000 prints to its National Air Photographic Library; and distributed approximately 400,000 prints of aerial negatives.

In its geodetic field work, which provides the framework basis for surveying, mapping, and engineering projects, the Branch again gave considerable attention to the application of electronic methods of determining distances. The measurement of distances up to 300 miles by "Shoran" is enabling the Branch to carry triangulation control into northern Canada at a pace that would have been impossible by any other means. The distances are measured by the time interval taken by a radar signal to travel from an airplane to a ground-control station and return. Results to date indicate an overall efficiency of 1 in 50,000, which is regarded as a high degree of accuracy.

By somewhat similar "Shoran" techniques the precise position of a properly equipped plane engaged in air photography can be determined at the

instant of exposure of each photograph. This method is to be tried out in Canada in 1951 and should it prove satisfactory a great saving in establishing horizontal control should result where the method can be used.

Experiments are being carried out by use of the radar altimeter for obtaining ground elevations by electronic means from a plane. This method is being used in contouring the 8 and 16 mile to the inch air navigation charts and shows promise of proving satisfactory for larger scale work.

Because of military requirements for standardization it has been decided to publish the National Topographic Series of maps on 1 to 50,000 and 1 to 250,000 scales rather than on 1 mile and 4 miles to the inch scales. The sheets already published will be gradually converted when they are reprinted or revised.

The Geological Survey of Canada, whose primary function is to provide geological maps indispensable to the prospector and exploration company, had 89 parties in the field in 1950. More than half the work was in areas of possible occurrence of metals now in critical supply for the defence program of Canada and its allies. Particular attention was paid to the study of radioactive mineral deposits, for which the Geological Survey has a direct responsibility to the Atomic Energy Control Board in maintaining a complete inventory of information. To date this inventory comprises information on more than 500 properties. Canada has many good prospecting areas for radioactive minerals, and the intensive studies of the Survey have been providing very satisfactory results. The Survey provides free and comprehensive advisory and testing services to uranium prospectors and to the mining industry, thus encouraging the search for uranium deposits in Canada. During the fiscal year it tested over 4,000 samples and made many hundreds of identifications of radioactive minerals and of associated ore and gangue minerals.

Much work was done also in relation to oil and gas developments in western Canada and in southwestern Ontario. In both regions there is great need to collect the drilling data as they become available and to correlate well samples in order that the precise stratigraphic conditions of occurrence may be known for the intelligent direction of exploration in new fields. To assist in the correlation of samples received from oil and gas wells from western Canada and thus to facilitate the search for these fuels, the Geological Survey opened an office in Calgary in 1950.

Work was continued on investigation of the geology of the coals and on estimates of the coal resources of Canada. Revised geological maps of some of the coal fields of Alberta were prepared that permitted more accurate estimates of coal reserves.

Stratigraphic studies are being undertaken in the Sydney basin of Nova Scotia in reference to the constitution of the coal and the sediments associated with it. These are considered to be of great scientific and practical importance to all the mines in the area in establishing the relation between the character of the local sedimentation and the quality of the coal where drilling preceding the mining is impossible because of the undersea mines from which the coal is obtained. High-sulphur coal is objectionable in smelting iron ore and great advantages will result in predicting the quality of the coal from a knowledge of the stratigraphy previous to mining.

Areas totalling 45,285 square miles, mainly in Alberta and the Northwest Territories, were covered by airborne magnetometer surveys. The Geological Survey initiated the use of this new type of survey in Canada several years ago, and it has since covered many thousands of square miles by the method in various sections of the country. Such surveys are designed as an aid to geological mapping, but they will also detect the presence of magnetic minerals. The greatest success achieved by the Geological Survey with use of the instrument was the disclosure of a body of magnetite beneath a cover of about 100 feet

of limestone in the Marmora area in eastern Ontario. Bethlehem Steel Corporation has been drilling the deposit.

The Mines Branch was engaged in a wide range of activities centred mainly around the devising of new processes and the improvement of present processes for the treatment of ores as an aid in the design of milling plants and in reducing milling costs; investigations on industrial minerals aimed largely toward the greater utilization of domestic sources of these minerals; tests and research on radioactive minerals and on solid, liquid, and gaseous fuels; investigations in physical metallurgy dealing with such matters as the properties of metals, the development of new and superior alloys, metal fabricating methods, and nuclear metallurgy; compilation of an inventory of Canada's mineral resources; and economic studies of various phases of mineral development in Canada.

Further research was done with encouraging results on a method of extracting the light metal lithium from spodumene, extensive deposits of which occur in Manitoba and Quebec.

Research on the corrosion of metals was intensified, particularly in relation to problems submitted by the Department of National Defence on the corrosion of aircraft engines and bodies, the deterioration of metal parts of motor vehicles, and the protection of various metal parts of ships from corrosion by sea water.

The increasing importance of the industrial minerals in the Canadian economy and the need for more extensive research, particularly on the utilization of these minerals, led to the establishment of an Industrial Minerals Division within the Mines Branch in June 1950. The Division's activities during the fiscal year included: continuation of a field survey of the mineral resources of Newfoundland; an investigation into the possibilities of producing silica sand of high purity from domestic sandstones; an investigation into methods of beneficiating impure gypsum, research on the development of new and improved ceramic products; development of a method of improving the qualities of Canadian fireclays for the production of "super duty" firebrick hitherto not made in Canada; completion of a survey of the waters of Fraser and Skeena River basins in British Columbia; and an investigation into sources of lightweight aggregates in Canada.

The Branch made available to industry much declassified information pertaining to such matters as methods of determining uranium in ores, and the chemical determination of thorium in its ores. In its work on radioactive minerals it gave chief attention to the development and application of methods for the production of marketable concentrates from individual uranium ores. It carried out 23 investigations for industry on the concentration of bulk ore samples from various properties.

Among the fuels investigations of special interest is a study that was started of rock pressures in the steeply dipping coal seams of the Crowsnest area of Alberta and British Columbia. Rock pressures are making coal mining progressively more difficult in some of the mines, and a purpose of the study is to assist the industry in lowering the cost of coal extraction by improving the design of mine workings and decreasing the danger to miners from violent pressure occurrences known as "bumps" or "gas outbursts".

Upwards of 90 per cent of the work in physical metallurgy was in connection with the defence program. For the most part, however, the various researches are of benefit as well to industry, more particularly to the foundries and to metal fabricating plants. The activities included forming, casting, and testing of designs in light metals for use in airborne equipment, mortar bases, and bomb tails; research on the development of high temperature alloys for jet engines; and work on welding problems related to naval ship construction and on problems concerning the maintenance of weapons and equipment in Arctic temperatures. The Mines Branch handles the metallurgical problems

of the atomic energy project at Chalk River, Ontario, and in view of the steady expansion of this project, work on these problems now constitutes a major activity of the Branch. In this connection it completed for the National Research Council the metallurgical research essential to the construction of the new atomic reactor at Chalk River.

Reflecting the heightened interest in mineral exploration, engineers and others seeking information on mining properties and prospects made increasing use of the Branch's mineral inventory. More than 5,000 mineral occurrences throughout Canada are now indexed and a map library maintained in conjunction with this index contains more than 8,000 maps on which are shown the geology and topography of the areas concerned.

A varied program consisting in part of direct services to the public, including the daily time service, and in part of research designed to assist in the development of natural resources and in the advancement of scientific knowledge in the fields of astronomy and geophysics was carried out by the Dominion Observatories.

Provision of a daily time service of the highest accuracy continued as a major activity of the Dominion Observatory at Ottawa. This service is available to all Canadians with standard receiving sets. Another time service available to short-wave receivers is intended primarily for surveyors, navigators, and persons living or travelling in remote parts of Canada.

Making use of new spectrographic equipment it designed and constructed, the Dominion Observatory continued investigations of disturbances on the sun that cause auroras, magnetic storms, and radio fadeouts. It completed a new catalogue of close to 1,600 stars for use in navigation, longitude determination, and general surveying practice. In a new approach to a study of the density and other characteristics of the earth's atmosphere, over 3,000 meteors were observed to determine the retarding effect on them of the thin upper air of the earth. As one object of this work is to predict the trajectories of high-speed projectiles, part of it was done in co-operation with the Department of National Defence. More elaborate equipment in the form of two special type cameras is under construction for use in this project, one for installation in the observatory at Meanook, Alberta, and the other in the observatory at Newbrook, Alberta.

In a major geophysical project application is being made of the methods of seismology to a study of the earth's crust in local regions of Canada. In this project field work was completed in 1950 on a study of the region between Ottawa and Kirkland Lake, which forms part of the Canadian Shield. The observations are being used to determine the thickness of the surface rocks and the nature of the basement structure. It is proposed to extend studies of this kind to other parts of Canada.

At the Astrophysical Observatory at Victoria, British Columbia, all phases of the fundamental research programs were actively advanced. The broad purpose of this work is to increase our factual knowledge of the heavenly bodies so that we may better understand the nature of the universe and the laws that prevail in it. Determination of the radial velocities of the stars has been one of the main activities at this Observatory and approximately one-quarter of all known velocities, now in excess of 1,000, have been found at Victoria. Current programs contain nearly 1,000 stars being studied for this datum for the first time. Two of these programs are expected to increase our knowledge of galactic motions from very distant stars, and to give information on the distribution of matter in the galactic plane near the sun.

Good headway was made by the Geographical Branch in its major project of preparing a new Atlas of Canada. Great care is being taken in this work in view of the many changes that have occurred in the Canadian economy since 1915 when the last atlas of Canada was published, and in the hope of producing a comprehensive edition of maximum usefulness.

For use of the Department of National Defence the Branch made a survey of the physical conditions of the land in relation to drainage and vegetation cover in an area in central Labrador, and made a similar study of islands in Hudson Bay. Its field work included also a study of the effect of aridity on the occupations and uses of land in the interior valleys of central British Columbia.

No changes were made in the Explosives Act, which the Department administers, other than an amendment to Explosives Regulation Part V, to permit packing of larger quantities of electric detonators. The Act regulates the manufacture, testing, sale, storage, and importation of explosives.

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

SUMMARY OF REVENUE AND EXPENDITURES FOR THE FISCAL YEAR 1950–51

——	Revenue	Ordinary expenditures
Minister of Mines and Technical Surveys	.....	$ 3,596.77
Departmental Administration	$ 4,239.36	299,598.83
Mines Branch	10,087.36	2,013,717.19
Geological Survey of Canada	6,155.85	1,437,457.12
Surveys and Mapping Branch	76,091.24	4,737,085.24
Geographical Branch	420.22	170,371.47
Dominion Observatories	139.03	472,797.97
Emergency Gold Mining Assistance	.....	7,114,213.51
Payments to the Royal Canadian Air Force and commercial companies for air photography, and to defray the expenses of the Interdepartmental Committee on Air Surveys	.....	1,299,639.81
Gratuity to Mrs. Michael Feniak	.....	2,000.00
Payment to the province of Manitoba—re Angus Thomas	.....	5,922.89
	$97,133.06	$17,556,400.80

EXPLOSIVES DIVISION

The Division administers the Explosives Act, 1946, which regulates the manufacture, testing, sale, storage, and importation of explosives. The transportation of explosives other than by railway, aircraft, or vessel also comes within the scope of the Act.

No changes were made in the Act, but Explosives Regulation Part V was amended by Order in Council P.C. 6107, December 21, 1950, to permit packing of larger quantities of electric detonators.

The production of commercial explosives was 93,490,217 pounds, an increase of 8,000,000 pounds over 1949, the previous peak year. There were no fatal accidents in explosives factories despite this record production.

Rapidly growing demands for explosives in eastern British Columbia, and in Alberta and the Northwest Territories, have made additional explosives manufacturing facilities imperative. Canadian Industries Limited began construction of a commercial explosives factory near Calgary, Alberta, in October 1950. The plant is expected to enter production in 1952.

The pamphlet, "The Storage of Explosives" in English and French, was revised and reprinted.

Members of the Royal Canadian Mounted Police, who are deputy inspectors of explosives, under P.C. 5115, December 12, 1946, continued to give valuable assistance in making inspections, investigating accidents and thefts, and in prosecutions for violations of the Act and Regulations.

EXPLOSIVES LABORATORY

The testing and analysis of explosives required in the administration of the Explosives Act are done in the Explosives Laboratory, Montreal Road, operated jointly by the Department and the National Research Council. Fireworks, chiefly Chinese firecrackers, arriving at the port of Vancouver are tested by the Food and Drugs Laboratory, Department of National Health and Welfare, Vancouver.

During the year 794 samples were received for chemical and physical examination and reports were prepared on the results.

Samples of free-venting fuse, igniter cord, and ammunition, and of 13 fireworks submitted by Canadian manufacturers, were approved. Six high explosives and 181 fireworks manufactured outside Canada were received for authorization. Some of the fireworks were rejected on account of prohibited ingredients, fire hazard, or dangerous functioning.

The Division continued an investigation, started in 1945, into the hazards attending the storage and shipment of ammonium nitrate fertilizer and prepared a third report, "Fire and Explosion Hazards" of ammonium nitrate. In this report all available data on tests from British, United States, and Canadian sources are compiled. The data appear to indicate that pressure and gas mixtures (products of decomposition) play a decisive part in detonation. The need of free ventilation and the use of containers incapable of maintaining more than a few atmospheres of pressure are stressed as essential for safe storage and shipment of ammonium nitrate fertilizer.

Through his retirement on superannuation in March 1951 the Division lost the services of M. C. Fletcher who joined its staff as explosives chemist in 1922 and who took over the duties of chief explosives chemist in 1940.

FACTORIES

The Act requires that factories for the manufacture of explosives and magazines for storage be licensed. In 1950 there were 17 licensed factories and storage depots, one more than in 1949.

MAGAZINES — REGISTERED AND UNLICENSED PREMISES

There were 391 permanent and 690 temporary magazine licences in force at the end of 1950, compared with 392 permanent and 634 temporary licences at the end of 1949. Registered premises increased from 59 to 62.

The records of several thousand dealers selling small arms ammunition were checked to ensure compliance with the regulations. Numerous unlicensed premises where blasting explosives were kept for private use in small quantities were inspected.

INSPECTIONS

	Factories	Magazines	Registered premises	Unlicensed premises
Explosives Division Inspectors	37	664	49	978
Royal Canadian Mounted Police	—	510	18	6,467

IMPORTATION PERMITS

The Division issued 532 permits and 16 special permits for the importation of such items as nitrocotton for the paint industry, fireworks, distress signals, propellant powders used in making small arms ammunition, and small quantities of nitroglycerine for blowing oil wells.

ACCIDENTS

Five persons were injured in two accidents that occurred in a fireworks factory where toy caps were being manufactured.

One man died several months after he had received burns in a fire that occurred in the mixing room of an ammunition plant of Canadian Arsenals Limited.

An unusual accident occurred near the town of Malartic, Quebec, when the magazine owned by Barnat Mines Limited exploded following a fire. The cause of the fire has not been determined. There were no serious injuries as the explosion occurred at night. Damage was estimated at $40,000, including the breaking of over 2,000 windows in the town of Malartic. Although this magazine is not under the jurisdiction of the Division, inquiries were made at the scene because of the value of data that might be obtained on the damage done.

Reports were received of 120 accidents in the use and handling of explosives. As a result of these accidents 13 persons died and 123 were injured. Most of them occurred in the mining, logging, and construction industries, but a number of children were injured as a result of playing with detonators and other explosives.

—	Accidents	Killed	Injured
Mines and quarries	46	4	54
Elsewhere in industry	27	6	24
Playing with detonators	11	0	13
Playing with other explosives	12	1	19
Miscellaneous	3	0	4
Manufacture, keeping, and conveyance	21	2	9
Total	120	13	123

PROSECUTIONS

Ten cases were prosecuted for violations of the Explosives Act. Nine convictions were obtained and fines were imposed. Infractions were as follows:

Improper storage	7
Failure to keep records of sales	1
Smoking in prohibited areas	2

Four men were fined for improper use of explosives under provincial mining acts.

Eight persons were fined under city by-laws for causing damage to property or injury to persons with fireworks.

DESTRUCTION

Abandoned or deteriorated explosives destroyed amounted to 22,800 pounds of blasting explosives and 30,500 detonators.

SURVEYS AND MAPPING BRANCH

W. H. Miller, Director

The demand for surveys, maps, and charts continued to grow, and facilities were taxed to the limit to complete even those projects given a high priority. Most of the efforts, as high as 90 per cent in some divisions, was directed to the production of maps and charts required for defence purposes.

The introduction of new developments in technique and equipment resulted in a marked increase in the manuscripts compiled and prepared for printing.

Close co-operation was maintained with provincial and federal organizations, who supplied most useful information for inclusion in the publications.

The Branch continued to co-operate with the Army Survey Establishment of the Department of National Defence in the production of topographical maps.

Reports on the activities of the Branch follow.

TOPOGRAPHICAL SURVEY

The Topographical Survey does the field control surveys and completes the resultant map manuscripts up to the stage of final draughting, for medium and large scale mapping required by the Federal Government. It includes the National Air Photographic Library, which is responsible for indexing, preserving, and distributing prints for all air photography done by or for the Federal Government; and it administers and provides funds for the Canadian Board on Geographical Names.

The Topographical Survey has two major units, namely, the Topographical Mapping Section, which is responsible for field surveys, and the Air Survey Section, which plots and produces maps from aerial photographs with control provided by field surveys. Its Map Editing Section and Computation Section, are responsible, respectively, for map editing and finishing, and mathematical computations.

The work of the Survey has been steadily expanding since 1946 to meet the requirements of the accelerated mapping program, as approved by the Cabinet, and the program for the fiscal year was the largest yet undertaken. A moderate increase in field staff and the use of more modern and efficient plotting instruments and techniques resulted in an appreciably greater output than in any previous year. Difficulty was again experienced in recruiting and holding graduate engineers suitable for field work.

Following the successful use of helicopters in 1949 for field transportation, two projects were undertaken in 1950, one with two helicopters and a servicing aircraft in northern Yukon, the other with one helicopter and auxiliary aircraft in Quebec–Labrador. Although the area covered in Yukon was below expectations, it is believed this is the most feasible method of mapping northern areas difficult of access. The Quebec–Labrador operation was very successful, as regards both speed and economy.

Production from the multiplex plotting sub-section continued to improve in quantity and quality. An important addition was made to the precision equipment now in use by the acquisition of a Wild A-5 "Autograph".

More than 18,000 advance information prints were distributed to federal and provincial authorities and to the public, a marked increase over previous years.

TOPOGRAPHICAL MAPPING

This Section did original ground surveys for control of mapping from aerial photographs over widely distributed areas totalling 132,645 square miles. Eighteen of the seventy-eight field parties were provided by the Army Survey Establishment. The field projects carried out are listed below:

Province or territory	Number of parties	Type	Scale	Area (square miles)
Northwest Territories	2	Special investigations	.....	.....
Yukon	6	Photo-topographical	1 in. to 4 miles	13,800
British Columbia and Yukon	3	Triangulation	.....	270-mile net
	3	Topographical	1 in. to 1 mile	450
British Columbia	6	Photo-topographical	1 in. to 4 miles	18,800
	1	Photo-topographical	1 in. to 1 mile	960
	1	Winter traverse (chain)	1 in. to 1 mile	95 lin. miles
	1	Winter traverse (stadia)	1 in. to 4 miles	380 lin. miles
Alberta	4	Topographical	1 in. to 1 mile	4,665
	1	Interpretation	.....	.....
Saskatchewan	3	Topographical	1 in. to 1 mile	4,978
Manitoba	1	Levelling	1 in. to 1 mile	1,000 lin. miles
	3	Planimetric	1 in. to 1 mile	5,992
	1	Interpretation	.....	.....
Ontario	1	Topographical	1 in. to 1 mile	429
Quebec–Labrador and Quebec	4	Topographical	1 in. to 1 mile	21,319
Quebec	4	Planimetric and Interpretation	1 in. to 1 mile	7,392
Quebec–New Brunswick	1	Topographical	1 in. to 1 mile	360
New Brunswick	5	Topographical	1 in. to 1 mile	2,771
Nova Scotia	5	Topographical	1 in. to 1 mile	2,762
Newfoundland	4	Topographical	1 in. to 1 mile	5,467
	60			90,145
		Field Interpretatian		
Alberta, Manitoba, and Quebec	Three parties were employed part of the season on field checks and interpretation over a total area of			21,390
		Army Survey Establishment		
Northwest Territories and Yukon	4	Triangulation	1/250,000	630 lin. miles
Yukon	3	Photo-topographical	1/50,000	9,600

Province or territory	Number of parties	Type	Scale	Area (square miles)
British Columbia	4	Photo-topographical	1/250,000	26,000
	2	Photo-topographical	1/50,000	2,400
	1	Winter traverse (chain)	1/50,000	
Alberta	3	Topographical	1/50,000	3,300
Newfoundland	1	Topographical	1/50,000	1,200
	18			42,500

During the latter part of the field season, several field officers were moved to the Winnipeg district to do a levelling project in connection with flood control measures in the Red River Valley.

Three parties during the first 3 months of 1951 were engaged in running control traverse for mapping in the Fort Nelson district, northern British Columbia, in an area where swamp and muskeg makes summer traverse impractical. One party was provided by, and was under the direction of, the Army Survey Establishment. Another, through co-operation of the Geodetic Survey, established traverse control north of Fort Nelson.

Five senior officers were engaged in field supervision and co-ordination. One was in charge of the helicopter project in northern Yukon, and another was responsible for reconnaissance mapping in central British Columbia. The third gave his attention to the helicopter work in Quebec and Labrador, and two others supervised surveys in New Brunswick and Nova Scotia.

AIR SURVEY

This Section is organized in two subsections of three plotting units each and one multiplex subsection of three plotting units. It completed the following mapping work:

Province or territory	Number of map-sheets	Publication scale	Area (square miles)
Planimetry—			
Northwest Territories	5½	1 in. to 4 miles	20,929
	8	1 in. to 1 mile	1,483
Yukon	2½	1 in. to 4 miles	10,640
British Columbia	1¼	1 in. to 4 miles	7,368
Alberta	30	1 in. to 1 mile	10,930
Saskatchewan	47	1 in. to 1 mile	18,127
Saskatchewan and Manitoba	4	1 in. to 1 mile	1,452
Manitoba	70	1 in. to 1 mile	25,040
	1	1 in. to 4 miles	5,296
Manitoba and Ontario	2	1 in. to 1 mile	774

Province or territory	Number of map-sheets	Publication scale	Area (square miles)
Quebec	4½	1 in. to 1 mile	1,528
	2	1 in. to 4 miles	9,746
Quebec and Labrador	6	1 in. to 4 miles	28,512
New Brunswick	1	1 in. to 1 mile	335
Nova Scotia	6	1 in. to 1 mile	2,161
Coastal areas (for Hydrographic Service and miscellaneous mapping)—			
Northwest Territories	8	1 in. to 1 mile	3,184
	3	1 in. to ½ mile	625
	1	1 in. to 2 miles	450
	10	1 in. to 4 miles	25,181
Yukon	3	1 in. to 4 miles	223
	2	1 in. to 500 feet	23
British Columbia	1	1 in. to 500 feet	3
	2	1 in. to ½ mile	691
	2	1 in. to 4 miles	3,231
Manitoba	3	1 in. to 4 miles	4,385
Ontario	1	1 in. to 1,000 feet	10
	3	1 in. to ½ mile	1,023
	2	1 in. to 4 miles	11,774
Quebec	2	1 in. to 1 mile	414
	1	1 in. to 4 miles	1,655
Quebec and Labrador	1	1 in. to 1 mile	15
New Brunswick	1	1 in. to 1 mile	415
Nova Scotia	1	1 in. to 1 mile	4
Newfoundland	2	1 in. to 1 mile	55
Grand total of planimetric mapping			197,682
Topographical maps—			
Northwest Territories	11	1 in. to 1 mile	2,528
British Columbia	1	1 in. to 1 mile	326
Alberta	1½	1 in. to 1 mile	433
Quebec	5	1 in. to 1 mile	1,131
Quebec and Labrador	6	1 in. to 1 mile	1,807
Quebec and New Brunswick	1	1 in. to 1 mile	50
New Brunswick	1	1 in. to 1 mile	416
Nova Scotia	3	1 in. to 1 mile	44
Newfoundland	11	1 in. to 1 mile	2,808
Grand total of topographical mapping			9,543

Province or territory	Number of map-sheets	Publication scale	Area (square miles)
Mosaics—			
Northwest Territories	2		5,973
Yukon and British Columbia	12		32,193
Quebec	12		14,157
Newfoundland	15		15,905
Total	41		68,228

The planimetric mapping shows an increase of about 40 per cent and the topographic shows a twelvefold increase over 1949–50. The increase in both types of mapping is attributed to additional training, experience, and more efficient methods.

Contouring Equipment

Multiplex. This consists of fifteen full tables with adequate projectors and spare tracing tables, together with two three-projector tables, and one two-projector table for plotting single overlaps. The whole procedure of multiplex plotting is under review to determine its most economical and effective use in meeting Canadian mapping conditions.

Wild A-5 Autograph. This equipment is being used on a large scale survey of the flood areas along Red River in Manitoba.

Wernstedt-Mahan Plotter. One of these instruments is in operation.

MAP EDITING

This Section processes map manuscripts to their final stage before being forwarded for reproduction and publication. It prepares tracings for advance information prints, draws projections for the whole organization, and prepares metal mounted manuscript sheets. The work during the fiscal year is tabulated below:

Map-sheets Forwarded for Reproduction

Province or territory	1 mile	4 mile	Total	Area (square miles)
Newfoundland	5	.....	5	1,982
Nova Scotia	19	.....	19	7,988
New Brunswick	7	.....	7	2,916
Quebec	.....	1	1	5,015
Quebec-Newfoundland	6	3	9	19,057
Manitoba	15	1	16	10,381
Saskatchewan	6	.....	6	2,320
Alberta	11	.....	11	3,840
British Columbia	.....	2	2	9,746
Yukon	.....	5	5	22,913
Northwest Territories	22	3	25	19,590
	91	15	106	105,748

Special Map Projects Forwarded to Geological Survey

Province or territory	Projects	Area (square miles)
Quebec–Newfoundland	1	38
Quebec	1	96
Northwest Territories	1	49

Special Projects Forwarded to Hydrographic Service

Ontario and Quebec	1	10

Manuscripts Forwarded to Special Projects Branch, Department of Resources and Development

British Columbia–Yukon (Comprises 16 manuscripts and 5 detail drawings)	1	450

Map-sheets Inked or Traced for Advance Information Prints

Newfoundland	10
Newfoundland–Quebec	23
Nova Scotia	16
New Brunswick	7
Quebec	17
Ontario–Manitoba	1
Manitoba	77
Saskatchewan	60
Alberta	46
British Columbia	11
Yukon	12
Northwest Territories	31
	311

Three hundred and twenty-three projections were drawn to various scales and three hundred manuscripts were mounted on metal. Numerous index maps, charts, and special drawings were prepared.

COMPUTING

This Section does the computations and adjustments relative to the operations of the field parties and the geographical control required by the Air Survey and Map Editing Sections. Computations were made for certain provincial, railway, and highway surveys and for the Dominion Lands System. The geographic positions of township corners on all base lines and meridians in Alberta north of the 15th base line, and in British Columbia for the Peace River Block, were computed and adjusted to the most recent ties made by the Geodetic Survey, and the results were blueprinted. This and other control data were supplied to Federal Government units, to the provinces, and to various private organizations.

NATIONAL AIR PHOTOGRAPHIC LIBRARY

This unit is a central reference library of aerial photography in Canada. A printed copy of each aerial negative exposed by or for the Federal Government is filed and indexed to show its geographical location. In the fiscal year, 195,954 prints were added to the collection, bringing the total number of prints on hand to 2,254,708.

Coverage by vertical photography during the fiscal year totalled 499,700 square miles, and by trimetrogon photography, 405,800 square miles, the latter areas being in the Northwest Territories and the Arctic Islands.

Complete records concerning the conditions under which the aerial negatives were exposed, and the facilities for stereoscopic examination of the prints, are available to all those engaged in the development of Canada's resources.

During the past year 2,320 requisitions covering the purchase of 395,851 prints of aerial negatives were prepared and forwarded to the Photographic Establishment of the Royal Canadian Air Force. These prints were for transmission to Dominion and Provincial Government services, engineering, commercial, and educational institutions, and to private individuals.

CANADIAN BOARD ON GEOGRAPHICAL NAMES

Names for 156 maps and 14 hydrographic charts were adopted, and many new names, name changes, and other items of related business were considered. Numerous inquiries from the public and departments of the public service were investigated and the required information was supplied. Preparation of the forthcoming Gazetteer of Canada series was under way.

Seven provincial members or their representatives attended the February 1951 meeting of the Board at which several items of particular interest to the provinces were discussed. The secretary of the Geographic Board of Alberta was also present.

The present membership of the Board is:

Chairman	P. E. Palmer
Executive Committee	C. H. Smith
	R. J. Fraser
	M. G. Cameron
Members	Norman Fee
	A. McFarlane
	J. G. Wright
	C. E. Cairnes
	N. L. Nicholson
Provincial members:	
British Columbia	W. H. Hutchinson
Alberta	H. P. Brownlee
Saskatchewan	A. I. Bereskin
Manitoba	H. E. Beresford
Ontario	F. W. Beatty
New Brunswick	J. G. B. Pugh
Nova Scotia	A. E. Cameron
Prince Edward Island	The Honourable J. Walter Jones
Secretary	L. B. Skinner.

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

HYDROGRAPHIC SURVEY

The Survey produces the hydrographic aids to navigation, covering the oceanic, estuarial, and inland navigable waters of Canada, its principal func-

tion being the production of standard nautical charts. These aids to navigation show the coasts and their conspicuous landmarks, foreshores, soundings, depth-contours, channels, shoals, reefs, and islands. Also delineated on the charts are the lighthouses, buoys, beacons, and other navigational features on the various water routes. Nautical publications include the standard Canadian navigation charts, charts for special purposes, Coast Pilots and Sailing Directions, Water-level Bulletins, and the official Tide and Current Prediction Tables.

Administration is directed from the headquarters at Ottawa, which is also the clearing centre for general navigational information. The district establishment at Victoria, British Columbia, supervises the charting and tidal operations on the Pacific coast and serves as the principal distributing centre for nautical publications pertaining to that seaboard. Technical work of the Hydrographic Survey is performed by four main operating sections: Charts and Sailing Directions; Hydrography and Ships; Tidal and Current Survey; and Precise Water-levels.

CHART PRODUCTION

So far as possible chart production was geared to meet the expanding naval requirements. In this connection a new trend in hydrographic demand is for complete chart coverage of Canadian Arctic and sub-Arctic waters. Canadian charts are based mainly on the results of original field charting, but in the case of northern regions, where such detailed surveys are not always available, "provisional" charts of certain isolated harbours, anchorages, and roadsteads are compiled from the most reliable reports of explorers, logs of Government patrol vessels, naval advices, and air-photographic plots supplied by the Topographical Survey.

Thirty-three new charts were made available to the public during the year, included in which were general charts of Hudson Strait and of the St. Lawrence-Great Lakes Waterway. The expansion of the water-borne tourist trade was again reflected in an increased demand for large-scale charts and detailed sailing directions specially prepared for owners of the fleet of small vessels that operate in inland waters.

A modern chart catalogue and price list containing sectional index maps, showing the areas covered by the individual charts, was made available. The publication of new charts subsequent to those listed in the catalogue, are advertised through the medium of Canadian Notices to Mariners.

PILOTS AND SAILING DIRECTIONS

The nautical information contained in these standard publications supplements that shown on the charts. They describe the coastal and inland navigable waters of Canada and set forth concise instructions for navigating difficult waters. Additional volumes are required to cover the seaboards of Newfoundland including Labrador. Revised editions of standard volumes are published from time to time, and supplements to the parent books are issued when sufficient new information has accumulated. Several of these publications were produced during the fiscal year.

NAUTICAL RESEARCH

This unit investigated, evaluated, and compiled source material for special hydrographic chart purposes, emphasis being on the collation of Arctic data. It assisted in the preparation of new chart-layout schemes of Arctic areas, in chart-checking, and in nautical and cartographic calculations.

HYDROGRAPHY AND SHIPS

Surveys were conducted on the Canadian Atlantic and Pacific seaboards, Gulf of St. Lawrence, Hudson Strait, Hudson Bay, and in Frobisher Bay. Work in inland waters included the Yukon system of lakes and rivers. In no other year were field operations more widely dispersed.

The surveying fleet of major vessels, *Acadia*, *Cartier*, *Kapuskasing*, and *Fort Frances*, on the Atlantic, and the *Wm. J. Stewart* and *Parry* on the Pacific, was joined during this year by two chartered ships, the *Algerine* and the *Terra Nova*, both of which were operated in northern waters. In addition to these, the motor cruisers *Bayfield*, *Boulton*, *Henry Hudson*, *Anderson*, *Dawson*, and *Grebe* were in commission. A fleet of twenty-four echo-sounding power launches and other small tenders were attached to the surveying vessels.

HYDROGRAPHY

Atlantic Coast and Arctic Waters

Bell Island-Battle Harbour, Nfld. The *Acadia* charted Newfoundland waters, including the areas of Bell Island in Conception Bay and Battle Harbour on the coast of Labrador. The echo-sounders with which the ship and her auxiliary launches are equipped proved highly capable of producting large-scale records, almost pictorial in appearance and precision, by locating and identifying by dimensions and outline the submerged wrecks of three ore carriers torpedoed during the war. Other work consisted of obtaining detailed soundings over Merlin and Ruby Rocks at the entrance to St. John's Harbour, Nfld., and shoal examinations at other places on the coast. As a result of the work a new chart of the Bell Island area will be published, and basic data will be made available for forthcoming new charts of the Battle Harbour area. Hydrographic work accomplished consisted of:

Ship sounding	130	linear	nautical	miles
Boat sounding	836	"	"	"
Coastlining	49	"	"	"
Shoals examined	4			

Botwood and Lewisporte, Nfld. The *Cartier* first surveyed an area off Pointe des Monts reported by the Naval Service, and did detailed charting for the Defence Department in the Bay of Exploits and at Lewisporte, Nfld. As a result of the season's work two new nautical charts will be published. Hydrographic work accomplished consisted of:

Ship sounding	1,065	linear	nautical	miles
Boat sounding	282	"	"	"
Coastlining	20	"	"	"

Hare Bay and Approaches, Nfld. The *Kapuskasing* completed the detailed charting of Hare Bay area and of special surveys in the Strait of Canso. As a result of the season's operations four new navigation charts will be published. Hydrographic work accomplished consisted of:

Ship sounding	1,300	linear	nautical	miles
Boat sounding	1,985	"	"	"
Coastlining by stadia	15	"	"	"
Shoal examination	121			

Several bathythermographic tests were made and the results were supplied to the Biological station at St. Andrews, N.B.

Halifax, N.S., Area and Saint John Harbour, N.B. The *Fort Frances*, with the auxiliary motor cruisers *Anderson* and *Dawson*, conducted a major

coastal survey from Egg Island to West Ironbound Island, N.S., including the immediate approaches to Halifax. Radio direction-finding stations at Camperdown and Red Head were calibrated.

On the urgent request of the Department of Transport the motor cruiser *Dawson* made a last-minute voyage from Halifax to Saint John in mid-November to survey the waters of the upper harbour in the interests of a projected oil-tanker service for the Saint John industrial area.

As a result of the season's operations three new nautical charts will be published. Hydrographic work accomplished consisted of:

Ship sounding	2,886	linear	nautical	miles
Launch sounding	1,584	"	"	"
Coastlining	120	"	"	"
Shoals examined	95			

Hudson Strait-Labrador. The chartered vessel *Terra Nova* did preliminary charting in Hopedale Harbour and approaches, Labrador, and then proceeded to Hudson Strait where an examination was made of a south coast area. The main project was the extension of the charting of Coral Harbour, Southampton Island. Ship soundings were obtained on various courses in Hudson Strait and in the runs inside the islands on the Labrador coast. At the commencement of the season the motor cruiser *Henry Hudson* was used to extend the previous year's charting of the East River-Pictou Harbour area.

As a result of the season's work a new edition of the Coral Harbour chart will be issued, additions will be made to hydrographic data on the general charts of Hudson Strait and Hudson Bay, and the groundwork is laid for more extensive surveys on the Labrador and Hudson Strait coasts. Hydrographic work accomplished consisted of:

Ship sounding	430	linear	nautical	miles
Boat sounding	320	"	"	"
Coastlining	25	"	"	"

Frobisher Bay. In its main work of the season the chartered ship *Algerine* charted Frobisher Bay from Pink Lady Island to Koojesse. It also made a survey of Port Burwell and approaches. Several previously uncharted reefs were found in Frobisher Bay, various passages and inlets were examined, and tidal information was obtained; also track soundings for chart use were taken on the voyage. As a result of the work three new charts will be published. Hydrographic work accomplished consisted of:

Ship sounding	1,628	linear	nautical	miles
Boat sounding	520	"	"	"
Coastlining	250	"	"	"
Shoals examined	12			

Chesterfield Inlet–Baker Lake. As a result of the charting of this waterway by the launch *Grebe*, a deep-water channel leading from the inlet into Baker Lake was found and suitably marked by navigational ranges. While on board the local supply vessel, soundings for chart use were obtained at various places in Hudson Bay.

Hydrographic work accomplished included:

Ship sounding	510	linear	nautical	miles
Boat sounding	135	"	"	"
Coastlining	20	"	"	"
Shoals examined	4			

INLAND WATER OPERATIONS

Using an echo-sounding launch, a party from the Pacific Coast Establishment of the Hydrographic Service sounded parts of Yukon River and connecting lakes, and investigated navigation conditions there.

Great Lakes. The motor launch *Bayfield* cruised the Rideau and St. Lawrence Rivers and Great Lakes from Ottawa to Meaford, testing types of echo-sounding apparatus, and investigating and checking channels and harbours for chart revisions and Sailing Directions.

PACIFIC COAST OPERATIONS

The *Wm. J. Stewart* carried out major hydrographic operations in Queen Charlotte Strait, Browning Entrance, and Whale Channel areas. It conducted operations at various other places for special defence purposes, and made isolated hydrographic examinations between Vancouver and Prince Rupert.

At the request of the Joint Committee on Oceanography, made up of representatives from the Royal Canadian Navy, the Fisheries Research Board of Canada, the National Research Council, and the Hydrographic Survey, the *Wm. J. Stewart* made a special cruise to determine ocean depths and currents along a route of 1,400 nautical miles, which extended 500 miles into the Pacific Ocean. During this work daily water samples were collected to determine temperatures and salinities of sea water at various points, which information was required by the Department of National Defence, and for use in the biological research being conducted by the Department of Fisheries.

As a result of the charting operations a number of new charts will be published. Hydrographic work accomplished consisted of:

Ship sounding	663	linear	nautical	miles
Boat sounding	2,176	"	"	"
Coastlining	325	"	"	"
Shoals examined	415			
Oceanographic stations	47			

The smaller ship *Parry* was used for charting in Discovery Passage, and was used subsequently in connection with an extensive tidal current study known as the Fraser River Estuary Project, in the Burrard Inlet approaches to Vancouver Harbour and Fraser River. The latter work was done to determine the best way of disposing of sewage from the Greater Vancouver district so it would be dissipated by the currents and would not pollute the city foreshore.

PRECISE WATER-LEVELS

The recording, tabulating, and co-ordinating of the water-level fluctuations of the St. Lawrence–Great Lakes Waterway and lower Ottawa River was continued. The information is required in connection with lake- and river-level control, power development, municipal engineering, and navigation. A preliminary study of the water levels in the Great Slave Lake-Mackenzie River system is in progress. Self-registering gauges were maintained at forty-eight locations from Quebec to Port Arthur. The water-level information was promulgated in twelve monthly, five annual, five graphical, and six general bulletins. Five concise hydrographs of water levels since 1860 were prepared, and were much in demand.

TIDAL AND CURRENT SURVEY

This unit investigates tides and tidal currents in Canadian coastal waters, and prepares the official annual tidal prediction tables. The work is required for marine navigation, fishing, harbour administration, and marine engineering in general. An intensive survey was made of the tidal current in Vancouver Harbour, approaches to Victoria Harbour, Gordero Channel, B.C., and in Halifax Harbour. Specialized information was furnished to shipping municipalities, government departments, and coastal industries.

Co-operation with Other Services. Much nautical information was exchanged with other departments.

The Hydrographic Survey provides a world-wide service to mariners engaged in Canada's export and import trades. There was a continual flow of hydrographic information between the Survey and the hydrographic departments of the Admiralty, the United States Coast and Geodetic Survey, and the United States Lake Survey. Canada made arrangements to apply for membership in the International Hydrographic Bureau, a consultative body established in 1921 under the auspices of the League of Nations, to standardize publications, improve charting methods, and advance the theory and practice of hydrography. The Survey is represented on the Canadian Board on Geographical Names and on the Canadian Joint Committee of Oceanography.

DISTRIBUTION OF HYDROGRAPHIC PUBLICATIONS

Naval requirements were a main factor in the record demand for nautical charts. Sales to the water-borne tourist trade remained at the high level established in 1949. In accordance with recognized international practice, the information contained in Canadian Hydrographic charts and publications is reproduced by other hydrographic offices for the use of their own vessels, so that the total world circulation is greatly in excess of the 1950 figures given below.

Catalogue of Charts, Sailing Directions, and Tidal Information with index maps	1,563
Navigation charts	49,738
Instructional charts, special charts, etc.	68,815
Pilots and Sailing Directions	1,266
Supplements to Pilots	531
Tide Tables	60,473
Water-level bulletins, graphs, etc., exclusive of those distributed through Notices to Mariners	9,983

Canadian nautical publications are made available to the sea-going trades either from headquarters at Ottawa and Victoria or through official chart agents appointed in the principal seaports and inland-water ports.

GEODETIC SURVEY

The Geodetic Survey provides the necessary framework for surveying, mapping, and engineering projects throughout Canada that are undertaken by the Federal and Provincial Governments and by private engineering firms. The Division determines the latitudes and longitudes of selected points, and their precise elevations above mean sea-level, to an accuracy suitable to the demands. The positional information, termed "horizontal control", is obtained by different methods — triangulation, astronomical observations, and newly developed radar electronic distance measurements. The elevations, or "vertical control", are obtained by lines of accurate levels based on the Canadian Geodetic level datum.

The Survey placed thirty parties in the field, and about 90 per cent of this work will form a basis for mapping related directly or indirectly to defence projects. The Shoran method of determining long distances was applied in the field in co-operation with the National Research Council, Royal Canadian Air Force, and the Meteorological Service. An area in Manitoba and Saskatchewan 1,100 miles long and 200 miles wide was completed in a highly satisfactory manner. Canadian and other survey organizations have shown widespread interest in this application, and to help meet the demand for further details, nine semi-technical articles were prepared and were published in the Canadian Surveyor.

Recent developments in electronics indicate that instruments may be available shortly for very accurate measurement of short lengths, or base lines such as are needed in the length control of visual triangulation. Their application would supersede present methods of invar taping and greatly reduce the cost of this type of control.

TRIANGULATION

Six main parties comprising twenty-four sub-parties did primary and secondary triangulation in widely separated areas.

Along the Alaska Highway, two main parties operating east of Watson Lake and near Dawson Creek completed 170 miles of primary triangulation as a basis for control of surveys and topographical mapping. Stations for a network between Dawson Creek and Prince George were also reconnoitred, and following the Hart Highway were prepared to the vicinity of Pine Pass.

In Ontario, a party operating north of Lake Superior completed 100 miles of the gap of 550 miles of the proposed primary net covering the southern part of Canada, which when completed will extend from St. John's, Newfoundland, to the Pacific coast. This net is now completed to the vicinity of Schreiber, Ontario, and stations have been selected to permit the extension of the net to Lake Nipigon.

A small party in the Ottawa area selected and prepared a large number of stations for a secondary triangulation net for use of the National Research Council in calibrating aerial cameras, and carried out an observational program at these stations.

Commencing at Wakauch Lake, about 70 miles north of Knob Lake in the Quebec–Labrador iron ore region, a secondary triangulation net was extended for 110 miles to the vicinity of Fort McKenzie. As a result of this and previous work, the net now extends from Fort McKenzie to Seven Islands on the north shore of the Gulf of St. Lawrence, the terminal port for the railway now being constructed to the iron ore deposits. This net will be carried to Fort Chimo and will provide a basis from which further control may be extended to other parts of the mineralized zone and for topographical mapping of the area.

In Newfoundland, a secondary triangulation net was completed between Trinity Bay and Fortune Bay, and a number of stations were selected and prepared for extension of the net along the southern coast to Little or Grey River. A request has been made by France to extend the survey to include the islands of St. Pierre and Miquelon.

PRECISE LEVELLING

In Newfoundland, approximately 195 miles of precise levelling were completed along the Canadian National Railway's main line between Shoal Harbour and Quarry Bay, and an additional 154 miles along branch lines. The elevations of 166 bench marks were established to provide vertical control for topographic mapping in certain mineralized areas of the province.

Approximately 435 miles of precise levels were run along the Alaska and Hart Highways, and spur lines to establish basic elevations for use in topographic mapping and in engineering investigations connected with water storage and power developments for the area south of Whitehorse, Yukon. The elevations of 192 bench marks were determined.

In Manitoba, 100 miles of levels were run along Red River to provide a basis for engineering investigations in connection with flood control in the Winnipeg and adjacent areas.

To provide vertical control for the test area to be used by the National Research Council in calibrating aerial cameras, 43 miles of secondary levels

were run in the area north of Ottawa River west of Hull, Quebec. In this work, 7 Geodetic Survey bench marks were established and the elevations of 143 Topographical Survey bench marks and 6 triangulation stations were determined.

A party extended a line of precise levels from Fort Nelson on the Alaska Highway to the 60th parallel of latitude, to provide control for the Alberta–Northwest Territories boundary survey and for mineral and oil explorations.

GEODETIC ASTRONOMY AND ISOSTASY

Field work was carried on over a wide area, including parts of the Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Labrador.

Five Laplace azimuth stations were established in the Northwest Territories and in northern Quebec and Labrador for the control of twist in the triangulation and Shoran nets.

Seven precise latitude stations were established between longitude 122°13′ west and Liard River for the demarcation of the 60th parallel of latitude between British Columbia, Alberta, and the Northwest Territories.

Sixty-eight second-order astronomical stations were observed in position for control of aerial mapping in several areas and for the control of the central Canada Shoran net.

A base-line adjacent to the airplane landing strip maintained by Hollinger Ungava Transport Company at Knob Lake was measured with primary accuracy to control the length of the second-order triangulation net in northern Quebec and Labrador.

Magnetic observations were obtained at 36 points to increase the data in connection with terrestrial magnetism.

MATHEMATICAL ADJUSTMENTS

The scope of this unit was enlarged to include with triangulation adjustments the adjustment of precise level nets.

Work in connection with the adjustment of four primary and six secondary triangulation nets was undertaken. A new general adjustment of the entire Canadian precise level net is proposed.

INTERNATIONAL BOUNDARY COMMISSION

The International Boundary Commission functions by virtue of the treaty of 1925 between Canada and the United States. Article IV of this treaty provided that the International Boundary Commissioners, one for Canada and one for the United States, appointed under the treaty of 1908, should be re-appointed "to provide for the maintenance of an effective boundary line between the Dominion of Canada and the United States and the Dominion of Canada and Alaska", and "upon the death, resignation, or other disability of either of them, the Party on whose side a vacancy occurs shall appoint an Expert Geographer or Surveyor as Commissioner". The treaty further stipulated:

> "The said Commissioners shall submit to their respective Governments from time to time, at least once in every calendar year, a joint report containing a statement of the inspections made, the monuments and buoys repaired, relocated, rebuilt, moved, and established, and the mileage and location of vistas opened, and shall submit with their reports, plats and tables certified and signed by the Commissioners, giving the locations and geodetic positions of all monuments moved

and all additional monuments established within the year, and such other information as may be necessary to keep the boundary maps and records accurately revised."

Each Section of the Commission has its own staff of engineers, draughtsmen, and stenographers. Expenditures for the maintenance of the boundary are shared equally by the two countries, but each country pays the salaries and travelling expenses of its own Commissioner and his assistants. The Commissioners meet at least once annually, alternately in Ottawa and Washington, to co-ordinate the work of the two Sections, to sign letters of transmittal and certificates for their annual joint reports, to sign statements of divisible expenditures, and to discuss boundary matters in general.

CONFERENCES OF THE COMMISSIONERS

At a meeting of the Commissioners held in Washington from April 17 to April 19, 1950, J. L. Rannie, the recently appointed Commissioner for Canada, presented his credentials to the United States Commissioner, John A. Ulinski. Matters were discussed relating to the revision of certain parts of the forthcoming joint report upon the establishment of the International Boundary from Portland Canal to Mount St. Elias, and the special adviser on geography of the United States Department of State was consulted regarding the publication of maps that are to accompany the report. In discussing boundary maintenance, the Commissioners agreed: that tenders should not be submitted to bidders for the project of removing the present leaning offshore range mark at Point Roberts and re-erecting it on a new site on dry land until the 1951 United States congressional appropriation for that purpose was assured; that the unlighted buoys in Lake Erie southeast of Pelee Island should be replaced by lighted buoys; and that maintenance operations should be conducted by Canadian parties on the Southwest Line and on St. Francis River, on the Quebec–Maine and the Quebec and New Brunswick–Maine boundaries respectively, and by United States parties on the Highlands and on the North Line on the Quebec–Maine and the New Brunswick–Maine boundaries respectively.

A second meeting of the Commissioners was held in Ottawa from February 20 to February 23, 1951. Details regarding the publication of the joint report upon the establishment of the International Boundary from Portland Canal to Mount St. Elias were agreed upon, and the United States Congress having by then released funds for the Point Roberts project, it was agreed that invitations to tender should be sent to Canadian and United States contractors. Further regarding boundary maintenance, the Commissioners agreed: that Canadian parties should operate on the Southwest and South Lines on the Quebec–Maine boundary and on the 49th Parallel from the Columbia Valley to the Pacific Ocean on the British Columbia–Washington boundary; and that the United States parties should continue their operations on the Highlands between Quebec and Maine and on the North Line and St. John River on the New Brunswick–Maine boundary.

INSPECTION BY THE COMMISSIONERS

The Commissioners met in Ottawa on July 23. Next day they left for Quebec city where they interviewed the Deputy Minister of Lands and Forests and the Director of Surveys for the province of Quebec. They then inspected maintenance work in progress on the Southwest Line and St. Francis River, following which they examined the boundary tablets on the bridge between St. Leonard and Van Buren, Maine. Thence, via Woodstock, New Brunswick, and Houlton, Maine, they inspected work in progress by the United States party on the North Line.

Next they inspected boundary markers on St. Croix River and on Passamaquoddy Bay. On the breakwater at Lubec, Maine, they found that the base of Range Mark No. 27 had deteriorated badly. From Lubec they went to Colebrooke, New Hampshire, and thence to the Highlands section of the boundary where they inspected work in progress by the United States party. This completed their inspection work.

MAINTENANCE OF THE BOUNDARY

On the Southwest Line, 72 monuments were inspected, 2 monuments were repaired, 2 new monuments were established, and 42 miles of boundary vista were recleared.

On St. Francis River, 30 miles of boundary line and 89 reference monuments were inspected, 25 reference monuments were repaired, 3 were established, 1 was moved, and 3 boundary turning points and 2 line markers were established on land. In addition, 25·2 miles of plane-table surveys of the river, from Beau Lake to Estcourt, were made for the Commission maps to show the new channels made in the course of the river since 1911 when surveys were last made. It was found that 76 boundary turning points are now on dry land and 24 are on gravel bars in a number of parts of the original channel. Two of the islands shown on the Commission maps have disappeared, and three new islands have been formed.

On the St. Lawrence River, a new reference monument, No. 59, was established at Oak Point on the New York side of the river to replace the original reference monument destroyed by building operations.

On Lake Huron and St. Clair River, the geographic positions of the Point Edward Front range light, moved in 1946, and of reference monument 57 were determined, repairs were made to reference monument 55, and another marker was established near it, as it may be displaced by further construction on the water front.

LEGAL SURVEYS AND AERONAUTICAL CHARTS

The Division makes and records legal surveys of lands belonging to His Majesty in the right of Canada or of which the Government of Canada has power to dispose, that are situated in Yukon, Northwest Territories, and the national parks, and that are Indian lands or reserves; prepares and maintains aeronautical charts and flight manuals; prepares electoral maps; plots planimetric base maps from tri-camera aerial photographs; records and indexes survey returns and plans; and distributes plans, maps, and aeronautical charts.

LEGAL SURVEYS

Provincial Boundary Surveys

A survey was made of 90 miles of the unsurveyed part of the Alberta–British Columbia boundary, leaving 85 miles still to be delineated on the ground.

Precise astronomical observations were made to provide control on which to base detailed surveys for 56 miles of the British Columbia–Northwest Territories boundary and 157 miles of the Alberta–Northwest Territories boundary. Field work for the detailed survey of 92 miles of the latter boundary was completed.

Maintenance was undertaken of a part of the British Columbia–Yukon boundary that was surveyed over 50 years ago, and the monuments were restored with substantial concrete blocks.

Permanent concrete monoliths were erected on the northerly 280 miles of the Ontario–Manitoba boundary.

Indian Reserve Surveys

Surveys were undertaken in the following Indian reserves and lands to delineate boundaries, to convey rights of way for highways, etc., and other surrendered areas, to lay out settlement and village lots, and to subdivide the land for agricultural use.

Quebec	Caughnawaga
Ontario	Nipissing, Mountbatten, Rankin Location, St. Regis, Factory Island
Manitoba	Brokenhead, Lizard Point
Saskatchewan	Meadow Lake, One Arrow, Muskoday
Alberta	Ermineskin, Samson, Louis Bull, Montana, Sarcee, Eden Valley
British Columbia	Semiahmoo, Saanich South
Northwest Territories	Latham Island at Yellowknife

Territorial Land Surveys

Northwest Territories. At Hay River Settlement two additional blocks were subdivided into building lots.

Yukon Territory. Lot subdivision surveys were made at Minto and at the intersection of the Alaska Highway and the Haines cut-off road.

Eighteen group lots or parcels of land were surveyed and seven small revision surveys were made.

An investigation was made to select a site for a proposed cemetery at Whitehorse.

Semi-precise, permanently monumented traverses to define the right-of-way limits and provide control for cadastral surveys were made of the new 26-mile highway from Atlin to Jake's Corners, and of the 144 miles of highway from Carmacks to Mayo.

Fifty-three mineral claims were surveyed in the Keno Hill district. New staking in the area is proceeding at a faster pace than the surveys, which to date have been restricted to blocks of claims.

Other Surveys. Surveys were made of: an addition to Prince Edward Island National Park; Port Joli bird sanctuary in Nova Scotia; Queenston Ordnance lands in Ontario; and an historic site at Cobden, Ontario, to mark the spot where Champlain's astrolabe was found; 68 miles of the west boundary of Wood Buffalo Park in Alberta, in co-operation with the province, the cost being equally divided; the townsite of Field in British Columbia, this being a preliminary survey to show encroachments of improvements on road allowances; and of an addition to Mount Revelstoke National Park in British Columbia. Part of the southerly boundary of this park was restored.

Office

Preparation of Plans and Records. At the request of the Provincial Government the Division completed 201 Dominion land survey township plans showing restoration surveys in Saskatchewan for approval and confirmation as required by the Dominion Land Surveys Act. These surveys were made prior to the transfer of the natural resources from the Dominion to the provinces in 1930, but plans of them were not prepared.

It drew 256 miscellaneous plans, tracings, and Indian location ticket sketches; prepared 17 maps showing the Indian agencies in British Columbia

and the names and locations of the reserves in each agency for administrative purposes; added information to 146 plans and to 1,018 blueprints of plans, mostly of Indian reserves; prepared field notes of surveys of 38 mineral claims in Yukon for record purposes; and had in hand compilation of plans and field notes of Muskoday and One Arrow Indian reserves in Saskatchewan.

It recorded 123 plans and 49 field books in the survey records of the Indian Affairs Branch, Department of Citizenship and Immigration; deposited 18 plans for registration in the Land Titles Office for the Northwest Territories at Ottawa, and 12 for registration in the Land Titles Office at Dawson, Yukon; examined 241 plans and 85 field books of legal surveys; dispatched 5,399 blueprints and 681 photostats of survey records; prepared 408 legal descriptions for use in land conveyances, and 124 descriptions of mineral claims.

AERONAUTICAL CHARTS

This Section supplies topographical material from tri-camera photography for the construction of aeronautical charts required for civil and military use, and prepares all air information shown on these charts.

Air Photogrammetry

One mile to 1 inch and 1½ miles to 1 inch plots from tri-camera photographs.

National Topographic Series Index No.	Area plotted Square miles
33	84,973
34	62,924
47	15,536
56	24,480
65	50,010
66	9,520
	247,443
Special plots	18,641
Total	266,084

The Section indexed and filed 37,000 tri-camera photographs, supplied copies of all revised index sheets to the National Air Photographic Library, and prepared operational flight line maps for completion of the tri-camera photography program for Canada.

The accuracy of the tri-camera plots was determined well within the requirements for the 8 mile to 1 inch aeronautical charts. The maximum error in the experiment was ¼ mile and only three points approached this error. The aeronautical charts based on tri-camera plotting are controlled by astronomical fixes that may have a station error as great as ¼ mile.

Chart Construction and Air Information

The section prepared 24 new air information plates of the 8 mile to 1 inch series of aeronautical charts, and revised 157 plates; and prepared 17 new plates at the 1:1,000,000 scale, and revised 12 plates.

The 1:1,000,000 series is designed for coverage of all the land masses of the world at the common scale of 15·78 miles to 1 inch and to the uniform specifications prescribed by the International Civil Aviation Organization. Canada's commitment includes the preparation of the 65 charts necessary to

cover all Canadian territory. To date, 32 map-sheets of the 1:1,000,000 series have been printed, leaving a balance of 33 sheets to complete the coverage of Canada.

The seven charts of the eastern Canadian seaboard, to be used by carrier-based aircraft, were published.

A three-sheet outline map coverage of Canada at a scale of 47⅓ miles to 1 inch (1/3,000,000) on an angle true projection was prepared at the request of the Royal Canadian Air Force to be used as a plotting chart. The base will serve for different overprintings required to facilitate different methods of air navigation. Two editions are planned. One showing isogonals will facilitate navigation by reference to local meridians. The other is designed for navigation by reference to "grid north" lines that are placed on the chart parallel with the Greenwich meridian. On it the magnetic lines or isogrives refer to the grid lines. Both editions will show all major aerodromes and radio facilities.

Canada Air Pilot

Amendments to "The Canada Air Pilot", including a total of 629 aerodrome pages, were sent to subscribers fortnightly. Pages for 12 new aerodromes were printed.

Compilation was started on a full revision of the seaplane base synoptic pages for Volume I of "The Canada Air Pilot". The new issue will have approximately three times the number of seaplane base pages that are now published.

Instrument approach procedures were completely reviewed and issued in a new standard form for 51 aerodromes.

Seven of the new series of 37 radio facility charts were printed and 33 of the present series were revised.

Low approach letdown charts for instrument landing systems for 5 aerodromes were printed, and later revised for two of these aerodromes. Approach and landing charts were printed for 5 aerodromes and preliminary low approach letdown charts were printed for 8 aerodromes.

Columbia River Basin Project

This project now calls for 88 detailed and contoured topographical map-sheets at a scale of ½ mile to 1 inch, 26 of which have been printed or proofed. During the year 13 manuscripts were completed and four field parties obtained data for another 15 sheets.

Radar Altimeter

The drawing was completed of contours obtained from radar altimeter terrain profiles over 125,000 square miles of Quebec and Labrador.

Radar altimeter terrain profiles were obtained over 42,700 square miles of Newfoundland and the transfer of the resulting contour information to aeronautical charts was in progress.

Under a sub-committee of the National Research Council's Survey Research Committee, flight tests were carried out to determine whether terrain profiles of acceptable accuracy can be obtained by radar altimetry. Some sources of error were isolated, and in several flights the elevations of water surfaces were measured with a maximum error of 20 feet. The probable error from the measurements was approximately 6 feet.

SURVEY RECORDS AND ELECTORAL MAPS

Survey Records

Much of the work of the Section consists of supplying information from records to mapping divisions of the Dominion Government, provincial governments, and other organizations.

The Section distributed 8,384 township plans, 1,161 settlement plans, and 397 blueprints of other plans.

All printed stocks of township plans of Manitoba, Saskatchewan, and of the former Dominion lands in British Columbia were transferred to the provinces concerned.

Electoral Maps

Information on electoral district boundaries and other details regarding the maps were supplied to the Chief Electoral Officer, government departments, and others. Data were collected, examined, and filed in preparation for the next redistribution.

Computations

Calculations of several long air mile distances were supplied to the Air Transport Board and to the Post Office Department. Shorter distances were supplied by scaling on aeronautical charts.

MAP DISTRIBUTION OFFICE

During the year 34,467 requests for maps, charts, and publications were dealt with, 500 less than the previous year. The total volume of maps distributed shows an increase of 21,000 over last year.

During the year 130 new maps were received from the press.

The following material was distributed:

National Topographic series maps	152,752
National Topographic series maps published by the Army Survey Establishment, R.C.E.	77,508
Aeronautical and Plotting charts	169,034
Sectional maps	17,289
Old Geographic series	3,910
Miscellaneous maps	243,284
Forestry maps	43
Electoral maps	8,219
Publications	4,019
Total distribution exclusive of Canada Air Pilot	676,058
Canada Air Pilot (Volumes I and II)	
Volumes	189
Amendments	49,304
Sheets	20,768

BOARD OF EXAMINERS FOR DOMINION LAND SURVEYORS

The Board held the annual meeting called for by Section 9 of the Dominion Land Surveys Act. Examinations were held at Ottawa, Winnipeg, Saskatoon, Edmonton, and Victoria. Of a total of 61 candidates, 14 passed the preliminary examination and 14 passed the final examination.

Eleven certificates of preliminary examination, nine commissions as Dominion Land Surveyors, and six Dominion subsidiary standard measures of length were issued as provided for in the Act.

MAP COMPILATION AND REPRODUCTION DIVISION

This Division compiles the base maps on which all aeronautical charts of Canada are produced and is responsible for the revision and printing of the topographical maps of the Surveys and Mapping Branch. It produces most of the maps prepared by other units of the Department. These maps vary widely in types and scales to cover Canada. The work involves the compilation, draughting, and reproduction by photo-lithography in multi-colour, of maps for distribution. There is also a service to government departments for photographic reproductions, photostats, and black and blue-line printing.

There was a marked increase in the demand for maps on the part of the Armed Services, whereas that from the public showed little change from the previous fiscal year.

In 1950-51 the Division printed 568 maps and charts, of which it produced a total of 1,011,425 copies, an increase of 23 maps and charts and 142,000 copies over the previous fiscal year. The maps and charts included 18 new sheets of the World Aeronautical Charts series on a scale of 1:1,000,000, of which Canada is committed by agreement with the International Civil Aviation Organization to supply 65 sheets covering the whole of the country; 47 revisions of 8 miles to 1 inch aeronautical charts of areas in Canada; 3 new and 13 revised topographical maps at 4, 2, and 1 mile to 1 inch; 4 new sheets of the Columbia River Basin series being issued in connection with investigations of the power development, irrigation, and flood control conditions of the Columbia River system; 101 hydrographic charts of coastal and inland waters; and 7 geological figures or maps.

COMPILING

Full or part revisions of maps of the National Topographic series compiled included: thirty-eight 8-mile aeronautical chart bases, ten 4-mile, nine 2-mile, and four 1-mile maps. New compilations included: seven world aeronautical charts at 1:1,000,000; eleven National Topographic series maps; and three new R.C.A.F. navigation plotting charts at 1:3,000,000 scale, covering the whole of Canada. The new compilation of the 100-mile map of Canada was completed to the draughting stage.

Summary of Compilation

—	Scale	First edition	Revised editions
Standard aeronautical charts	8 mi.	.....	8
Preliminary aeronautical charts	8 mi.	.....	30
National Topographic series	1:250,000	9	10
National Topographic series	2 mi.	1	9
National Topographic series	1 mi.	1	4
World aeronautical charts	1:1,000,000	7	.....
Sectional	3 mi.	.....	2
Miscellaneous	.....	4	5

COMPUTING

Co-ordinates were provided for 58 different maps on various projections and at various scales. A modification of the Lambert conformal conical projection for the 100-mile map of Canada was developed to provide improved scale accuracy above 80 degrees north latitude.

DRAUGHTING

This Section draws all the maps and charts produced by the Division and by the Topographical Surveys Division, and does some draughting for other divisions and departments.

New and revised maps for which drawings were completed:

—	Scale	Number
Standard aeronautical charts	8 mi.	11
Preliminary aeronautical charts	8 mi.	23
National Topographic series	1:250,000 (4 mi.)	17
" " "	2 mi.	7
" " "	1 mi.	7
World aeronautical series	1:1,000,000	10
Columbia River Basin series	1:31,680	4
Sectional	3 mi.	2
Overprints	.....	95
Miscellaneous	.....	14

New topographical maps in the 1-, 2-, and 4-mile series compiled by the Topographical Survey are also drawn, checked, and sent to the Army Survey Establishment for photo-lithography.

Statistics on these maps are:

—	Scale	Number
National Topographic series	4 mi.	4
" " "	2 mi.	5
" " "	1 mi.	88
Printing plates corrected — 270 Colour offset plates prepared — 270		

PHOTO-MECHANICAL

This Section produces the lithographic plates, one for each colour of each chart, by photographing the drawings and making negatives from which the plates are made. It turns out the plates for maps and charts of the Legal Surveys Division, the Hydrographic Survey, the Geological Survey of Canada, and the Forestry Branch of the Department of Resources and Development.

Summary

Photo Processing

Wet plate negatives (sq. ft.)	1,903
Film negatives (sq. ft.)	11,061
Photo-litho plates	1,062
Multilith plates	231
Mounted blue lines (F.P.)	499

Photography

Infra red (plates developed)	5,616
Infra red (contact)	3,658
Roll film (developed)	191
Bromide enlargements	2,818
Velox prints	6,274
Transaloid	408
Lantern slides	94
Sensitized linen	1,908
Photostats (sheets)	20,147

Contact and Blue Printing

Blue prints (sq. ft.)	180,211
Blue prints (contact)	20
Vandyke prints (sq. ft.)	14,751
Vandyke prints (contact)	3,740
OCE prints (sq. ft.)	149,217

LITHOGRAPHIC

New and revised maps printed during the fiscal year are shown in the table at the end of this report. Reprints included thirty-eight 8-mile aeronautical charts; five 4-mile, six 2-mile, and one 1-mile sheet of the National Topographic series; and thirty-nine miscellaneous reprints, such as the 100-mile map of Canada, the map showing the forest classification of Canada, Newfoundland 10-mile map, and the orographical map of Canada.

Summary of Printing

——	Maps published	Total copies	Impressions
New maps printed	42	106,375	638,275
Revised maps printed	83	328,585	1,754,045
Maps reprinted	83	273,040	933,490
Hydrographic charts	101	73,835	246,000
Overprints	259	229,590	245,090
	568	1,011,425	3,816,900
Army Survey Establishment			
Maps reprinted	4	26,000	137,000

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1950-1951

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(*i*) *Aeronautical Charts — National Topographic Series*				
Newfoundland	2 SW.	Notre Dame–Bonavista	8 mi.	48°00′ to 50°00′	52°00′ to 56°00′	Stan. edn.—revision
Newfoundland	12 SE.	St. George's–White Bay	8 "	48°00′ " 50°00′	56°00′ " 60°00′	" "
Nova Scotia–P.E.I.	11 NW.	Magdalen Is.–Charlottetown	8 "	46°00′ " 48°00′	60°00′ " 64°00′	" "
Quebec–N.B.	21 NW.	Quebec–Edmundston	8 "	46°00′ " 48°00′	68°00′ " 72°00′	" "
Quebec	22 SW.	Chicoutimi–Rimouski	8 "	48°00′ " 50°00′	68°00′ " 72°00′	" "
Quebec	23 NW.	Kaniapiskau	8 "	54°00′ " 56°00′	68°00′ " 72°00′	Prelim. edn.—revision
Quebec	23 SW.	Nichicun	8 "	52°00′ " 54°00′	68°00′ " 72°00′	" "
Quebec	24 NW.	Fort Chimo	8 "	58°00′ " 60°00′	68°00′ " 72°00′	" "
Quebec–N.W.T.	25 SE.	Resolution Island	8 "	60°00′ " 62°00′	64°00′ " 68°00′	" "
Quebec–N.W.T.	25 SW.	Wakeham Bay	8 "	60°00′ " 62°00′	68°00′ " 72°00′	" "
Quebec	35 SW.	Cape Smith	8 "	60°00′ " 62°00′	76°00′ " 81°00′	" "
Quebec–N.W.T.	35 N.	Hudson Strait W.	8 "	62°00′ " 64°00′	72°00′ " 80°00′	" "
Quebec–Ontario	32 SW.	Noranda–Waswanipi	8 "	48°00′ " 50°00′	76°00′ " 80°00′	Stan. edn.—revision
Ontario–Quebec	31 SE.	Ottawa–Montreal	8 "	44°00′ " 46°00′	72°00′ " 76°00′	" "
Ontario–Quebec	31 NW.	Upper Ottawa River	8 "	46°48′ " 48°00′	76°00′ " 80°00′	" "
Ontario	40 NE.	Windsor–Toronto	8 "	42°00′ " 44°00′	79°00′ " 83°00′	" "
Ontario	52 SE.	Ignace–Ft. William	8 "	48°00′ " 50°00′	88°00′ " 92°00′	" "
Manitoba	54 NW.	Churchill	8 "	58°00′ " 60°00′	92°00′ " 96°00′	Prelim. edn.—revision

Manitoba	63 SE.	Lake Winnipeg	8 "	52°00′ " 54°00′	96°00′ " 100°00′	Stan. edn.—revision
Manitoba	64 NE.	Seal River	8 "	58°00′ " 60°00′	96°00′ " 100°00′	Prelim. edn.—revision
Manitoba–Saskatchewan	63 NW.	Flin Flon	8 "	54°00′ " 56°00′	100°00′ " 104°00′	Stan. edn.—revision
Manitoba–Saskatchewan	64 SW.	Wollaston Lake	8 "	58°00′ " 60°00′	100°00′ " 104°00′	Prelim. edn.—revision
Saskatchewan	73 NE.	Green Lake–Stanley	8 "	54°00′ " 56°00′	104°00′ " 108°00′	Stan. edn.—revision
Saskatchewan–Alberta	72 W.	Medicine Hat–Maple Creek	8 "	49°00′ " 51°00′	108°00′ " 112°00′	" "
Alberta–B.C.	82 SE.	Cranbrook-Lethbridge	8 "	48°00′ " 50°00′	112°00′ " 116°00′	" "
Alberta–B.C.	82 NE.	Banff–Bassano	8 "	50°00′ " 52°00′	112°00′ " 116°00′	" "
B.C.	92 SE.	Victoria–Vancouver	8 "	48°00′ " 50°00′	120°00′ " 124°00′	" "
B.C.	92 NE.	Merritt–Lac la Hache	8 "	50°00′ " 52°00′	120°00′ " 124°00′	" "
B.C.	92 NW.	Campbell R.–Rivers Inlet	8 "	50°00′ " 52°00′	124°00′ " 128°00′	" "
B.C.–Alaska	104 SE.	Stikine River	8 "	56°00′ " 58°00′	128°00′ " 133°00′	Prelim. edn.—revision
B.C.–Alaska	104 NW.	Juneau–Atlin	8 "	58°00′ " 60°00′	132°00′ " 136°00′	" "
N.W.T.	16 N.	Cape Dyer	8 "	66°00′ " 68°00′	56°00′ " 64°00′	" "
N.W.T.	25 N.	Frobisher Bay	8 "	62°00′ " 64°00′	64°00′ " 72°00′	" "
N.W.T.	26 S.	Cumberland Sound	8 "	64°00′ " 66°00′	64°00′ " 72°00′	" "
N.W.T.	27 N.	Clyde	8 "	70°00′ " 72°00′	64°00′ " 72°00′	" "
N.W.T.	36 S.	Foxe Peninsula	8 "	64°00′ " 66°00′	72°00′ " 80°00′	" "
N.W.T.	57 S.	Rae Strait	8 "	68°00′ " 70°00′	88°00′ " 96°00′	" "
N.W.T.	58 S.	Somerset Island	8 "	72°00′ " 74°00′	88°00′ " 96°00′	" "
N.W.T.	66 N.	Ogden Bay	8 "	66°00′ " 68°00′	96°00′ " 104°00′	" "
N.W.T.	67 N.	McClintock Channel	8 "	70°00′ " 72°00′	96°00′ " 104°00′	" "
N.W.T.	76 S.	Upper Back River	8 "	64°00′ " 66°00′	104°00′ " 112°00′	" "
N.W.T.	76 N.	Bathurst Inlet	8 "	66°00′ " 68°00′	104°00′ " 112°00′	" "
N.W.T.	77 S.	Cambridge Bay	8 "	68°00′ " 70°00′	104°00′ " 112°00′	" "

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1950-1951—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(i) Aeronautical Charts — National Topographic Series				
N.W.T.	78 N.	Byam Channel	8 mi.	74°00′ to 76°00′	104°00′ to 112°00′	Prelim. edn.—revision
N.W.T.	79-89 N.	Borden Island	8 "	78°00′ " 80°00′	104°00′ " 116°00′	" "
N.W.T.	86 S.	Camsell River	8 "	64°00′ " 66°00′	112°00′ " 116°00′	" "
N.W.T.	89 S.	Prince Patrick Island	8 "	76°00′ " 78°00′	112°00′ " 124°00′	" "
		(ii) Other National Topographic Series Maps				
Quebec	31 P/4	Clear Lake	1 mi.	47°00′ to 47°15′	73°30′ to 74°00′	Revision
Quebec	31 N/1	Bark Lake	1 "	47°00′ " 47°15′	76°00′ " 76°30′	New
Quebec	32 G/14	Michwacho Lake	1 "	49°45′ " 50°00′	75°00′ " 75°30′	Revision
Quebec	32 C/NW.	Landrienne	2 "	48°30′ " 49°00′	77°00′ " 78°00′	"
Ontario	42 L	Nakina	4 "	50°00′ " 51°00′	86°00′ " 88°00′	"
Ontario	52 K	Lac Seul	4 "	50°00′ " 51°00′	92°00′ " 94°00′	"
Manitoba	62 H	Winnipeg	4 "	49°00′ " 50°00′	96°00′ " 98°00′	"
Manitoba	63 K/11	Cranberry Portage	1 "	54°30′ " 54°45′	101°00′ " 101°30′	"
Sask.-Manitoba	63 F	The Pas	4 "	53°00′ " 54°00′	100°00′ " 102°00′	"
Saskatchewan	63 M	Pelican Narrows	4 "	55°00′ " 56°00′	102°00′ " 104°00′	"
Saskatchewan	74 A	Foster Lake	4 "	56°00′ " 57°00′	104°00′ " 106°00′	"
B.C.	92 I	Ashcroft	4 "	50°00′ " 51°00′	120°00′ " 122°00′	New

B.C.	93 N	Manson River	4 "	55°00′ " 56°00′	124°00′ " 126°00′	Revision
B.C.	104 A/16	McEvoy Flats	1 "	56°45′ " 57°00′	128°00′ " 128°30′	New
N.W.T.	85 J-I	Yellowknife Bay	4 "	62°00′ " 63°00′	112°00′ " 116°00′	Revision
Yukon	105 M	Mayo	4 "	63°00′ " 64°00′	134°00′ " 136°00′	"

(iii) World Aeronautical Charts

Quebec–Maritimes	2262 (21)	St. John River	1:1,000,000	44°00′ to 48°00′	64°00′ to 72°00′	First edition
Quebec	2222 (22)	Saguenay River	1:1,000,000	48°00′ " 52°00′	64°00′ " 72°00′	"
Quebec–Labrador	2179 (23)	Kaniapiskau River	1:1,000,000	52°00′ " 56°00′	64°00′ " 72°00′	"
Quebec–Labrador	2146 (24)	Koksoak River	1:1,000,000	56°00′ " 60°00′	64°00′ " 72°00′	"
Quebec–Ontario	2221 (32)	Broadback River	1:1,000,000	48°00′ " 52°00′	72°00′ " 80°00′	"
Quebec–N.W.T.	2109 (35)	Kovik River	1:1,000,000	60°00′ " 64°00′	72°00′ " 80°00′	"
Ontario	2264 (41)	Montreal River	1:1,000,000	44°00′ " 48°00′	80°00′ " 88°00′	"
Ontario	2210 (42)	Albany River	1:1,000,000	48°00′ " 52°00′	80°00′ " 88°00′	"
N.W.T.	2110 (45)	Sutton River	1:1,000,000	60°00′ " 64°00′	80°00′ " 88°00′	"
Ontario–Manitoba	2182 (53)	Sachigo River	1:1,000,000	52°00′ " 56°00′	88°00′ " 96°00′	"
Manitoba–Ontario	2143 (54)	Churchill River	1:1,000,000	56°00′ " 60°00′	88°00′ " 96°00′	"
Manitoba Saskatchewan	2218 (62)	Assiniboine River	1:1,000,000	48°00′ " 52°00′	96°00′ " 104°00′	"
Manitoba–Saskatchewan	2183 (63)	Carrott River	1:1,000,000	52°00′ " 56°00′	96°00′ " 104°00′	"
Saskatchewan–Alberta	2217 (72)	South Saskatchewan R.	1:1,000,000	48°00′ " 52°00′	104°00′ " 112°00′	"
N.W.T.	2113 (75)	Lockhart River	1:1,000,000	60°00′ " 64°00′	104°00′ " 112°00′	"
Alberta	2140 (84)	Hay River	1:1,000,000	56°00′ " 60°00′	112°00′ " 120°00′	"
N.W.T.	2114 (85)	Slave River	1:1,000,000	60°00′ " 64°00′	112°00′ " 120°00′	"
Saskatchewan–Alberta	2141 (74)	Clearwater River	1:1,000,000	56°00′ " 60°00′	104°00′ " 112°00′	"

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1950-1951—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(iv) Columbia River Basin Series				
B.C.	59	Upper Kootenay River area	1:31,680	49°59′ to 50°09′	115°41′ to 115°54′	First edition
B.C.	70	Similkameen River area	1:31,680	49°00′ " 49°10′	119°35′ " 119°48′	"
B.C.	71	Similkameen River area	1:31,680	49°10′ " 49°18′	119°43′ " 120°00′	"
B.C.	73	Similkameen River area	1:31,680	49°23′ " 49°31′	120°16′ " 120°33′	"
Canada	.....	Geodetic operations 1950	100 mi.	.....	.....	Rev. for Geodetic Survey
Canada	.....	Airways routes and T.C. areas	.....	.....	.....	Revision
East Coast	100	Cape Cod–Yarmouth	1:1,000,000	.....	.....	R.C.N. aero. chart. New
East Coast	102	Halifax–Sydney	1:1,000,000	.....	.....	R.C.N. aero. chart. New
East Coast	104	Sable–St. Pierre	1:1,000,000	.....	.....	R.C.N. aero. chart. New
East Coast	105	Cape Race	1:1,000,000	.....	.....	R.C.N. aero. chart. New
East Coast	106	Newfoundland central	1:1,000,000	.....	.....	R.C.N. aero. chart. New
East Coast	107	Gulf of St. Lawrence	1:1,000,000	.....	.....	R.C.N. aero. chart. New
East Coast	108	Newfoundland north	1:1,000,000	.....	.....	R.C.N. aero. chart. New
Eastern Canada	.....	Lines of levels in eastern Canada.	50 mi.	.....	.....	Rev. for Geodetic Survey
Northwest Canada	.....	Northwest Canada transportation facilities.	50 "	.....	.....	Revision
N.W.T.	.....	Canada-northern extension	64 "	.....	.....	First edition
Northern Canada	.....	Canadian Arctic regions	.....	.....	.....	Revision

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment, Fiscal Year 1950-1951

Location	Number	Name	Scale	Latitude	Longitude	Remarks
New Brunwick	21 I/14	Kouchibouguac	1 mi.	46°45′ to 47°00′	65°00′ to 65°30′	First edition
New Brunswick	21 I/15	Point Sapin	1 "	46°45′ " 47°00′	64°30′ " 65°00′	"
New Brunswick	21 J/11	Juniper	1 "	46°30′ " 46°45′	67°00′ " 67°30′	"
New Brunswick	21 P/3	Chatham	1 "	47°00′ " 47°15′	65°00′ " 65°30′	"
New Brunswick	21 P/4	Sevogle	1 "	47°00′ " 47°15′	65°30′ " 66°00′	"
New Brunswick	21 P/5	Nipisiguit Falls	1 "	47°15′ " 47°30′	65°30′ " 66°00′	"
New Brunswick	21 P/12	Bathurst	1 "	47°30′ " 47°45′	65°30′ " 66°00′	"
New Brunswick	21 O/1	Big Bald Mountain	1 "	47°00′ " 47°15′	66°00′ " 66°30′	"
New Brunswick	21 O/9	Tetagouche	1 "	47°30′ " 47°45′	66°00′ " 66°30′	"
New Brunswick	21 O/12	Gounamitz River	1 "	47°30′ " 47°45′	67°30′ " 68°00′	"
Quebec	32 A/8	Chambord	1 "	48°15′ " 48°30′	72°00′ " 72°30′	"
Quebec	32 A/9	Roberval	1 "	48°30′ " 48°45′	72°00′ " 72°30′	"
Quebec	32 D/6	Kanasuta River	1 "	48°15′ " 48°30′	79°00′ " 79°30′	"
Ontario–Manitoba	52 L/6	Ryerson Lake	1 "	50°15′ " 50°30′	95°00′ " 95°30′	"
Ontario–Manitoba	52 L/11	Flintstone Lake	1 "	50°30′ " 50°45′	95°00′ " 95°30′	"
Manitoba	52 L/12	Maskwa Lake	1 "	50°30′ " 50°45′	95°30′ " 96°00′	"
Manitoba	52 L/13	Manigotagan Lake	1 "	50°45′ " 51°00′	95°30′ " 96°00′	"
Manitoba	52 M/4	Wanipigow	1 "	51°00′ " 51°15′	95°30′ " 96°00′	"
Manitoba	62 H/8	Marchand	1 "	49°15′ " 49°30′	96°00′ " 96°30′	"
Manitoba	62 H/7	St. Malo	1 "	49°15′ " 49°30′	96°30′ " 97°00′	"

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment, Fiscal Year 1950-1951—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Manitoba	62 I/5	St. Laurent	1 mi.	50°15′ to 50°30′	97°30′ to 98°00′	First edition
Manitoba	62 I/6	Teulon	1 "	50°15′ " 50°30′	97°00′ " 97°30′	"
Manitoba	62 I/9	Pine Falls	1 "	50°30′ " 50°45′	96°00′ " 96°30′	"
Manitoba	62 P/1	English Brook	1 "	51°00′ " 51°15′	96°00′ " 96°30′	"
Manitoba	62 N/7	Baldy Mountain	1 "	51°15′ " 51°30′	100°30′ " 101°00′	"
Manitoba	62 N/10	Singush	1 "	51°30′ " 51°45′	100°30′ " 101°00′	"
Manitoba	62 N/11	Childs Lake	1 "	51°30′ " 51°45′	101°00′ " 101°30′	"
Manitoba	63 C/1	Duck Bay	1 "	52°00′ " 52°15′	100°00′ " 100°30′	"
Manitoba	63 C/2	Renwer	1 "	52°00′ " 52°15′	100°30′ " 101°00′	"
Manitoba	63 C/7	Lenswood	1 "	52°15′ " 52°30′	100°30′ " 101°00′	"
Manitoba	64 C/9	Eden Lake	1 "	56°30′ " 56°45′	100°00′ " 100°30′	"
Manitoba	64 C/10	Sickle Lake	1 "	56°30′ " 56°45′	100°30′ " 101°00′	"
Manitoba–Saskatchewan	63 N/4	Duval Lake	1 "	55°00′ " 55°15′	101°30′ " 102°00′	"
Saskatchewan	63 L/15	Birch Portage	1 "	54°45′ " 55°00′	102°30′ " 103°00′	"
Saskatchewan	73 K/5	Pierceland	1 "	54°15′ " 54°30′	109°30′ " 110°00′	"
Saskatchewan	73 K/6	Goodsoil	1 "	54°15′ " 54°30′	109°00′ " 109°30′	"
Saskatchewan	73 K/7	Dorintosh	1 "	54°15′ " 54°30′	108°30′ " 109°00′	"
Saskatchewan	73 K/11	Muskeg Lake	1 "	54°30′ " 54°45′	109°00′ " 109°30′	"
Saskatchewan	73 K/12	Cold River	1 "	54°30′ " 54°45′	108°30′ " 109°00′	"

Saskatchewan	73 K/15	Lost Lake	1 "	54°45′ " 55°00′	108°30′ " 109°00′	"
Saskatchewan	73 K/16	Keeley Lake	1 "	54°45′ " 55°00′	108°00′ " 108°30′	"
Saskatchewan	74 A/1	Maribelli Lake	1 "	56°00′ " 56°15′	104°00′ " 104°30′	"
Alberta	84 C/SW.	Grimshaw	2 "	56°00′ " 56°30′	117°00′ " 118°00′	"
Alberta	84 D/SE.	Hines Creek	2 "	56°00′ " 56°30′	118°00′ " 119°00′	"
N.W.T.	86 B/4	Mattberry Lake	1 "	64°00′ " 64°15′	115°30′ " 116°00′	"
N.W.T.	86 C/8	Ingray Lake	1 "	64°15′ " 64°30′	114°00′ " 114°30′	"

GEOLOGICAL SURVEY OF CANADA

W. A. Bell, Director

The Geological Survey undertook the largest program of field work in its history in 1950 when it assigned 89 parties to this work, an increase of 17 parties over the previous year. Fifty-seven of these parties were directed by the Regional Geology Division, 14 by the Division of Pleistocene, Groundwater, and Engineering Geology, 7 by the Palæontological Division, 6 by the Oil, Natural Gas, and Coal Division, 4 by the Radioactivity Division, and 1 by the Geophysics Division. This program was designed to provide, on an enlarged scale, geological information necessary to meet the growing demands of the mineral and oil industries whose combined value of production is now in excess of $1,000,000,000 a year. Special attention was given to areas under development or where chances of development were most promising, but the systematic investigation of new areas was continued to determine their potentialities for mineral and oil prospecting. All the provinces, the Northwest Territories, and Yukon shared in the field work.

The growing importance of western oil and gas developments created a need for close and immediate co-operation with the industry, and for this purpose a branch office of the Oil, Natural Gas, and Coal Division was established at Calgary. It will keep in touch with the numerous drilling operations throughout the western provinces, will compile and correlate well logs and related records, and will study the subsurface geology.

Field investigations on radioactive minerals were continued, and laboratory facilities for work on these minerals were reorganized and enlarged. Additional scientific equipment was provided to enable the staff to take advantage of up-to-date and more accurate mineral determinations.

Use of the airborne magnetometer was continued, and approximately 65,000 line miles were flown over selected areas in Saskatchewan, Alberta, and Northwest Territories, and over a small part of the Quebec-Labrador iron ore belt. The results of this work are expected to aid geological mapping, subsurface studies, and the solution of problems relating to the possible occurrence of mineral deposits and the accumulation of oil and natural gas.

As an aid in the search for minerals, about 9,000 specimens submitted for examination were identified and reported on, and more than 86,000 mineral and rock specimens were distributed. As agent for the Atomic Energy Control Board, the Geological Survey tested more than 4,000 samples for radioactivity.

The Paper series of mimeographed reports and preliminary, blue-line maps continued to provide advance information on the results of field investigations, and during the year 33 Preliminary Papers consisting of geological reports or maps were published. In addition, the Survey initiated a new series of Geophysics Papers designed to make known the results of geophysical explorations in Canada. Twelve papers of this series were issued, and 21 aeromagnetic maps on a scale of 1 inch to 1 mile, covering areas in various parts of Canada, were prepared for publication.

Standard publications issued during the year comprised 7 memoirs, 2 bulletins, and 13 lithographed geological maps.

Approximately 114,000 reports, maps, and other publications were distributed to the public.

Fifteen additional geologists were appointed to the temporary staff. R. T. D. Wickenden was placed in charge of the Western Oil and Natural Gas office at Calgary, and A. B. Irwin was appointed resident geologist at the Yellowknife office in Northwest Territories in place of W. E. MacQuarrie who had resigned.

Visiting oil geologists employed in Canada were provided with temporary office accommodation, and the records and facilities of the Palæontological and Oil, Natural Gas, and Coal Divisions were placed at their disposal.

A report on current geological research in Canada, by J. F. Henderson, was prepared at the request of the National Advisory Committee on Research in the Geological Sciences.

BRITISH COLUMBIA OFFICE

A total of 4,024 visitors registered at the office and many inquiries were handled by mail and telephone. Altogether, 4,140 reports and 4,207 separate maps were issued in response to requests by the public. Determinations were made of many rock and mineral specimens.

YELLOWKNIFE OFFICE

The office is serviced jointly by a resident geologist of the Geological Survey and by representatives of the Lands and Development Services Branch of the Department of Resources and Development. Advice and assistance relative to mining and prospecting were given to the many visitors to the office, and first-hand data were collected in the field on new discoveries and on active mining developments. Monthly reports were submitted to Ottawa to enable headquarters to keep abreast of mining activities in Northwest Territories. Many Geological Survey publications were distributed.

WESTERN OIL AND NATURAL GAS OFFICE

This office in Calgary is relatively convenient to the greatly expanded oil and gas industry of western Canada. Its principal purposes will be to study the subsurface geology of the potential oil and natural gas regions of the west, to establish correlations of the subsurface formations, to co-operate with oil companies and provincial authorities in developing a knowledge of the geology in relation to the occurrence of oil and gas, and to publish the results of investigations in time to be of service to the industry.

LIBRARY

Acquisitions:

Books acquired by purchase	551
Books (complete unbound volumes by purchase)	553
Books by transfer, exchange, and gift	237
Canadian Government documents — individual issues (by gift and exchange)	2,414
British and foreign Government documents — individual issues (by gift and exchange)	3,163
Canadian periodicals, individual issues	1,136
British and foreign periodicals, individual issues	4,230
Scientific societies' bulletins, proceedings, and transactions — individual issues (by gift and exchange)	4,057
Total	16,341

Other data:

Recorded loans of books, pamphlets, and periodicals	17,731
Inter-library and occasional loans	2,404
Books borrowed from other libraries	455
Maps and charts added to the library	1,773
Maps and charts borrowed from the library	388

Lantern slides borrowed	1,156
Lantern slides added to library	189
Photographs loaned (exclusive of albums)	1,570
Volumes bound	624
Volumes accessioned	1,572
Cards added to general catalogue	17,929
Cards added to map catalogue	470
Cards added to slide catalogue	577
Letters and cards received	3,438
Letters and cards sent	4,583
New serials received and catalogued	221

PHOTOGRAPHIC SECTION

This Section reported an increased output of photographic items, chief of which were the following:

Magnetometer film developed	25,800 feet
Magnetometer film printed	75,169 feet
Contact prints made, up to 40" x 49"	22,443
Exposures developed, field work	6,181
Kodalith and Vandyke negatives and prints	3,346

REPRODUCTION PROCESSES

Blueprints	419,243 square feet
Océ prints	27,424 square feet
Photostat (18" x 22")	10,305 sheets
Mimeograph	1,329,052 impressions

LAPIDARY

Thin sections	3,625
Polished sections	93

REGIONAL GEOLOGY DIVISION

This Division gives chief attention to the continued, systematic mapping of Canada, with special reference to areas of potential mineral resources. Forty-three of its parties placed in the field in 1950 were assigned to this work, and an additional 14 parties were engaged in special investigations on mineral deposits or in related stratigraphic or structural studies. Through the field work of this and the other Divisions, the Geological Survey has kept abreast of mining projects of immediate concern, such as those relating to the Quebec-Labrador iron deposits, the uranium-bearing ores of Lake Athabasca, and the Yellowknife gold belt.

The filing of all available geological information on Canadian mineral occurrences was continued. Commencing with the earliest years of mining activity in Canada, it forms an invaluable record from which pertinent geological data on any metal or strategic mineral or on any mineralized area or region can be assembled in whatever form or for whatever purpose required.

Field Work

Seven of the 57 field parties operated in the Northwest Territories, 6 in Yukon, 4 in the Arctic, 12 in British Columbia, 2 in Alberta, 2 in Saskatchewan, 2 in Manitoba, 4 in Ontario, 2 in Quebec, 2 in New Brunswick, 4 in Nova Scotia, 3 in Newfoundland, and 7 in two or more provinces or territories.

Standard geological mapping on scales of 1 mile or 4 miles to an inch was conducted in 38 areas across Canada; reconnaissance surveys were made in 4 regions; and detail mapping was continued at Giauque Lake in Northwest Territories, on Keno and Galena Hills in Yukon, and in Dasserat township along the Cadillac-Rouyn mineral belt in western Quebec. Other field activities included special mineralogical studies of uranium-bearing deposits in the Goldfields district of Saskatchewan, and of the gold ores of the Yellowknife greenstone belt; structural studies along the Flin Flon mineral belt of western Manitoba and eastern Saskatchewan, and of the gold-bearing series of rocks in Nova Scotia. A résumé of field investigations of the Division follows.

NORTHWEST TERRITORIES AND ARCTIC

F. Q. Barnes commenced and completed geological mapping of the Snowdrift area (longitude 110°30′ to 111°, latitude 62°15′ to 62° 30′) on the south shore of the east arm of Great Slave Lake. The area and its environs have provided encouraging indications of radioactive mineral deposits.

R. W. Boyle investigated the mineral deposits of the Yellowknife gold belt, with special reference to the temperature of formation of the associated vein quartz, in an effort to determine why the ore shoots occur where they do.

W. L. Davison continued geological mapping on southern Baffin Island. The work comprised 1-mile mapping in the vicinity of Lake Harbour on the south coast of the island, and also included reconnaissance mapping along the northeast shores of Frobisher Bay. He observed evidence of mineralization and of the occurrence of white mica and graphite deposits in rocks that bear much resemblance to the Grenville series of eastern Canada.

R. E. Folinsbee completed geological mapping of the Walmsley Lake area (longitude 108° to 110°, latitude 63° to 64°). Some prospecting for gold has been done in the area in a variety of rocks, including sedimentary schists, greenstone, granite, and an acidic dyke, and further prospecting seems warranted.

Y. O. Fortier and R. Thorsteinson commenced an exploratory survey of Cornwallis Island and vicinity in the Arctic islands. Cornwallis Island appears to be underlain mainly by folded Silurian limestone and dolomite. They made observation flights over all the Parry Islands and to northern Ellesmere Island.

C. S. Lord made a brief inspection trip in Northwest Territories, where he accumulated information of active mining and prospecting developments, and examined certain beryl- and manganese-bearing deposits.

J. C. G. Moore completed geological mapping of the Carp Lakes area (longitude 112° to 114°, latitude 63° to 64°). Some significant gold-bearing deposits have been discovered in the southwest corner of the area near Giauque Lake.

V. K. Prest acted as geological observer assigned to the Arctic Weather Station Resupply Mission United States Navy Operation Nanook 50. He acquired much information on the geology of the east coast of Ellesmere Island and on parts of Devon Island.

G. C. Riley and K. E. Eade were on loan to the Arctic Institute of Canada in its reconnaissance expedition to northern Baffin Island.

L. P. Tremblay completed detailed geological mapping in the vicinity of Giauque Lake in the Carp Lakes 4-mile area. During the summer several mining companies were doing exploratory work in search for gold, which occurs in quartz veins and in the adjacent wall-rocks.

G. M. Wright completed geological mapping of the Christie Bay (longitude 110° to 112°, latitude 62° to 63°) and Reliance (longitude 108° to 110°, latitude 62° to 63°) areas in the basin of the east arm of Great Slave Lake. Copper sulphide showings occur at several places in these areas, and some work

has been done on a nickeliferous deposit 5 miles northwest of Sachowia Point. Prospecting for uranium has been active in the vicinity of Stark Lake and to a lesser degree along Barnston River. Large, rusty mineralized shear zones in Yellowknife sedimentary rocks along the shores of Daisy Lake merit prospecting.

YUKON

R. B. Campbell continued geological mapping of the Glenlyon area (longitude 134° to 136°, latitude 62° to 63°), which is geologically favourable for gold and base metal deposits.

E. D. Kindle completed geological mapping of the Dezadeash area (longitude 136° to 138°, latitude 60° to 61°), which contains a promising copper belt and a newly discovered coal-bearing zone.

K. C. McTaggart completed detailed geological mapping of Galena and Keno Hills, Mayo district, a well-known silver-lead mining camp.

J. E. Muller commenced geological mapping of Kluane Lake area (longitude 138° to 140°, latitude 60° to 61°). Some placer gold has been obtained from Burwash Creek, and a lignite coal deposit occurs about 10 miles west of Burwash Landing.

R. Mulligan commenced geological mapping of the Teslin area (longitude 132° to 134°, latitude 60° to 61°). The area is traversed by the Alaska Highway and includes parts of the Canol and Atlin roads. Some placer gold has been obtained from this area.

J. O. Wheeler continued geological mapping in the Whitehorse area (longitude 134° to 136°, latitude 60° to 61°), a potential source of a variety of ores and minerals. He spent part of the field season in a special examination of the bedrock geology and drift in the vicinity of Miles Canyon and Chadburn Lakes in connection with a proposed dam site on Lewes River.

YUKON AND BRITISH COLUMBIA

H. S. Bostock visited Whitehorse and neighbouring areas in Yukon and northern British Columbia in connection with the geological examination of construction sites pertaining to the Yukon River Power and Storage Project. He supervised the work of Geological Survey parties assisting this project.

BRITISH COLUMBIA

J. E. Armstrong had charge of parties under G. A. Wilson and J. A. Roddick, which continued geological mapping in the Vancouver North area (longitude 123° to 123°30′, latitude 49°15′ to 49°30′), and commenced geological mapping in the adjacent Coquitlam area (longitude 122°30′ to 123°, latitude 49°15′ to 49°30′). Some prospecting has been done in these areas and evidence of mineralization is widespread. Occurrences of building and ornamental stones and constructional materials become important in this relatively highly populated district.

R. L. Christie continued geological mapping in the Bennett area (longitude 134° to 136°, latitude 59° to 60°). Numerous occurrences of copper, copper-gold, gold telluride, gold-silver, lead-zinc, and antimony ores have been found in the Mesozoic sedimentary and volcanic rocks of the eastern part of the area, but the western part is still almost unknown territory. He also made a detailed geological examination of prospective sites for the Yukon River Power and Storage Project.

W. E. Cockfield made preliminary studies of dam sites on Shuswap, Columbia, and Fraser Rivers for other government departments. He examined

several mineral properties, and with W. L. Brown investigated the water supply for three Indian Reserves and the foundations for proposed fishways at Moricetown Falls on Bulkley River.

S. Duffell continued geological mapping of the Whitesail Lake area (longitude 126° to 128°, latitude 53° to 54°). The area occupies part of the eastern flank of the Coast Range batholith in which recent prospecting has revealed significant lead-zinc and gold-bearing deposits.

H. Gabrielse continued geological mapping of the McDame Creek area (longitude 128° to 130°, latitude 59° to 60°). An asbestos deposit about 12 miles northwest of McDame Lake has attracted considerable attention. He examined some gold-bearing quartz veins near McDame Lake, Table Mountain, and Quartz City.

J. W. Hoadley completed geological mapping of the Zeballos area (longitude 126°30′ to 127°, latitude 49°45′ to 50°), Vancouver Island, which lies just south of the Zeballos gold camp. The work provides useful information on the structure and stratigraphic relationships of the formations in this mineralized region. Most of the few known prospects resemble the gold-bearing quartz vein deposits of the Zeballos camp, and conditions are favourable for the occurrence of magnetite iron and of copper-lead-zinc replacement deposits.

A. G. Jones continued geological mapping of the Revelstoke area (longitude 118° to 119°, latitude 50° to 51°). The more significant mineralized part of the area has yet to be mapped, but elsewhere are abundant pegmatitic rocks carrying a variety of strategic minerals.

G. B. Leech commenced geological mapping of the St. Mary Lake area (longitude 116° to 116°30′, latitude 49°30′ to 49°45′), which includes the Sullivan zinc-lead-silver mine and numerous other mines and prospects. Both precious and base metal deposits are represented and some placer gold has been mined.

H. W. Little continued geological mapping of the west half of the Nelson area (longitude 117° to 118°, latitude 49° to 50°), one of the most productive in the province. The work will bring information on mining activities up to date and will be of use in revising and correlating the work of earlier geologists in different parts of the area.

J. E. Reesor commenced geological mapping of the Dewar Creek area (longitude 116° to 116°30′, latitude 49°45′ to 50°), which lies northwest of Kimberley and the Sullivan mine. The area is underlain by Late Precambrian formations intruded by a large granite batholith and is geologically favourable for mineral deposition.

H. W. Tipper continued geological mapping of the Nechako area (longitude 124° to 126°, latitude 53° to 54°), in which little prospecting has been done.

BRITISH COLUMBIA AND ALBERTA

R. de Wit completed geological mapping of the Wabamun Lake area (longitude 114° to 115°, latitude 53° to 54°) west of Edmonton; made a stratigraphic study of the Upper Devonian Fairholme formation in the mountains west of Rocky Mountain House, Alberta; examined some Devonian sections in the Rocky Mountains west of Hudson Hope, British Columbia; and made a subsurface study of the Middle Devonian Presqu'île dolomite near Great Slave Lake, Northwest Territories, at the Pine Point concession of The Consolidated Mining and Smelting Company of Canada, Limited.

ALBERTA

R. J. W. Douglas commenced geological mapping of the Waterton (longitude 113°45′ to 114°, latitude 49° to 49°15′) and Mountain View (longitude 113°30′ to 113°45′, latitude 49°15′ to 49°30′) areas.

E. J. W. Irish commenced geological mapping of the Copton Creek area (longitude 119°15′ to 119°30′, latitude 54° to 54°15′). Coal seams of mineable width were seen in the Lower Cretaceous Luscar formation of this area.

SASKATCHEWAN

D. A. W. Blake mapped geologically the Forget Lake area (longitude 108° to 108°15′, latitude 59°30′ to 59°45′) and the small area lying between it and Lake Athabasca. This combined area lies east of and adjoins the Goldfields-Martin Lake area where important uranium discoveries are being developed. Considerable prospecting has been done in the Forget Lake area and some discoveries have been made.

K. R. Dawson made a field study and collected samples illustrative of wall-rock alteration in the uranium-bearing deposits near Goldfields, Lake Athabasca. The object of the study is to determine the relationships of various types of wall-rock alteration to the deposition of pitchblende or other radioactive minerals.

SASKATCHEWAN AND MANITOBA

D. S. Robertson made a study of geological structures in western Manitoba and eastern Saskatchewan along the Weldon Bay-Flin Flon mineral belt, with special reference to their bearing on the succession of formations and on the occurrence of the associated mineral deposits.

MANITOBA

John McGlynn continued geological mapping of the Elbow Lake area (longitude 100°30′ to 101°, latitude 54°45′ to 55°), which includes a productive gold mine and many old prospects, chiefly gold bearing, associated with north-trending shear zones.

T. Podolsky commenced geological mapping of the Cranberry Portage area (longitude 101° to 101°30′, latitude 54°30′ to 54° 45′), which includes a productive gold mine, and several gold and base metal prospects.

ONTARIO

T. E. Bolton commenced a study of the Silurian stratigraphy of the Niagara escarpment, and its relation to possible accumulations of oil and natural gas, and to occurrences of other contained deposits of possible economic value. The work will facilitate subsurface studies in potential oil and gas areas of southwestern Ontario where the Silurian formations are not exposed.

C. A. Burns commenced geological mapping of the Tweed (Kaladar E/2) area (longitude 77° to 77°15′, latitude 44°30′ to 44°45′), which appears to include favourable prospecting ground for a variety of industrial minerals and structural materials. In the past, gold, pyrite, mica, and actinolite have been obtained from the area.

B. A. Liberty geologically mapped the Palæozoic rocks of the Kirkfield-Fenelon Falls (longitude 78°30′ to 79°, latitude 44°30′ to 44°45′) and adjoining Lindsay (longitude 78°30′ to 79°, latitude 44°15′ to 44°30′) areas; completed geological mapping in several other areas to the west and northwest in the Lake Simcoe district; and logged the cores of the four Great Lakes Carbon wells on Manitoulin Island. The work will assist subsurface studies in the potential oil and natural gas fields of southwestern Ontario.

H. A. Quinn completed geological mapping of the Renfrew area (longitude 76°30′ to 77°, latitude 45°15′ to 45°30′), on which work was first done in 1917 to 1919 and was continued in 1949 by other geologists. The area contains many magnetite iron deposits, numerous molybdenite prospects, a zinc property, and deposits of constructional materials.

QUEBEC

W. G. Johnston continued detailed geological mapping in Dasserat township in the vicinity of the Cadillac-Larder Lake mineral belt, part of which is obscured by the overlying Cobalt series.

A. S. MacLaren completed revision of geological mapping in the Kinojevis area (longitude 78°30′ to 79°, latitude 48° to 48°15′). Beryl, spodumene, and some molybdenite occur in the southern part of the area and esker ridges provide abundant gravel for road surfacing.

NEW BRUNSWICK

F. D. Anderson commenced geological mapping of the Millville area (longitude 67° to 67°45′, latitude 46° to 46°15′), which contains manganese deposits.

R. Skinner and J. D. McAlary completed geological mapping of the Nipisiguit Falls area (longitude 65°30′ to 66°, latitude 47°15′ to 47°30′). Large bodies of magnetite iron ore were mined from this area during World War II.

NOVA SCOTIA

D. G. Crosby completed geological mapping of the Wolfville area (longitude 64° to 64°30′, latitude 45° to 45°15′), in which, at Walton, is the largest known barite deposit in Canada. Gypsum and silica rock are also obtained from this area.

W. S. Shaw completed a detailed study of the Cumberland coal basin and revised geological mapping of the Springhill area (longitude 64° to 64°30′, latitude 45°30′ to 45°45′). The work was designed mainly to delineate the coal reserves of this basin with greater accuracy; to provide guidance for coal operators in the extension of present workings; and to obtain information on the sedimentary sequence, particularly where it concerns the nature and distribution of the coal-bearing facies.

I. M. Stevenson commenced geological mapping of the Truro area (longitude 63° to 63°30′, latitude 45°15′ to 45°30′). The area contains extensive deposits of limestone and gypsum, a lead-zinc deposit at Smithfield, and a barite deposit at Brookfield. Several abandoned iron pits were observed in the Horton group of Mississippian rocks, and coal has been mined recently at Kemptown.

C. H. Stockwell made a structural study of folded strata in the gold fields of Nova Scotia, to secure data on the nature and origin of folds and their significance in relation to associated gold deposits.

QUEBEC AND LABRADOR

W. F. Fahrig commenced geological mapping of the Griffis Lake area (longitude 65°30′ to 66°, latitude 55° to 55°15′). Sulphide deposits consisting mainly of pyrite and pyrrhotite replace thin beds of high carbon slates.

M. J. Frarey commenced geological mapping of the Willbob Lake area (longitude 66° to 66°30′, latitude 55° to 55°15′). A zone trending northwesterly through the area contains a few known base metal occurrences.

J. M. Harrison commenced a detailed structural and stratigraphic study of the Labrador-Quebec iron ranges. He supervised the field work of other parties in this region.

NEWFOUNDLAND

A. M. Christie conducted a reconnaissance geological survey along the southern coast of Labrador from the Quebec border north to Cape Porcupine. Mica deposits have been prospected in the vicinity of Square Island and Gready Harbour and bodies of anorthosite-gabbro might be profitably prospected for ilmenite. He did further field work in the Bonavista area (longitude 53° to 54°, latitude 48° to 49°), Newfoundland.

J. Kalliokoski commenced geological mapping of the Gull Pond area (longitude 56° to 56°30′, latitude 49° to 49°15). A large copper deposit on Gull Pond is being explored.

T. O. H. Patrick commenced geological mapping of the Campbellton area (longitude 54°30′ to 55°, latitude 49°15′ to 49°30′). Some prospecting has been done on a nickeliferous deposit on Sugar Loaf Island and on a copper deposit on the northwest shore of Chapels Island. The area is structurally a part of the Notre Dame Bay district in which most of Newfoundland's copper has been found.

EASTERN CANADA

T. L. Tanton examined contact metamorphic iron deposits at Bristol mine, Pontiac county, Quebec; the Wabana iron deposits on Bell Island, and manganese deposits in Conception Bay, Newfoundland; and made geological examinations of iron ore occurrences in Yarrow and Kimberley townships, Ontario.

L. J. Weeks guided gravimetric exploration of the Stirling lead-zinc-copper orebodies, Richmond county, Nova Scotia. He supervised field parties operating in the Maritime Provinces and Newfoundland.

PALÆONTOLOGY DIVISION

Reports were prepared on 53 fossil collections from various parts of Canada submitted for identification and for determination of the age of the enclosing rocks. Eight of the collections were from the Arctic regions. Fifteen of the reports were for oil companies operating in Canada, two were for the British Columbia Department of Mines, and three for the Alberta Petroleum and Natural Gas Conservation Board.

In addition to collections examined by the Division, Alice E. Wilson reported on 8 collections of Ordovician and Silurian fossils from various parts of Canada; R. T. D. Wickenden reported on Cretaceous fossils obtained from samples from an oil well in northern Alberta; and L. S. Russell of the Department of Resources and Development reported on a collection of Mesozoic fossils from Ootsa Lake, British Columbia.

The Division investigated various problems in palæontological research. This included a study of Cambrian trilobites from Cape Breton Island and eastern Newfoundland; of Devonian brachiopods from the Rocky Mountains, and of Carboniferous fossils from these mountains; work on Jurassic ammonoids from the west coast of British Columbia; on Cretaceous species of an ammonite genus from the western interior of Canada; on late Mesozoic belemnoids and aucellas from western Canada; and continuation of a study of Triassic ammonoids from northeastern British Columbia. All these studies are of fundamental importance to the geologist and stratigrapher, and in explorations for oil and natural gas, coal, or bedded deposits of metallic or industrial minerals.

Collections of fossils were donated to the Geological Survey by: Socony Vacuum Exploration Company, Hudson Bay Oil and Gas Company, Union Oil Company of California, Shell Oil Company, Gulf Oil Company, Texaco Oil Company, Barnsdall Oil Company, British Columbia Department of Mines, Alberta Petroleum and Natural Gas Conservation Board, the Arctic Institute of Canada, and the Geographical Branch of the Department.

Field Work

BRITISH COLUMBIA

J. A. Jeletzky continued detailed stratigraphic studies of the fossiliferous Mesozoic formations along the west coast of Vancouver Island between Kyuquot Sound and Esperanza Inlet. The study will assist geological mapping in northern Vancouver Island and elsewhere in areas of Mesozoic rocks in western Canada.

BRITISH COLUMBIA–ALBERTA

Hans Frebold began a stratigraphic and palæontological study of the Jurassic system as represented by the Fernie group. It is expected that this study will assist geological mapping and facilitate subsurface studies in the Interior Plains and Foothills.

ALBERTA

E. T. Tozer continued a study of non-marine invertebrate faunas from the Upper Cretaceous and Lower Tertiary formations of the Waterton–Mountain View region. Preliminary studies of these faunas indicate that some variations of species have stratigraphic age significance.

MANITOBA

S. J. Nelson began a stratigraphic and palæontological study of mid-Palæozoic formations in the vicinity of Churchill. The work is designed to assist explorations for oil and natural gas in the Hudson Bay Lowland.

C. W. Stearn commenced a stratigraphic and palæontological study of Silurian and Devonian rocks in the Lake Winnipeg region. The work will assist explorations for oil and natural gas in this and neighbouring regions, and will provide useful information on suitable building stones and industrial mineral deposits.

ONTARIO

F. J. Wagner examined sections of, and obtained invertebrate fossils from, the Pleistocene drift in the vicinity of Moosonee, James Bay. The work will assist in the correlation of glacial drift elsewhere in Canada.

QUEBEC

L. M. Cumming studied the palæontology and stratigraphy of Upper Silurian and Lower Devonian formations in eastern Gaspe peninsula. Several drilling projects in search for oil and natural gas are under way, and a large copper deposit at the headwaters of York River is being explored.

NEWFOUNDLAND

R. D. Hutchinson mapped geologically the Harbour Grace area (longitude 53° to 53°30′, latitude 47°30′ to 47°45′) and made a detailed stratigraphic study of the Cambrian rocks there, which will assist correlation and geological mapping elsewhere in Newfoundland and the Maritime Provinces.

MINERALOGY DIVISION

About 9,000 specimens of rocks and minerals sent in from all parts of Canada by prospectors and others searching for mineral deposits were examined and identified and reports as to their nature and possible commercial value were sent to the parties concerned. Similar information was given to about 1,000 visitors.

During the year, 2,401 collections of Canadian rocks and minerals comprising 86,666 specimens were prepared and distributed to prospectors and various mining and educational institutions, the distribution, by collections and specimens, respectively, being:

	Collections	Specimens
British Columbia and Yukon	330	11,876
Northwest Territories	105	3,865
Alberta	265	9,185
Saskatchewan	291	10,151
Manitoba	301	11,586
Ontario	523	18,012
Quebec	485	18,451
New Brunswick	72	2,520
Nova Scotia	29	1,020

Chemical analyses of rocks made to assist geological research included the following: 4 samples of Precambrian lavas from Dasserat township, Quebec; 4 samples of Precambrian granitic rocks from Weldon Bay map-area in west-central Manitoba; and 6 samples of volcanic rocks, 1 of chert, and 1 of hornblende porphyry from the Zeballos map-area on the west coast of Vancouver Island.

Considerable additional equipment was provided to cope with demands for spectroscopic analyses as an aid to geological, mineralogical, and economic studies. More than 2,400 exposures were made on 242 photographic plates, and 17 reports were provided on 79 samples received. A chemical testing set was assembled for use at the Yellowknife Office.

RADIOACTIVITY AND GEOPHYSICS DIVISION

RADIOACTIVITY

The Division provides without charge a comprehensive advisory and testing service designed to encourage the search for uranium deposits in Canada. It advises the prospector where and how to look for uranium deposits, tests his samples, and identifies the uranium and thorium minerals present. It makes detailed studies of the nature of the radioactive minerals found in Canada, their relationships to the rocks in which they occur, their associa-

tions with other minerals, and any phenomena bearing on the search for deposits. During the year the Division tested 4,009 samples and made many hundreds of identifications of radioactive minerals and of associated ore and gangue minerals.

More than 150 uranium- and thorium-bearing minerals are known. Their study and identification require special equipment and a highly trained staff in order that reports on samples be made promptly. Nearly half of the test results are forwarded the day the samples are received.

Special problems of research undertaken included: a study, in association with the Physics Department, University of Toronto, and the Radioactivity Division, Mines Branch, of a series of samples prepared by the Geological Survey to test the accuracy of radioactive methods in general, and some in particular, as compared with chemical analysis; and an investigation of the effects of the radioactivity of potassium in prospecting with the Geiger counter.

During the year, 659 X-ray powder photographs were taken, most of them for study and identification of radioactive minerals. Other work included chemical and physical treatment of minerals in preparation for X-ray diffraction analysis, as part of a program of investigations carried on jointly with United States authorities. A large number of mineral identifications were made for the public and for other government departments.

As the official agent of the Atomic Energy Control Board in matters concerning raw materials for atomic energy, the Geological Survey maintains a confidential inventory of Canadian deposits of uranium and thorium. To date it comprises information on more than 500 properties. Little of this is confidential for security reasons, but all information supplied by discoverers and property owners in conformity with regulations of the Atomic Energy Control Board is treated as strictly confidential until released voluntarily for publication.

A. H. Lang continued investigations of uranium deposits and examined occurrences in the Northwest Territories, Saskatchewan, Ontario, and Quebec.

S. C. Robinson continued field studies of the mineralogy of the various uranium-bearing deposits of the Goldfields district, Saskatchewan, where he examined 48 deposits or groups of deposits. The field work will be supplemented by laboratory studies, the purposes of the project being to identify the various minerals and to determine the genetic relationships of the uranium-bearing ores.

R. B. Rowe studied a uranium-bearing pegmatite deposit near Wilberforce, Ontario, in great detail to determine the distribution, extent, and grade of the deposit, and to assess the applicability of the method employed to other deposits of the Wilberforce type.

W. E. Hale examined 35 uranium-bearing deposits or groups of deposits in the area between Rennie, Manitoba, and Sault Ste. Marie, Ontario. Considerable surface work has been done on several of these, and veins carrying visible pitchblende have been discovered.

Geophysics

Geophysical methods are used by the Geological Survey in conjunction with geological information, and are thus an aid to geological mapping, subsurface stratigraphic and structural studies, and to the investigation of problems relating to the possible occurrence of mineral deposits or accumulations of oil and natural gas.

Efforts were concentrated on surveys by the airborne magnetometer in different parts of Canada and under a variety of geological conditions. These surveys covered areas totalling 45,285 square miles, distributed as follows:

—	Square miles	Longitude	Latitude
Labrador	500	66° to 67°	54°50′ to 55°10′
Ontario and Quebec	3,500	75° to 76°	45° to 46°
Alberta	27,170	107° to 114°	54° to 55°
		107° to 108°	55° to 56°
		111°30′ to 114°	53° to 54°
		113° to 114°	53°10′ to 53°30′
Northwest Territories	14,115	112° to 116°	60° to 62°
		114° to 114°30′	62°15′ to 63°

These surveys required the flying of 65,000 line miles of magnetic profile, and a flying time of about 750 hours.

The Division completed the plotting of twenty-one 15′ x 30′ 1-mile map-sheets, which are being issued as blue-line prints under a new series of Geophysics Papers. Compilation of earlier magnetic work in New Brunswick, Quebec, and Ontario is proceeding.

PLEISTOCENE AND ENGINEERING GEOLOGY DIVISION

The study of Pleistocene geology is becoming increasingly important in relation to soils, constructional materials, ground-water supply, and various engineering projects. Results of Pleistocene geological mapping and the collection and compilation of ground-water data by the Geological Survey are of great importance to municipalities, industries, private individuals, and in engineering projects. Many areas in Canada are deficient, or becoming deficient, in a good water supply from convenient sources at the surface and must rely more and more on underground sources, much of which is found in the thick drift that mantles large areas in Canada.

The services of the Division were utilized by numerous industries, municipalities, and individuals throughout the year. Considerable work was done at the request of the Department of Resources and Development and the Department of National Defence.

Field Work

Fourteen parties were assigned to field work, of which 3 operated in British Columbia, 4 in Alberta, 2 in Manitoba, 2 in Ontario, 1 in Quebec, 1 in New Brunswick, and 1 in Prince Edward Island.

BRITISH COLUMBIA

W. L. Brown under supervision of J. E. Armstrong continued mapping and study of the glacial and other unconsolidated deposits in the New Westminster area (longitude 122°30′ to 123°, latitude 49° to 49°15′).

J. G. Fyles commenced mapping of the Pleistocene geology and a study of the ground-water resources in the Horne Lake area (longitude 124°30′ to 125°, latitude 49°15′ to 49°30′), Vancouver Island.

E. Hall continued his work at Columbia River dam sites, where he examined and correlated drill cuttings and cores for the Engineering and Water Resources Branch, Department of Resources and Development.

ALBERTA

B. G. Craig mapped the Pleistocene geology and investigated the ground-water resources of tps. 39 to 42, rges. 1 to 4, W. 5th mer., south-central Alberta.

W. T. Hatfield commenced mapping the Pleistocene geology of the Grande Prairie (Rycroft) area (longitude 118° to 119°, latitude 55° to 56°), Alberta, with special reference to its economic possibilities and relation to ground-water supply.

E. P. Henderson commenced mapping the Pleistocene geology of the Watino area (longitude 117° to 118°, latitude 55° to 56°), Alberta, which adjoins the Grande Prairie area, and to which similar considerations were given.

A. MacS. Stalker continued investigations of Pleistocene geology and ground-water supplies in south-central Alberta. He completed the work in tps. 35 to 38, rges. 1 to 4 inclusive, W. 5th mer., and in tp. 34, rge. 4, W. 5th mer., and made a study of the ground-water supply in the Morinville-Legal area (tps. 55 to 57, rge. 25, W. 4th mer.).

MANITOBA

J. A. Elson mapped the Pleistocene drift in tps. 1 to 10, rges. 10 to 17, W. prin. mer., in southwestern Manitoba. Eskers, outwash plains, and alluvial fills in the area are important sources of road metal and building material, and local concentrations of manganese nodules from the Riding Mountain shales would possibly provide a source of manganese in an emergency.

E. C. Halstead mapped the Pleistocene drift and investigated ground-water resources in tps. 11 to 14, rges. 18 to 25, W. prin. mer., in southwestern Manitoba.

ONTARIO

C. Gravenor mapped the Pleistocene and Recent drift in the Peterborough area (longitude 78° to 78°30′, latitude 44°15′ to 44°30′). The area is probably unsurpassed in its excellence of drumlin formations and is an almost unlimited source of road materials.

E. B. Owen completed geological mapping of the Pleistocene drift and a field study of the ground-water resources of the five townships along the northwest side of the St. Lawrence River between Cornwall and Prescott tributary to the International Section of the St. Lawrence Seaway Project. He also visited other localities in Ontario and Quebec in connection with water supply problems.

QUEBEC

N. R. Gadd commenced a study of Pleistocene drift and ground-water resources in the Bécancour area (longitude 72° to 72°30′, latitude 46°15′ to 46°30′).

NEW BRUNSWICK

H. A. Lee mapped the Pleistocene and Recent drift in the Edmundston area (longitude 68° to 68°30′, latitude 47°15′ to 47°30′). Gravel is of great economic importance in this area for road building, and some new deposits of considerable size were located. A deposit of well-sorted outwash sand that occurs in the area may also prove suitable for the manufacture of concrete building bricks.

PRINCE EDWARD ISLAND

E. I. K. Pollitt completed the collection of data on the ground-water resources of the Tignish area (longitude 64° to 64°30′, latitude 46°45′ to 47°), and commenced work on the Malpeque area (longitude 63°30′ to 64°, latitude 46°30′ to 46°45′). He also established more than thirty observation wells throughout the province.

FUELS RESOURCES DIVISION

The Division gathers pertinent information for subsurface studies and collects, organizes, and files records and samples of wells drilled for petroleum, natural gas, and coal in various parts of Canada. It studies and interprets this material for correlating subsurface geological beds and formations.

Drill samples available for study and reference now total 1,377,675. During the fiscal year 83,044 samples were received and 69,759 were prepared for examination. Of those received, 67,394 samples were from wells in Alberta, mainly in the Leduc-Woodbend and Redwater areas, and from numerous exploratory wells; 14,886 samples were from Ontario, principally from wells in established fields in the southwestern part of the province, and from Manitoulin Island; and 764 samples were from three wells in the Gaspe region of Quebec.

Acknowledgments are made to the following persons and organizations through whose co-operation samples were received: Alberta Petroleum and Natural Gas Conservation Board, Calgary, for all samples received from Alberta; R. B. Harkness, Ontario Natural Gas Commissioner, Toronto, for samples from Ontario; and Paul Payette, of Montreal, for those received from Quebec.

Acknowledgment is made to Alberta Petroleum and Natural Gas Conservation Board for all periodical drilling reports, interim reports, electrologs, and maps dealing with drilling in Alberta; to the Department of Natural Resources and Industrial Development, Saskatchewan, for information on drilling in that province; to J. D. Allan, chief geologist, Department of Mines and Natural Resources, Manitoba, for a report on the Devonian formations of the Lake Manitoba-Lake Winnipegosis region; to I. W. Jones of the Department of Mines, Quebec, for logs of wells in Quebec; and to officials of many oil companies for much useful information.

Samples were examined from scattered wells in Alberta, Saskatchewan, Manitoba, Ontario, and Quebec, and stratigraphic logs were compiled. Maps showing the locations of exploratory and field wells in Alberta were maintained. Advice was supplied on deep test wells drilled for oil or gas in cases where special tax exemptions are allowed by the Federal Government in order to encourage development.

The services of the Division were extended to visiting geologists of Imperial Oil Limited, Hudson's Bay Oil and Gas Company, Union Gas Company of Canada, California Standard Oil Company, and the Department of Mines and Natural Resources, Manitoba, who examined samples and records made available to them.

Work on coal comprised: a continuation of the program of detailed surface and subsurface mapping of selected coal-bearing areas; the collection and compilation of all available data on Canada's coal reserves; laboratory investigations of the coal seams in specific coalfields; and assistance in the solution of geological problems connected with mining developments.

An atlas of the 50 coal areas in Alberta was completed. It contains geological maps on a scale of 1 inch to 4 miles of each of these areas, together with statistical data on the thickness, depth, and attitude of more than 2,000

coal occurrences, and on the type of mine development. A somewhat similar atlas covering 2,200 occurrences of coal in Saskatchewan is being prepared.

Detailed surface and sub-sea investigations were continued on seams of the Sydney coalfield, Nova Scotia, in conjunction with close petrographic study of the coal. The aim is to determine the stratigraphy and structure of the coal seams and associated coal measures, the changes in the quality of the coal, and the probable thickness and character of the coal seams in areas in advance of coal mining operations.

Field Work

WESTERN CANADA

B. A. Latour visited various coal areas in British Columbia, Alberta, and Saskatchewan, and held interviews with the provincial authorities to determine what further information was available that would assist in more complete computation of the coal reserves of western Canada.

ALBERTA

R. B. MacLeod continued subsurface studies of the Lower Cretaceous formations of east-central Alberta southeast of the Edmonton district. The work is designed to assist explorations for oil and natural gas.

P. C. Badgley commenced a study of the Lower Cretaceous formations in the Edmonton district as represented by well cores, drill cuttings, and electrologs of wells, to assist explorations for oil and natural gas.

ALBERTA-SASKATCHEWAN

R. T. D. Wickenden continued investigations of the subsurface geology in the Lloydminster area, and supervised field work of other parties engaged in similar studies in Saskatchewan and Alberta.

SASKATCHEWAN

G. H. MacDonald made a study of subsurface Palæozoic formations in Saskatchewan south of township 50, based on the logs of 14 wells with an aggregate depth of 97,175 feet. The work was designed to assess the prospects of this general area for oil and natural gas.

NOVA SCOTIA

T. B. Haites and P. A. Hacquebard continued their year-round investigations of the coal seams of the Sydney coalfield. They submitted interim reports to assist mine operations and for the advice of the Nova Scotia Department of Mines and the Nova Scotia Research Foundation.

GEOLOGICAL CARTOGRAPHY DIVISION

Maps Published

Publication number	Title	Remarks
	YUKON TERRITORY	
50-20A	Keno Hill; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 50-20.
50-20B	Galena Hill; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 50-20.
	NORTHWEST TERRITORIES	
50-2A	Matthews Lake, District of Mackenzie (two sheets); scale, 1 inch to 1,500 feet	Preliminary geological maps. Paper 50-2.
50-4	Walmsley Lake, District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 50-4.
50-10A	Aylmer Lake, District of Mackenzie (second map); scale, 1 inch to 2 miles	Preliminary geological map. Paper 50-10.
50-13A	Ghost Lake, District of Mackenzie; scale, 1 inch to ½ mile	Preliminary geological map. Paper 50-13.
50-15A	Reliance, District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 50-15.
50-18A	Giauque Lake (Northeast Sheet), District of Mackenzie; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 50-18.
50-21A	Christie Bay (Great Slave Lake), District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 50-21.
50-28A	Fort Resolution, District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 50-28.
	BRITISH COLUMBIA	
106A	Groundhog Coalfield, Cassiar District (revised 1949); scale, 1 inch to 3 miles	Geology. For Bulletin 16 and separate distribution.
50-9A	Zeballos, Vancouver Island; scale, 1 inch to 1 mile.	Preliminary geological map. Paper 50-9.
50-19A	Salmo, Kootenay District; scale, 1 inch to 1 mile.	Preliminary geological map. Paper 50-19.
50-37A	Stratigraphy of the West Coast of Vancouver Island between Kyuquot Sound and Esperanza Inlet; scale, 1 inch to 2,000 feet	Preliminary geological map. Paper 50-37.

Publication number	Title	Remarks
	ALBERTA	
969A	Steveville, West of Fourth Meridian; scale, 1 inch to ½ mile	Geology. For memoir and separate distribution.
	Alberta, Oil and Gas Fields; scale, 1 inch to 20 miles	For separate distribution.
50-8	Mount Head, West of Fifth Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 50-8.
50-12A	Daniels Flats, West of Sixth Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 50-12.
24G	Morinville, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
25G	Redwater, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
26G	Bruederheim, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
27G	Willingdon, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
28G	Edmonton East, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
29G	Edmonton West, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
30G	Snake Hills, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
31G	Two Hills, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
32G	Leduc, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
33G	Cooking Lake, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
34G	Mundare, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
35G	Astotin Lake, West of Fourth Meridian; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	SASKATCHEWAN	
784A	Cypress Lake, West of Third Meridian (reprint); scale, 1 inch to 4 miles	Geology. For Memoir 242 and separate distribution.
856A	Cypress Lake, West of Third Meridian (structure contours) (reprint); scale, 1 inch to 4 miles	Geology. For Memoir 242.
50-25A	Ile-à-la-Crosse; scale, 1/160,000	Preliminary geological map. Paper 50-25.

Publication number	Title	Remarks
	MANITOBA	
987A	Crowduck Bay, West of Principal Meridian; scale, 1 inch to 1 mile	Geology. For separate distribution.
1001A	Brochet; scale, 1 inch to 4 miles	Geology. For separate distribution.
50-5A	Weldon Bay, West of Principal Meridian (second map); scale, 1 inch to ½ mile	Preliminary geological map. Paper 50-5.
	ONTARIO	
992A	Lake Simcoe District (Pleistocene Geology and Bedrock Outcrops); scale, 1 inch to 2 miles	Geology. For Memoir 256 and separate distribution.
993A	Lake Simcoe District (Physiographic Divisions and Locations of Soil Samples); scale, 1 inch to 2 miles	Geology. For Memoir 256 and separate distribution.
G13	Campbellford; scale, 1 inch to 1 mile	Aeromagnetic map.
G14	Bannockburn; scale, 1 inch to 1 mile	Aeromagnetic map.
G16	Coe Hill; scale, 1 inch to 1 mile	Aeromagnetic map.
G15	Bancroft; scale, 1 inch to 1 mile	Aeromagnetic map.
G11	Perth; scale, 1 inch to 1 mile	Aeromagnetic map.
G12	Carleton Place; scale, 1 inch to 1 mile	Aeromagnetic map.
50-11A	Orillia-Brechin; Simcoe, Ontario, and Victoria Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 50-11.
50-11B	Beaverton; Ontario, York, and Victoria Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 50-11.
	QUEBEC	
997A	Senneterre; scale, 1 inch to 2 miles	Geology. For separate distribution.
998A	Villebon; scale, 1 inch to 1 mile	Geology. For separate distribution.
999A	Fiedmont; scale, 1 inch to 1 mile	Geology. For Memoir 253 and separate distribution.
50-3A	Northwest Dasserat, Témiscamingue County; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 50-3.
17G	Macamic, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
18G	Desboues, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Publication number	Title	Remarks
19G	Kinojevis, Abitibi and Témiscamingue Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
20G	Taschereau, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
21G	Clericy, Abitibi and Témiscamingue Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
23G	La Motte, Abitibi County; scale, 1 inch to 1 mile.	Preliminary aeromagnetic map.
	NEW BRUNSWICK	
22G	Pointe Verte, Restigouche and Gloucester Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	NOVA SCOTIA	
995A	Mulgrave; scale, 1 inch to 1 mile	Geology. For separate distribution.
	NEWFOUNDLAND	
50-7A	Bonavista; scale, 1 inch to 2 miles	Preliminary geological map. Paper 50-7.
50-17	Little Rattling Brook; scale, 1 inch to 1 mile	Preliminary geological map. Paper 50-17.
50-22A	Fogo Island; scale, 1 inch to 1 mile	Preliminary geological map. Paper 50-22.
50-24	Torbay; scale, 1 inch to 2 miles	Preliminary geological map. Paper 50-24.
	CANADA	
900A	Canada, Mining Areas (reprint); scale, 1 inch to 125 miles	Geology. For separate distribution.

Four maps were prepared to accompany water supply papers. One hundred and twenty-seven maps and scientific figure drawings were draughted for reproduction by photolithography and by zinc-cut process for illustrating memoirs, reports, articles, and papers.

Five geological maps were at the Printing Bureau at the end of the fiscal year. Five map figures were at the Surveys and Mapping Branch for printing. Eight standard geological sheets, fifteen preliminary geological maps, one water supply map, and two preliminary aeromagnetic maps were in progress in the Division.

MINES BRANCH

C. S. Parsons, Director

The urgency of Canada's defence program necessitated increased attention to projects directly or indirectly related to this program. Thus, priority was given to the metallurgical problems of the atomic energy project, to tests and research on radioactive ores, to work on minerals having a high strategic value, and to the development of prototype weapons and of alloys.

Investigations were commenced into the development of a cheaper method of producing titanium, the alloying characteristics of the metal, and new uses to which it may be put.

Research was continued on development of a simple and economic process for producing lithium and the compounds from the lithium mineral, spodumene. In Canada the process would have particular application to development of the extensive spodumene deposits in Manitoba and Quebec.

As a service to the Department of National Defence, work was intensified on the prevention of corrosion in metals. Typical of the investigations is the research on protection from corrosion in aircraft engines, fuel tanks, ammunition, etc., and particularly in communication equipment of all kinds.

Producing mines and mines coming into production were assisted in the design of flowsheets and in overcoming difficult treatment problems. Approximately fifty investigations of ores and minerals of all types were carried out.

Production methods and tools were designed, and special alloys and extruded shapes were produced, for the atomic energy project at Chalk River, Ontario.

Research was extended into the development of light-weight, high-strength alloys so important to weight saving in aircraft, airborne equipment, and guided missiles, and the Branch completed the development of ZK61, a high-strength magnesium alloy lighter than aluminium.

The properties of nodular iron, a new type of cast iron that has high strength and resistance to shock, were under study. Heat treatments were worked out for various applications such as gears and shells and the new type of iron was successfully rolled into bars and plates.

The cause of short service life of modern pulp digesters in pulp and paper mills was investigated. This project is being financed by Canadian paper manufacturers who have underwritten the costs of a 2- to 4-year investigation in an effort to offset the heavy losses incurred through the necessity of replacing these digesters at frequent intervals.

The Branch continued to seek new and improved methods for the detection, assay, and treatment of radioactive ores and to aid the Crown-owned Eldorado Mining and Refining (1944) Limited and private industry in the concentration and treatment of ore samples.

At the request of the Dominion Coal Board it undertook a survey of the large industrial coal-burning plants in Ontario. The results of the survey will serve as a basis for recommending suitable types and grades of coal for the equipment. It has under way a study of excessive strata pressures in steeply dipping coal seams in the Crowsnest area.

At the request of the Government of Alberta it commenced a series of new investigations on the application of hydrogenation in the removal of sulphur from the tar sands bitumen so as to produce high quality fuels from the extensive deposits of these sands.

Good progress was made in the systematic survey of the mineral resources of Newfoundland where over 100 deposits were examined.

Investigations were continued into the possibility of producing pure silica sand from domestic sandstones to offset increasing quantities of imported

material required by industry to meet its glass sands needs. As one result of this work, private interests have undertaken the drilling of a deposit of Nepean sandstone at Bells Corners near Ottawa.

A process with commercial applications was developed whereby coarse salt of a high degree of purity may be produced from fine salt. The process is being tested by a salt-producing company.

In view of the shortage of sulphur, a survey was commenced of all Canadian resources of sulphur-bearing minerals, and a long-term investigation was under way on the various processes for recovering sulphur from such sources.

Work in ceramics centred about the development and improvement of ceramic products, and the investigation of additional sources of materials. One such investigation of a deposit of kaolin-type clay near Pine River, Manitoba, resulted in making a new source of high quality ceramic clay available to industry.

Research was started on the development of super duty and high alumina firebrick.

With the survey of the Fraser and Skeena River basins in British Columbia the general survey of the industrial waters of British Columbia was completed. The results are to be incorporated in one of a series of reports the Branch proposes to publish under the general title of "Industrial Water Resources of Canada". The rapid expansion of Canadian industry has caused an increasing demand for information of this kind.

Staff, space, and services continued to be provided for a special section producing and repairing anti-submarine equipment for the Canadian navy, and processing quartz for radio-frequency control units for the Armed Services.

Construction of the new mechanical shops building was commenced, which when completed will enable the Branch to carry on its work more expeditiously and remove a serious fire hazard. The addition of two stories to one of the physical metallurgy laboratory buildings, which is also under way, will provide space for important metallurgical development work for Canada's atomic energy project.

MINERAL RESOURCES DIVISION

The Division is concerned primarily with the economic aspects of the development, use, and conservation of Canada's mineral resources, and provides investigatory and information services on such matters. Thus it provides many types of information, mainly economic and non-technical, on mineral resources, and more particularly on the metallic minerals and their products.

The mineral occurrences index maintained by the Division proved of great value in meeting the need for urgent information on mineral supply for Canada's defence program. With more than 5,000 mineral occurrences listed, the index provides a concise summarized account of all significant deposits in Canada of metallic and industrial minerals. In addition to the constant references to the index by officers of the Department, it is used extensively by other Government departments and by prospectors and mining companies. A map library maintained in conjunction with the index contains more than 8,000 maps, which readily provide information on the topography and geology of the areas concerned and on the accessibility of the occurrences.

The Chief of the Division attended the Tin Study Group conference in Paris; a meeting in Washington of the Sub-Committee on Non-Ferrous Metals and Minerals of the Joint United States-Canada Industrial Mobilization Planning Committee; and the United Nations Technical Assistance Mission to Bolivia, as mineral economics adviser. During the quarter ending December 31, 1950, much of his time was occupied in assisting the Department of

Trade and Commerce in matters concerned with problems likely to arise from shortage of metals, and since the second week of January 1951, he has been assigned to the Director of Non-Ferrous Metals Division in that Department for liaison duty.

Studies were made or were in progress on: the role of non-ferrous scrap metal in Canada; the possibilities for the production of pig iron in Alberta; deposits and occurrences of antimony in Canada; the supply of by-product pyrite and matters concerned with the development of magnetite deposits in eastern Ontario. The Division prepared reviews for 1949 on the metals produced in Canada.

It assisted the Director General of Scientific Services in the administration of the Emergency Gold Mining Assistance Act, two engineers serving as a small administrative unit in receiving and processing applications for cost-aid with the assistance of the Cost Inspection and Audit Division of the Office of the Comptroller of the Treasury. One of these engineers visited all assisted lode gold mines during the year on inspectorial work in respect of exploration and development expenditures. Much time was given by another officer to special problems arising in the course of administration, and on studies of representations made by the industry for easement of its problems and related matters.

Through the Director General of Scientific Services the Division acted in an advisory capacity to the Department of National Revenue in the administration of Dominion income tax legislation relating specially to mining operations. Letters of comment were prepared on twenty-five applications and inquiries to that Department from mining companies under Section 74, Income Tax Act, providing a 3-year exemption from tax for new metalliferous and new industrial mineral mines based on non-bedded deposits. Applications from five industrial mineral mine operators for certification by the Minister that their mines were based on non-bedded deposits, as required to qualify for percentage depletion allowance, were examined in co-operation with the Geological Survey and the necessary submissions for the Minister's consideration were prepared.

Submissions were also prepared for the Minister's information in considering ten applications for approval by the Governor in Council for the special tax concessions made available under income tax legislation to oil companies drilling deep test oil wells so approved.

LIBRARY

The Mines Branch Library is administered by the Mineral Resources Division.

Acquisitions:

Canadian Government documents	1,353
British and foreign Government documents	1,739
Scientific societies' publications	950
Periodicals	6,545
Books and pamphlets purchased	472
Total	11,059

MINERAL DRESSING AND PROCESS METALLURGY DIVISION

The Division intensified and broadened its research and investigational work to meet the requirements of the expanding mining and metallurgical industries. It was again instrumental in solving various complicated problems the metallurgical industries have faced in meeting demands of the national economy and defence.

Its research included work on the concentrating of spodumene from deposits in Manitoba and on extracting lithium salts and refining of lithium, a metal for which new vital uses are being found in industry and in the atomic energy program.

The Division aided producing mines in increasing recoveries and lowering treatment costs, and mines coming into production in the designing of flowsheets based on laboratory results.

To assist the iron and steel industries, it undertook research on slags and on ore beneficiation and sintering. It pushed work on the development of methods to prevent or reduce metal corrosion because of the importance of such methods to the Department of National Defence and to the national economy arising from the great loss of metal through corrosion, the replacement of which imposes additional burdens on manufacturing plants already working to capacity.

The Division's research on determining the temperature of formation of minerals in ore deposits has provided valuable information on the succession of deposition of minerals at the Eldorado mine at Port Radium, Northwest Territories.

All possible direct aid was given to mines having ore dressing problems.

Sherritt Gordon Mines, Limited, successfully completed preliminary testing of the application of the Forward leaching process to its Lynn Lake ores in the pilot plant it installed in the Division's laboratories, and is now testing the process on a larger scale in a new plant it has established in Ottawa. The co-operation maintained with the company's engineers in their operation of the pilot plant enables the Division to evaluate the possibilities of the application of the leaching process to other Canadian ores.

Metallurgists of Ventures Limited carried out extensive investigations in the laboratories, assisted by the Division's engineers.

MINERAL DRESSING

Thirty reports on major investigations carried out during the fiscal year were sent to mining companies who had forwarded samples ranging from 100 pounds to several tons. Eight of these investigations were to improve recoveries of gold from its ores, and four were on gold ores from new properties. Recommendations were made for increasing the recoveries and decreasing the costs. Eight investigations were made on lead-zinc ores, and suitable mill flowsheets were designed. Two companies using the results erected milling plants that are now in production. The remainder of the investigations consisted of two on recoveries of silver from tailings; two on iron ores; and six on industrial minerals.

The results of eighteen further investigations were reported by letter. Several of these related to low-grade iron ores and the investigations provided information on small, scattered iron occurrences in Canada and on their possibilities for utilization.

The investigation on the cold water separation of bitumen from Alberta bituminous sands, which was started in the previous fiscal year, was concluded on a pilot plant scale. A research report showing 95 per cent recovery of the bitumen by the process, prepared on this investigation, was distributed to interested parties in Canada and the United States.

Eighteen companies used the facilities of the Division to conduct their own investigations, thirteen being concerned with metallic ores and the remainder with industrial minerals.

EXTRACTIVE METALLURGY

The Division developed a process on a laboratory scale for the extraction of lithium from the lithium mineral spodumene, large low-grade deposits of which occur in Canada. Patent has been applied for on this process, which has promise of commercial application as it is cheap and simple to operate and extracts over 98 per cent of the lithium compared with 75 to 80 per cent by the existing extraction process.

An investigation on siderite iron ores from the Michipicoten area, Ontario, led to determination of the conditions necessary for the maximum elimination of sulphur in the sintering of these ores. This elimination is of prime importance in the manufacture of iron and steel, as even small amounts of sulphur adversely affect operational capacity and the quality of output.

Research conducted on extraction of gold from refractory ore containing antimony and lead dealt with gold ores in Northwest Territories and showed why poor extractions were obtained when concentrates were roasted and how the difficulties might be overcome. Where both antimony and lead were present, the gold particles became coated during roasting with a film of antimony oxide, which protected the gold from the action of the cyanide solution. If the calcine was very finely ground, the coatings were removed and good extractions obtained. The formation of coatings of antimony oxide on gold particles with consequent poor gold extractions by cyanidation was also observed when antimony-lead concentrates originating from quite a different locality were roasted. In this case also fine grinding of the calcine removed the coatings and improved the extractions greatly. This suggests that the reactions taking place in roasting are probably generally applicable to concentrates containing antimony and lead.

In view of the problems that frequently arise in applying the long-established cyanide process to Canadian gold ores an investigation was initiated into the fundamental chemistry of the dissolution of gold in cyanide solutions in which the effect of oxygen, cyanide concentration, and certain impurities found in mill solutions was examined. This is part of the general program designed to put the metallurgy of gold cyanidation on a more scientific basis.

The roasting of ore concentrates is becoming increasingly important in Canada, and as conducted in single or multihearth furnaces it is usually only partly successful in improving metal extraction. A new technique, originally developed by the petroleum industry, in which concentrates are fluidized, has become available. To test its applicability to Canadian ores, an experimental furnace was designed by Branch engineers and is under construction.

CHEMICAL METALLURGY

Research was started to work out a cheaper method of producing titanium metal, which now sells for $5 to $7.50 a pound and which is produced in only limited amounts. Such a method would enable a much greater production and the metal would have extensive use because of its lightness and high resistance to sea water and other types of corrosion.

Investigations were commenced on the separation by high-temperature distillation of the various constituents of salt deposits that occur extensively in certain localities. Besides sodium chloride, these deposits contain considerable amounts of such valuable minerals as potassium chloride, bromides, iodides, and lithium chloride.

Research on the corrosion of metals was intensified. Most of the problems investigated were submitted by the Department of National Defence. Many of them concerned corrosion of aircraft engines and bodies, others, the deterioration of metal parts of motor vehicles, and still others, the protection of various

metal parts of ships from corrosion by salt water. Improvement of the corrosion resistance of ammunition was also investigated. Reports containing recommendations were issued to the parties concerned.

Much development work was done on the numerous methods of protecting steel, non-ferrous metals, die castings, and light alloys from corrosion. Some problems dealt with the corrosion resistance of stainless steel. Reports incorporating recommendations for satisfactory alleviation and prevention of corrosion were issued to the interested parties.

Continuing its intensive study of the factors that accelerate or inhibit the spontaneous formation of white tin to the grey variety under low temperature conditions the Division developed a method for determining the susceptibility of white tin to grey tin formation. The method was successfully tested on a series of commercial tinplate samples.

The Division worked in close co-operation with the National Research Council on the Atomic Energy Project and on corrosion research and prevention.

PHYSICAL AND CRYSTAL CHEMISTRY

This Section, organized during the fiscal year, is a specialized research unit for investigations in the chemistry and mineralogy of slags, minerals, ceramic refractories, etc.

To assist the iron and steel industries in the serious problems of desulphurizing metal, investigations were started on the physical properties of slags, on methods of slag control, and on the factors relating to removing sulphur by slag-metal reactions. To assist plant operators in finding the cause for variations in sulphur content of steel, several industrial electric furnace slags were examined. Typical blast furnace slag compositions were prepared to determine melting point and crystallization sequence. Preliminary work was done on the synthesis of open-hearth slags.

As sulphides of calcium, manganese, and iron are chiefly concerned in the desulphurizing reactions occurring in iron and steel, purified samples of these compounds were prepared and studies were started of rapid methods for controlling slag compositions. One such study is directed towards the extension and improvement of a method already used in industry. Two steel plants in the Montreal area were visited to discuss the problems of slags and their control.

Research is under way on the properties of titania-bearing slag, an important new commercial product being produced from Quebec ilmenite ores. X-ray diffraction and high-temperature studies are in progress to determine the nature of the crystalline compounds present in the slag and the temperatures at which they dissolve.

Equipment was installed for the identification and thermal study of materials by the differential thermal analysis method, and it is being used in co-operation with the Geological Survey of Canada to examine shales from the Quebec-Labrador iron ranges. As certain diagnostic features of the various shales are shown only by this method, it is of assistance in stratigraphic correlation of formations, and thus in locating iron deposits. The Division has also used the differential thermal analysis method in a survey of commercial clay properties and for determining inversion and decomposition temperatures in lithium minerals, low-grade nickel ores, etc.

High-temperature phase equilibrium investigations of basic refractory compositions were continued in co-operation with a manufacturer of these products, the object being to develop improved compositions that can withstand higher temperatures in metallurgical and other industrial furnaces. In the investigations the effect of spinel on basic refractory clinkers was studied. The phase diagrams that have been published as a result of these investigations

will be of assistance to manufacturers in determining refractory or non-refractory compositions by showing the melting relationships between dicalcium silicate, magnesia, and alumina.

Bone china compositions are being investigated from the phase equilibrium standpoint, to improve the firing characteristics of bone chinaware by determining the nature of crystalline compounds present at various temperatures and the compositions that give rise to the longest melting range.

Because of the growing use of simple oxide refractories for special purposes in industry and in military equipment, investigations were started on fabrication methods for such refractories composed of thoria, zirconia, and alumina.

The X-ray diffraction laboratory established in the previous year was used to good advantage in the various projects and in other research work in the Mines Branch.

CHEMICAL ANALYSIS

Research was continued on the application of instrumentation to chemical analysis to enable speedier and more accurate work.

Flame photometry was further developed for determining very small quantities of sodium and potassium in lithium metal, and a method to determine calcium in magnesium alloys was developed as another important application of the flame photometer.

A modified Breckpot polarograph was constructed and is giving very useful results in the analyses of steels and light alloys.

Excellent results have been obtained in the determination of fluorine by use of an amperometric titration apparatus designed and constructed in the Branch.

Work was continued on the separation of the nodules in nodular cast iron, which is finding increasing acceptance in foundry practice, in an effort to learn more about the nature of these nodules and the mechanism by which they affect the properties of the cast iron. Excellent recovery of the nodules was obtained by a cold acid solution method. A number of chemical analyses of the ashed nodular material showed a high concentration of titanium, suggesting that the formation of the nodules may act as a collecting mechanism for titanium and other elements that might be classed as inclusions in cast iron. The nodules were found to be magnetic.

With the use of an all-glass distillation apparatus designed and fabricated in the Branch most precise determination procedures were adopted for total nitrogen and aluminium nitride in all types of steel encountered to date. Steels and certain types of alloys contain aluminium nitride — nitrogen in very minute amounts. Even a slight variation in those amounts perceptibly affects the properties of alloys and steels. Further study of the nitrides of aluminium, titanium, and zirconium is in progress.

The wide interest shown by chemists in Canada and overseas in a booklet on "Methods of Analysis of Iron and Steel used at the Mines Branch Laboratories" made necessary the publication of a revised edition of the booklet.

MINERAGRAPHIC AND SPECTROGRAPHIC

The major research project in the mineragraphic laboratory was a study of the uranium ores of the Eldorado mine at Port Radium, Northwest Territories. Geothermometric apparatus for determining the temperatures at which the various hydrothermal minerals were deposited was designed and built in the laboratory and was operated at the mine for 2 months. Many specimens were collected underground and on the surface, several of which were studied geothermometrically, and to a limited extent microscopically.

All of the samples were brought to Ottawa for detailed studies. The results to date have proved useful in determining the paragenesis of the minerals and in establishing the sequence of their deposition and hence the genetic relationship of the uranium and other complex mineralization. Further geothermometric studies will possibly indicate conditions of ore emplacement throughout the mine, and if so will provide valuable information for use in planning operations.

Research projects completed included a study of the sources of adulterants affecting the quality of container glass, determination of the character of a spodumene ore, and an investigation into the character of anodic coatings on gold.

In the spectrographic laboratory, a new method was developed for the semi-quantitative determination of constituents in powdered samples. Special apparatus was designed and the results were reported in a paper presented at the Conference on Analytical Chemistry and Applied Spectrography held in Pittsburgh. The method is being applied chiefly in the Division to the analysis of mineral powders and mill products, but it is hoped that it can be applied to almost any combination of elements producing emission spectra.

Standard methods of spectrochemical analysis were developed to expand the range of materials that can be analysed and to obtain greater accuracy.

INDUSTRIAL MINERALS DIVISION

The acute shortage of industrial minerals for use in Canada's rapidly expanding chemical, construction, and manufacturing industries and the consequent urgency for research on these minerals to promote the development of new sources led to the establishment, in June 1950, of an Industrial Minerals Division in the Mines Branch. The Division was formerly a section of the Mineral Resources Division. It is engaged in basic research on industrial and rare-element minerals, and makes studies of the occurrence of ores of such alloying metals as cobalt, manganese, molybdenum, tungsten, and chromium.

It has four sections, namely, Non-Metallic Minerals, Ceramic, Construction Materials, and Industrial Waters. Each section does research on the occurrence, technology, and utilization of the minerals pertaining thereto, with special attention to developing new uses for these minerals and to the utilization of low-grade materials. Special attention is given also to strategic rare-element minerals, in which work liaison is maintained with other government departments of Canada and the United States interested in the supply of these minerals.

The Division identifies and appraises mineral samples submitted by industry and the public and provides technical information on the occurrence, processing, and utilization of these minerals.

Work was continued during the fiscal year on the field survey of the mineral resources of Newfoundland. Most of the mineral deposits within easy reach of road and rail transportation have now been examined and sampled. Chief attention was given to the pyrophyllite deposits at Manuels and to the clay and shale deposits in the eastern part of the province, and extensive laboratory tests were made on the samples collected.

Late in the summer of 1950 an engineer of the Division recognized the occurrence near Perth, Ontario, of vermiculite, a form of mica that expands on heating to form a light-weight insulating material. Further investigation revealed the vermiculite to be available in quantity, and a full-scale laboratory research program was undertaken to find out the best means of processing it to supply the Canadian market, which hitherto has been supplied entirely from outside sources.

An investigation into the possibilities of producing silica sand of high purity from domestic sandstones was brought to a successful conclusion and a plant will be built shortly at Bells Corners near Ottawa to supply sand suitable for the glass industry and for other industrial purposes. The Canadian requirements for glass sand are now imported. The possibilities of producing pure silica sand from sandstones elsewhere in Canada are being investigated.

Work on the production of a coarse salt of high purity from fine salt has led to the development of a satisfactory process that is being tried out by a salt-producing company. This process will make available from domestic sources a coarse salt of greater purity than that being imported and that will be suitable for use in the meat packing, fishing, hide curing, and refrigeration industries.

An investigation into methods of beneficiating impure gypsum was completed and a report on the results was issued.

The Division continued to investigate the possibilities of producing natural and artificially coloured roofing granules from Canadian rocks. It designed and built equipment in which the resistance of various kinds of rock to penetration by ultra-violet light can be measured and by the use of which rapid selection of rock types worthy of further investigation can be made. Industry is showing much interest in this work and drilling has been done on several deposits to determine their extent and uniformity.

Good progress was made in developing techniques for processing Canadian magnesia to render it suitable for use in a wide variety of products. Formulæ for magnesium oxychloride cement and magnesium oxysulphate cement have been developed as well as a technique for using magnesium hydroxide in the manufacture of light-weight 85 per cent magnesia insulation.

Research was continued on the making of citrate-soluble tricalcium phosphate and citrate-soluble calcium-magnesium phosphate from apatite and associated pyroxenite in Ontario and Quebec for the manufacture of fertilizer.

Much research was undertaken in connection with the development of new and improved ceramic products and the appraisal of new sources of ceramic raw materials.

An investigation into the suitability of certain quartzites in Ontario for making silica brick was successfully completed and a report on the results was issued.

Fifteen samples of clays and shales collected in Newfoundland were examined and tested to determine their suitability for the manufacture of clay products. Several of the samples from undeveloped deposits proved to be excellent materials for making face brick.

Research on the possibilities of improving fireclay refractory brick by the addition of alumina in various forms, undertaken at the request of a manufacturer, gave highly satisfactory results with one form of alumina. The result of the work, which is being continued, will be of interest to manufacturers of a variety of refractory products.

The Division, at the request of the Department of National Defence, undertook research into the possibilities of making certain electronic ceramic materials possessing special dielectric properties. A number of induction coil forms with satisfactory properties have been made.

It developed a method of improving the qualities of Canadian fireclays for the production of "super duty" firebrick, hitherto not manufactured in Canada. Commercial use of the process is expected in the near future.

A new source of ceramic clay of high quality has been made available to industry in western Canada as a result of an investigation of a kaolin-type clay found near Pine River, Manitoba.

The Division continued the general investigation involving the complete testing of all types of firebrick made in Canada or imported, the purposes being to show where improvements can be made in the various brands of Canadian

manufacture, to obtain data for the drawing up of specifications, and to find which type of brick is most suitable for a specific application.

It conducted many minor investigations on ceramic materials and tested 240 samples of clay and shale submitted from various sources throughout Canada to determine their suitability for industrial use.

It completed the survey of the waters of the Fraser and Skeena River basins in British Columbia. The survey of the waters of the Fraser River and its tributaries was done in co-operation with the Dominion-Provincial Fraser River Board. The general survey of the industrial waters of British Columbia is now complete and reports are being prepared.

In the investigation into sources of light-weight aggregates in Canada, 300 samples of shales and clays collected in western Canada during the fiscal year were processed. In general, the results show that Alberta and Saskatchewan have ample resources of suitable raw materials for making high-grade, coated, light-weight aggregate, but Manitoba is not so well supplied. Further work remains to be done in British Columbia and in central and eastern Canada. A procedure was evolved for the rapid evaluation of samples of shale and clay, and a series of physical tests has been decided upon to show the quality of the products.

An investigation was begun into the effect on strength of concrete when part of the cement is replaced with mineral powders such as limestone dust, granite dust, volcanic ash, ground silica, hydrated lime, and silt. The initial results show that under certain conditions there is no appreciable reduction in strength when as much as 30 per cent of the cement is replaced by certain of the powders.

Research was commenced into the effect of chert as a constituent of concrete aggregate. Studies are being made of the resistance to weathering of the several types of chert occurring in Canadian limestones and of the extent, if any, of chemical reaction between the chert and the cement.

The economics of making sand from rocks of various types was studied, as was the effect of waterproofing compounds on the strength of concrete.

A survey of construction materials in the area adjacent to the St. Lawrence River in eastern Ontario was completed, as were the laboratory tests on the numerous samples collected. A report is being prepared.

The Division loaned an engineer to the Department of Resources and Development to report on road materials available adjacent to the proposed route of the Trans-Canada Highway in Newfoundland. His report, entitled "Road Materials Survey in Newfoundland", was completed.

RADIOACTIVITY DIVISION

The Division continued its work on the treatment of radioactive ores, with emphasis on the development and application of methods for the production of marketable concentrates from individual uranium ores. It undertook twenty-three investigations for private industry on the concentration and treatment of bulk ore samples from various properties.

There were fifty-eight requests for other types of work, including special assay services not provided by the Geological Survey of Canada, and mineralogical studies. Two hundred and eighty-four samples were received for all types of work.

Apart from the above services the Division continued extensive experimental and development work on the treatment of ores and products from the properties of the Crown-owned Eldorado Mining and Refining (1944) Limited. The Division worked closely with the company on the design, installation, and operation of an experimental plant, which it operated successfully for several months at its mine at Port Radium, Northwest Territories, in trying out the

leaching process developed by the Mines Branch for recovery of uranium from ores unsuited to conventional methods of treatment. Eldorado is proceeding with the installation of a full-scale plant for the treatment of ore by this process.

The Division continued its basic experimental work on new and improved methods for detection, assay, and treatment of ores. It did 2,433 radiometric assays, 5,014 chemical assays for U_3O_8, and 4,410 other chemical assays. The total of 9,424 chemical assays involved 14,911 determinations on 5,302 samples. In the preceding fiscal year it made 12,023 chemical determinations on 2,600 samples.

It issued 22 confidential reports on ore treatment to firms and individuals from whom bulk ore samples had been received for investigation, and prepared 63 reports dealing with technical projects, information on which is restricted by security regulations, for the Atomic Energy Control Board. Twelve unclassified reports containing no restricted information were issued. These are listed below.

Unclassified Special Reports

SR–36/50 Report on the Colorimetric Determination of Phosphorus and Arsenic in Ores and Leach Solutions by Reduction of their Molybdates with Stannous Chloride, by F. T. Rabbitts and H. J. Herbst.
SR–39/50 The Chemical Analysis of Uranium in Ores, by the Staff, Radioactivity Division.
SR–44/50 Scintillating Crystals, by R. D. Wilmot.
SR–78/50 Progress Report for October and November, 1950, by C. Lapointe.

Unclassified Topical Reports

TR–46/50 Investigation of the Possibilities of a High Frequency Induction Furnace for Fusing Sodium Fluoride Beads in the Fluorimetric Determination of Uranium in Ores, by J. B. Zimmerman.
TR–47/50 Determination of Aluminium in Ore Samples and Solutions, by G. Brackenbury.
TR–48/50 Methods of Analysis Used in the Radioactivity Division, Mines Branch, by the Analytical Staff, Radioactivity Division.
TR–49/50 Colorimetric Determination of Cobalt in Ores and Solutions, by R. J. Guest.
TR–51/50 The Determination of the Optimum Thickness of Flake and Powder Phosphors for Gamma Scintillation Counters, by F. E. Senftle, L. S. Collett, and L. A. Ficko.
TR–52/50 Report on Four Miscellaneous Investigations, by F. E. Senftle and Staff of Physics and Electronics Section.
TR–58/50 A Circular Slide Rule for High-Pressure Ionization Chamber Calculations, by P. Normand.
TR–73/51 Report on Rapid, Colorimetric Method for Uranium Analysis, to be used in Plant Control Work, by G. Brackenbury.

FUELS DIVISION

The trend toward the use of oil in place of coal in the fields of domestic heating, industry, and transportation continued, and, accordingly, the Division again gave chief attention during the year to the technological problems of the coal industry, believing that well-planned and co-operative research can do much toward maintaining an adequate market for coal in those places and for those purposes for which it is best suited.

SURVEY OF COAL MINING METHODS

The survey of coal mining methods carried out by the Division in previous years revealed the existence of excessive strata pressures in some mining areas, and a study of these pressure phenomena is under way to obtain precise information of the stresses present in underground workings. The information will be of use in ascertaining methods of alleviating the hazards arising from the

violent pressures through improvement in the design of mine workings. Coal mining companies in Alberta and British Columbia are co-operating in the work.

TESTING MINE AIRS AND ELECTRIC MINING EQUIPMENT

The Division continued to collaborate with the provincial mining inspectors in testing mine air periodically and in cases of emergency. The use of diesel engines in mine locomotives has caused concern regarding possible contamination of the air with carbon monoxide. Accordingly, the Division is studying and comparing methods by which small amounts of carbon monoxide can be determined with certainty. It has obtained apparatus for this work and is constructing special equipment. It has done considerable work towards establishing procedure for testing electric mining equipment, the object being to develop safety standards for use in Canadian coal mines.

COAL PREPARATION AND BRIQUETTING

The preparation of raw coal from the mine into such condition as the market requires involves in part the elimination of the greater part of the ash. The Division has consistently encouraged the setting up of washeries at the mines as a means of reducing the amount of ash in marketable coal, and a number of washeries have been set up at some mines for this purpose. During the year it conducted performance tests at two washeries. The comprehensive results obtained were tabulated and used to indicate the efficiency of the washery under operating conditions. The Division also made a series of tests to determine the value of froth flotation in the beneficiation of fine coal.

It conducted tests in commercial briquetting plants and in the laboratories at Ottawa to determine the most suitable types and blends and the most suitable binders that might be used.

UTILIZATION OF COAL

The Division, on behalf of the Dominion Coal Board, undertook to obtain certain technical data regarding the relative properties of coal from United States and Canadian sources, the aim being to encourage the greater use of Canadian coal in railway locomotives. At the request of the Board it also undertook a survey of the large industrial coal-burning plants in Ontario as a basis for recommending suitable types and grades of Canadian coal for the equipment.

An automatically controlled stoker using coke was installed and operated in the laboratories to demonstrate to prospective users the economics of this type of equipment and to aid the coal industry to compete more successfully in markets for space-heating fuels.

COAL-FIRED GAS TURBINE

Investigational work incident to coal-fired gas turbines was continued throughout the year. Combustion efficiency tests were made on twenty-three different coals commonly used by Canadian railways, in a full-scale combustor of the type proposed for the open cycle turbine. A study was made of the relation of cycle efficiency to various operating conditions in exhaust-heated cycle equipment, in collaboration with the Gas Dynamics Laboratory of McGill University. The development of this type of power unit was considered of such

importance that an agreement has been entered into with McGill under which a 500-horsepower prototype plant is being designed and installed at the University, with the expectation that it will be brought into operation early in 1952.

VOLATILIZATION OF COAL, AND COKING TESTS

The Division has undertaken to study the mechanism of volatilization in view of the indications that it is important to avoid the formation of graphitic carbon during the combustion of pulverized coal. For this purpose it has set up equipment that, it is hoped, will show the maximum amount of volatile material that can be obtained from a given coal under controlled temperature and pressure conditions. If a greater amount of the volatile matter in the coal can be utilized in gaseous form the efficiency of the combustion process will be increased and the amount of graphite formed will be decreased.

In view of the increasing scarcity of high-quality foundry coke in Canada and the United States, the Division carried out coking tests on bituminous coals from British Columbia and Alberta, and on imported coals processed in by-product coke ovens in Ontario. In this, it gave particular attention to evaluating the physical properties of the resultant cokes, and to the swelling pressures developed during coking, and prepared a report thereon. In related studies it investigated the possibility of producing coke-like fuels from non-coking Canadian coals by carbonization. It studied the effect of blending different coals, of using varying proportions of inert materials, and of bonding the coke-oven charges with coal tar pitch, with particular reference to the development of coke structure and to the quality of the coke produced. It also investigated the suitability of low carbon-content beehive cokes for use in foundries, with a view to the extension of markets for Alberta coking coals.

SYNTHETIC LIQUID FUELS AND RESEARCH ON BITUMEN

Progress was made on the design and installation of high pressure hydrogenation equipment to be used in fundamental research on the application of hydrogenation to the production of high-quality liquid fuels from Canada's resources of heavy oils and bitumen.

Some experimental work was done on low pressure hydrogenation to study the effects of the inorganic materials present in the distillate from the coking of bitumen on the life of different catalysts that might be used to remove sulphur.

The Division made several tests on the bitumen it obtained in investigational work on the extraction of bitumen from bituminous sand that was carried out in the previous year jointly with the Mineral Dressing and Process Metallurgy Division. The water from the wet bitumen was removed satisfactorily by the dehydrator and a suitable stock of bitumen was produced for use in thermal cracking equipment. A sample of crude oil from Lloydminster was processed in a similar manner. Reports on various phases of the plant operation were prepared. Further work was done on the constitution of bitumen, using new methods to obtain sharper separation between different chemical species present.

ANALYSIS SURVEYS AND LABORATORY INVESTIGATIONS

The physical and chemical survey of Canadian coals was continued, with the taking of samples from mines in the Sydney area, Nova Scotia. These samples have been analysed and the data obtained are being assembled into a comprehensive report on the coals in this area. The revision of the "Analysis

Directory of Canadian Coals" is under way, and a comprehensive report is in press on the analysis of Canadian coals from all known occurrences, as is a report on the analysis of crude oils analysed by the Fuels Division since 1931. A survey of gasoline sold in Canada during the summer of 1950 was made and the results have been published in mimeographed form.

A method of determining the free swelling index of coal was developed, which, it is hoped, will be suitable for use in testing at collieries and elsewhere. The method enables the use of standard electrically heated laboratory equipment of relatively low cost instead of the gas-heated special equipment formerly used for this purpose.

Work was continued on determining the electrical conductivity of coal samples from western Canada, the object being to improve the quality of metallurgical coke. Methods by which the fusion temperature of coal ash can be determined more cheaply than at present were investigated. Equipment for the evaluation of crude petroleum, to yield products similar to those obtainable in a modern refinery in sufficient quantity to permit accurate laboratory analyses to be made, was redesigned and fabricated.

Laboratory analyses of various fuels and lubricants were made for other government departments and for different organizations.

PEAT MOSS SURVEYS

Field surveys were made of the peat moss industry in Quebec and the Maritime Provinces. The survey of Newfoundland disclosed several peat deposits, including one with commercial possibilities.

PHYSICAL METALLURGY DIVISION

Much of the work of the Division during the fiscal year was in connection with Canada's defence program. Although the full impact of armament orders has not yet been felt the indispensable prototype and specification work is well under way. As a consequence there was a sharp reduction in the time and facilities devoted to research other than that of immediate practical importance, and an increase in the efforts given to prototype production within the Division and in industry.

Approximately ten new projects were undertaken during the fiscal year, nearly all of them long term. More than one hundred research investigations were conducted. This diversified research program required the full-time services of one hundred and twenty persons.

The metallurgical problems of the Atomic Energy Project were given top priority and the work was greatly increased as a result of the new construction under way at Chalk River, Ontario. To handle this additional work the facilities and staff at the site were expanded. This makes possible for the first time, metallurgical investigations on the spot in which "hot" materials must be used. At the laboratories in Ottawa the design of production methods and of tools for critical items has been worked out and special alloys and extruded shapes produced.

Because of the interest of the Armed Services in the mechanical and corrosion resistant properties of titanium, the Division has undertaken an intensive program to develop melting and casting equipment and techniques that will make possible the early production of prototype parts. This program, together with the work on light metal alloys, is aimed at weight saving, so important to aircraft, airborne equipment, and guided missiles. Already the magnesium alloy ZK61, developed by the Division, is in production in Canada and the United States. Service reports confirm outstanding combinations of properties and satisfactory service life.

Hot impact extrusion of shells was found on investigation to offer promise of substantial savings in critically short steel, and of higher production rates at reduced costs. This process combined with more conventional methods makes large-scale shell production practicable with existing Canadian industrial equipment at short notice.

Work was continued on nodular iron, a new type of cast iron that has very useful combinations of properties such as two to three times the strength and several times the shock resistance of ordinary cast iron, and that possesses some ability to bend. These properties can be developed and enhanced by suitable heat treatments that have been worked out for such diverse applications as gears and shells. The development of rolling procedures has made possible the reduction of nodular iron billets into bars and plates. Electron microscopic studies of the graphite nodules now under way may reveal the reasons for their characteristic shape and form a basis of improved methods of production.

The Division has developed a special method of testing vital aircraft control cable that permits marked reductions of time and costs of testing and that has helped the producers to develop a suitable product in a short time.

An industrial X-ray laboratory for examination of castings and welds was put into operation and was used to design procedures for repairs of boilers of lake and ocean ships. The procedures have proven successful, with a considerable saving to vessel owners. Of equal interest to the shipping industry are the investigations of brittle fractures of ship plates and of the causes of failure of welded dock piling. Tests were made on every plate of an icebreaker now under construction to determine the susceptibility of the plates to failure in severe service.

New techniques in using electrical strain gauges in stress analysis have been devised as a result of development of equipment and ordnance for the Armed Services. These techniques are also applicable to the design of springs. Newly acquired supersonic testing equipment has been applied to detect flaws in large rotor forgings to be used in new ships of the Royal Canadian Navy. This is the first time such rotors have been produced in Canada and close control of quality is essential.

In an effort to reduce mine ore drilling costs, the Division has been investigating the possibility of improving drill rods and bits, as a result of which a method of improving fatigue life was recommended to the industry and is now under service trial. Two new methods of testing connections between drill rods and bits devised by the Division are being used to study the effects of heat treatments, surface finishes, etc., on service life.

Work in the field of metal physics has resulted in development of an improved way of solving complicated metal crystal structures by mathematical methods. This permits simplification of experimental requirements for work designed to make possible the prediction of the mechanical behaviour of alloy systems and so permit the design of useful alloys. An improved method of determining the orientation of crystals in a metal using an X-ray spectrometer was developed, which enables a better understanding of forging, rolling, and extrusion.

A spectrographic laboratory was set up for use in studying diffusion of metals. This phenomenon is often the governing factor in ingot segregation and in the response of metals to industrial heat treatments. A complete understanding of it would offer promise of cost reductions in commercial heat treatments. In addition, the importance of the influence of gases in metals is now appreciated in industry and is under intensive study in the Division.

The precision casting of metals, of importance to the aircraft instrument and jewellery industries, was continued. The process has been used by the Division also in the development of high-temperature alloys for jet engines. It has made exact scale models of aircraft propellers for design studies in the

wind tunnels of the National Research Council and has given practical assistance to Canadian manufacturers entering the precision casting field.

In co-operation with the Pulp and Paper Research Association, a program is being prepared to determine the cause of short service life of modern pulp digesters that convert wood chips into the raw material for paper. The program has the support of Canadian paper manufacturers, who will bear the costs of a 2- to 4-year investigation. The results will be of interest also to the paper manufacturers in the United States, with whom an exchange of information has been arranged.

Work was pressed on the development of jet engine alloys, particularly on those that will withstand the most severe applications and that do not involve the use of strategic metals. A paper published on Kinsalloy, developed in this Division, has aroused great interest in Canada and United States and has resulted in a demand from research organizations and commercial companies for samples of the alloy. Representatives of jet engine producers in the United States have visited the Division to learn how to produce the alloy. Kinsalloy is undergoing extensive service trials in jet engines, and the Division is assisting commercial producers in controlling quality and in developing production procedures. The effect of such impurities as iron, silicon, and carbon on the high-temperature properties of Kinsalloy is being investigated and a program is under way to explore its possible value in exhaust valves of piston-type engines.

The Division has applied for a patent on its aluminium-magnesium method of desulphurizing steel, which is being tried on a commercial scale.

The shortage of good scrap, which presents a serious problem to manufacturers of steel castings, led to an investigation, jointly with the Steel Castings Institute of Canada, into how small amounts of tramp elements, such as tin and copper, in scrap cause cracking of steel castings. Methods to avoid this difficulty have been developed and are being tested.

A new type of dental burr developed in the Division gives better wear and faster cutting by using the nitriding method of hardening. With faster cutting less heat is developed, and it is heat that causes the pain.

The Division issued 117 reports on metallurgical investigations for restricted distribution to the Canadian metal industry.

Senior members of the staff presented 28 formal lectures in response to requests from metallurgical societies and universities.

DOMINION OBSERVATORIES

The Dominion Observatories, the two main units of which are the Dominion Observatory at Ottawa and the Dominion Astrophysical Observatory at Victoria, British Columbia, provide a number of services to the public involving astronomical and geophysical observations. They also undertake extensive research programs aimed at improving the methods of geophysical exploration, and contributing to fundamental knowledge of the sciences of astronomy and geophysics. In addition to the two main observatories, permanent magnetic observatories are maintained at Agincourt, Ontario; Meanook, Alberta; and at Resolute Bay and Baker Lake, Northwest Territories. Seismic stations for recording earthquakes are operated at Ottawa and Victoria; and at Seven Falls and Shawinigan Falls, Quebec; Halifax, Nova Scotia; and Saskatoon, Saskatchewan; and a new seismic station was established recently at Resolute Bay, Northwest Territories.

The Dominion Observatory at Ottawa is responsible for the time service of Canada, which involves nightly astronomical observations of accurate star positions and radio broadcast services for distributing accurate time to all parts of Canada. Other astronomical activities centred at Ottawa include upper atmospheric studies by means of meteor observations, studies of the sun and its effect on earthly conditions, and mathematical studies of the atmospheres of the sun and stars. The geophysical work, also administered from Ottawa, includes the magnetic survey of Canada, with emphasis on aids to air and sea navigation, as well as field and observatory work of interest to the geophysical prospector. The methods of seismology are employed not only to study interesting and economically important aspects of the earth's crust in Canada, but also as part of world-wide investigations of the earth's interior. Gravity observations are carried on throughout Canada with a generally similar purpose, special attention being paid to methods of locating economic minerals.

The Dominion Astrophysical Observatory at Victoria is devoted to fundamental research into the physical characteristics of the sun, stars, planets, and the material of interstellar space. Its 73-inch reflecting telescope is one of the largest in the world and through its use many important contributions have been made to astronomical knowledge.

DOMINION OBSERVATORY

ASTRONOMY

Positional Astronomy

Astronomical observations with a broken-type transit for determining clock corrections were made on 187 nights, during which 2,572 transits were taken and 215 separate determinations of clock error were deduced. The Shortt clock was used for observing and control of the time-signal machines. A second crystal clock was installed, and the primary clocks now consist of two crystal clocks and the Shortt Free Pendulum. A new frequency standard was received. Seconds beats from two other crystal clocks at the National Research Council and the monitoring station of the Department of Transport were monitored each day.

The time distribution was improved in that the seconds beats are now controlled by a crystal clock, thereby assuring a more uniform second to second interval. Time signals were sent continuously by wire to the Canadian Broadcasting Corporation, National Research Council Laboratories, the monitoring station of the Department of Transport, and to Naval Headquarters, Ottawa,

the last for relay to Halifax twice daily for broadcast over CFH to ships on the Atlantic. The Canadian National Railways and the Canadian Pacific Railways received time signals by wire for a period of 2 minutes daily direct from the Observatory. These were sent by them across their systems from coast to coast, serving as local standards of time in many communities.

The Bell Telephone Company of Canada has been receiving the Observatory's time signals at 11:00 a.m. daily since December 1, 1950, and uses them as an official time signal throughout the company.

Time signals are supplied to the Canadian Broadcasting Corporation's chain of stations for daily broadcast at 1:00 p.m. This service makes time of the highest accuracy available to all Canadians with standard receiving sets. A broadcast service available to short-wave receivers was maintained continuously, 24 hours a day over station CHU, operated by the Observatory in co-operation with the Department of Transport. In this service, which is the major effort of the Observatory in the distribution of time, seconds time-signals, coded for identification of minutes and half minutes, were broadcast on the frequencies 3,330 k.c., 7,335 k.c., and 14,670 k.c. The broadcasts are intended primarily for surveyors, navigators, and persons living or travelling in remote parts of Canada where other sources of time are not available.

The 695 electrically operated clocks in government buildings in Ottawa, synchronized from the Observatory, were maintained. Observatory clocks, watches, and other timing mechanisms were kept in repair and nearly 400 watches were overhauled for other government offices. A special test was carried out on watches submitted to the Royal Canadian Air Force for purchase.

The photographic zenith tube was received, as was the 10-inch objective lens. The fine machine work of the automatic remote control of the telescope for photographing and timing star transits is well advanced in the Observatory machine shop. Electrical circuits were designed and are being tested, and it is planned to mount the telescope in the transit room to permit final changes and adjustments to be made.

Observations on a list of stars initiated in 1935 were completed, and a new series of observations was started on a list of approximately 1,500 stars. Most of the new program stars are needed for photographic zenith tubes at Greenwich in England, Richmond in Florida, and Ottawa. Observations were made on 108 nights and 3,989 transits and zenith distances were taken. Three hundred and five readings for the vertical and 198 instrumental constants were taken.

The automatic cameras installed for photographing the division marks on the circles have worked well down to a few degrees below zero.

Observations taken from 1923 to 1935 are about ready for publication. Pivot errors of the meridian circle were redetermined and the use of I.B.M. machines for the computations is being investigated in co-operation with the Computing Centre of the University of Toronto. Tables such as sunrise times were computed for 1951, and the practicability of one of the machines in the computing was demonstrated. The computations of observations taken from 1935 to 1950 are being completed, and the current computations are well in hand. As a test, these I.B.M. machines are to be used to complete the 1950 computations and the work is being prepared with that in view.

Tables of sunrise, sunset, moonrise, moonset, phases of the moon, and eclipse data were supplied to many firms and to civil and religious institutions.

Stellar Physics

Meteoric Studies. Studies of the upper atmosphere, making use of meteor observations, were continued with the aid of visual and photographic records. These observations were co-ordinated with radio observations made by the

National Research Council as in previous years. The Lyrids, Perseids, Geminids, and Quadrantids annual meteor showers were studied. Observations were carried out on 15 nights during the year, the average number of observers working each night being seven. Approximately 3,000 visual meteors were recorded during these observations and over 200 meteor photographs were obtained during 1,000 exposures made with the meteor cameras.

Active planning for the commencement of the international program of meteor photography was continued. A residence to house the meteor staff was completed at Meanook. The two observatory buildings at Meanook and Newbrook, Alberta, are effectively complete except for the installation of the Super Schmidt meteor cameras. The first camera will probably undergo final optical tests on the sky in April 1951.

The reduction of the combined meteor observations made by the National Research Council and the Dominion Observatory during 1947 to 1949 inclusive has progressed satisfactorily. Data on 2,500 meteors observed both visually and by radar have been reduced. A preliminary report on this program was made at the Conference on Ionospheric Physics, State College, Pennsylvania, in July 1950.

A photometric study was made of meteor spectra photographed at the Dominion Observatory, and results were reported at a meeting of the American Astronomical Society in Haverford, Pennsylvania, in December 1950.

A very brilliant fireball that appeared over the Ottawa-Montreal area on November 2, 1950, is being studied in detail from 200 observations collected through the co-operation of the daily press and the radio.

Solar Physics. The construction of a new solar spectrograph for studies of the sun's surface and the earth's atmosphere was nearing completion. This instrument is designed for photographic and photo-electric recording of the solar spectrum and is intended especially for studies of the infra-red region. A Lyot monochromatic filter for direct observation of the sun's hydrogen atmosphere was acquired and has given excellent optical performance. It will be used in a systematic study of solar eruptions and their influence on such terrestrial phenomena as magnetic storms, auroras, and radio fade-outs. Direct sunspot photographs were made on clear days, but it is expected that automatic photography with the monochromatic filter will replace such observations in the future.

Theoretical Astrophysics. Research was continued on the problem of the character of the emission line profiles produced by a star with continual ejection of material from its atmosphere. The procedures developed for treating shell models of stellar atmospheres in which resonance scattering is the principal mechanism were extended to cover cases of photo-electric recombination as well. The necessary computations were carried out and satisfactory explanations were found for a number of typical lines in P Cygni and Be spectra.

General Studies of Stellar Spectra. Progress was made on a study of stellar gradients from former Victoria observations. The main object of this study was to detect the reddening of stars due to absorption by inter-stellar material. Studies were also made on the intensities of atomic absorption due to interstellar gas and the relations of such intensities to stellar distance. An extended investigation of the spectra of the P Cygni stars was completed and published.

GEOPHYSICS

Seismology

The Seismological Division is the headquarters for all the seismograph stations operating in Canada. For many years these have been located at Halifax, Seven Falls, Shawinigan Falls, Saskatoon, and Victoria. A new

station at Resolute Bay was brought into operation in August 1950. The records from all these stations are read in Ottawa, and a bulletin is issued giving these data to other seismological stations throughout the world. To enable rapid determinations of epicentres, several key stations report their observations by radio each day to a central office in Washington. The stations at Ottawa and at Resolute Bay take part in this program, and it is hoped to bring Halifax and Victoria into it in the near future.

Because of the importance of this international program, a constant effort is made to improve and extend the Canadian network. The station at Resolute Bay, which is the most northerly first-class seismograph station in the world, is of the greatest importance. Two other changes to the network are in progress. The station at Halifax is to be improved with the building of a modern vault and complete re-instrumentation of the station. The instruments have been purchased and the construction of the vault is expected to begin shortly. At Kirkland Lake a station employed in the Seismic Survey will be converted to routine operation in the near future.

Research activities have been concentrated on two types of problems. The first, known as the seismic survey, utilizes rockbursts and blasts in the mining areas of northern Ontario in the study of crustal structures of that part of the province. The field program, which required 4 years, was completed during the summer of 1950 and the final analysis of the data is well advanced. The successful completion of the project was made possible by the splendid co-operation of the mining companies.

The other research problems arose from the study of the records produced, at stations throughout the world, by the Queen Charlotte Islands earthquake of August 22, 1949. This earthquake occurred at the edge of the continent, and it was possible to compare the records of surface waves that had followed oceanic paths from the epicentre with those that had followed continental paths. A paper, now in press, on the results was prepared by Professor J. Coulomb of the University of Paris, a distinguished European geophysicist, who spent 3 months in the Division, assisting in its work and advising on several problems. The epicentre happened to lie at a distance from the large network of California stations, exactly appropriate to a study of a section of the travel-time curves not previously well defined. The results of this study are being prepared for publication. It appears probable that the records of this earthquake will provide material for several other important investigations. The Division was also honoured by the presence, for a period of about 5 months, of Professor A. Galanopoulos of the University of Athens. This visit was carried out under a UNESCO fellowship.

Officers of the Division read papers at scientific meetings in Seattle, Los Angeles, and Chicago.

Terrestrial Magnetism

Magnetic observations for declination, inclination, and force were made at ninety-seven field stations extending from Cap Race, Newfoundland, to Grande Prairie, Alberta, and from Ottawa to Cornwallis Island, Northwest Territories. Forty-two of these stations were established in former years and were reoccupied to determine the annual change in the magnetic values, and the remaining fifty-five were established in extending the network of base stations to include areas where magnetic observations were lacking. Eight stations were occupied in Newfoundland, ten in Ontario, fifteen in Quebec, seven in Manitoba, ten in Saskatchewan, thirty-seven in Alberta, and ten in the Northwest Territories. The stations in the Northwest Territories were occupied with the co-operation of the Royal Canadian Air Force.

In addition to the observations made by the Division, declination values applying to 100 survey points throughout Canada were supplied by the Surveys and Mapping Branch and by provincial land surveyors.

Two magnetic maps of Canada were constructed, one depicting lines of equal vertical force and annual change, and the other, lines of equal total force and annual change. These maps, when published, should be of particular interest to geophysical investigators. The revision of the 1948 declination map of Canada was continued. Magnetic information necessary for new and revised topographical map-sheets and marine and air navigation charts was supplied for a total of 1,064 items. These comprised 612 for the Surveys and Mapping Branch and 452 for the Department of National Defence. In addition, numerous magnetic data were supplied to private investigators and prospecting companies.

A complete knowledge of the changes occurring in all magnetic elements during the day and throughout the years is essential to the accurate construction of magnetic maps. All magnetic information shown on maps and charts must apply to the date of publication, and there is an increasing demand for data applying to a time a few years after the date of publication. In order to make magnetic forecasts and to supply the best possible information for areas not yet included in the survey network, there must be some sound mathematical means of computing such information. To this end, a mathematical analysis of the earth's magnetic field in Canada was undertaken and has reached a stage where it is now possible to supply reasonably accurate information on the character of these changes for Canada, south of latitude 75 degrees. The knowledge of daily and seasonal changes taking place in the magnetic field in Arctic Canada, essential to the reducing of northern field observations, has been greatly increased by the progress of a thorough investigation of photographic records from Resolute Bay Magnetic Observatory and the River Clyde Station which was operated by other agencies during the war.

Three-hour-range indices, which provide measures of the frequency and intensity of magnetic disturbances resulting from the effects of solar radiations on the earth, were measured from magnetograms obtained at Agincourt and Meanook, and were supplied monthly to research centres in Holland, Germany, United States, and Canada. These indices, known as K-indices, have an immediate application in studies of the upper atmosphere, particularly in relation to radio wave transmission and cosmic ray incidence. The results from Canadian magnetic observatories, particularly those from Meanook, were instrumental during the year in altering the concepts formerly held by world-wide authorities in relation to the electrical currents flowing in the upper atmosphere.

Good progress was made in the construction programs for the improvement of facilities at the four magnetic observatories at Agincourt, Meanook, Baker Lake, and Resolute Bay. The office building at Agincourt was finished, and plans and specifications were completed for a modern non-magnetic observatory building at Meanook. An additional non-magnetic building was ordered for erection at Resolute Bay to relieve the congestion of instrumental equipment existing in the present structure.

Further progress was made in developing and constructing a universal airborne magnetometer, in which work the Department of National Defence, National Research Council, and the University of Toronto co-operated. Satisfactory test flights of parts of the airborne equipment were made, and the final stage of development is awaiting test flights of the complete equipment, which comprises a solar compass, gyro-stabilized platform, magnetometer, and ancillary apparatus.

Construction work was completed on four additional universal electrical magnetometers for field and observatory use. Refinements were made in the

circuits, the size of the control box was reduced, and stability in the performance of the magnetometers improved.

Gravity

Regional gravity measurements have a direct application in researches on the structure of the earth's crust, on the determination of its thickness, and on the degree of its isostatic equilibrium. They are of fundamental importance to an international geodetic program for the determination of the shape of the earth. Recent investigations of gravity anomalies have demonstrated their usefulness in delimiting the major geological structures in the Canadian Shield. This should eventually prove beneficial to the development of the mineral wealth of Canada.

During the year, about 2,500 gravimeter observations were taken across Canada, distributed over the ten provinces more or less in proportion to their relative areas, with the exception of British Columbia, in which only four observations were made. Two hundred and eighty-nine observations employing air transport were taken in the otherwise comparatively less accessible areas of the Canadian Shield. The area covered comprises approximately 100,000 square miles of northern Manitoba, northeastern Saskatchewan, and the adjoining area north of 60° latitude in the Northwest Territories.

On a co-operative scientific program with the Arctic Institute of North America, 157 gravity stations were established over an area of 1,000 square miles over the ice-cap and vicinity on Baffin Island. The purpose of the observations was to determine the probable thickness of glacial ice. The compilation and reduction of the observations and a report on the findings have been completed and prepared for publication.

The Observatory took 260 gravity observations over the area covered by the geological map of the Ottawa district, on a scale of 1 mile to 1 inch. Besides other geological features, this area includes the Hull-Gloucester and Hazeldean faults. Direct comparison was made between the results previously obtained with torsion balances and magnetometers over these structures and those recently obtained with gravimeters. A report of this work has been prepared for publication.

The Observatory collaborated with the United States Coast and Geodetic Survey in the establishment of the Canadian part of a line of pendulum gravity base stations, extending from the southern boundary of the United States north to The Pas, Manitoba.

A detailed gravimetric survey was carried out in the Stirling area, Richmond county, Nova Scotia, at the request of the Nova Scotia Department of Mines, in an endeavour to outline the possible extension of sulphide concentrations along the strike of the Old Stirling mine workings. All preliminary calculations of the field data have been completed.

DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.

The Dominion Astrophysical Observatory was organized in 1916 to conduct astrophysical investigations on the physical and chemical characteristics of the stars, and to determine the intrinsic luminosities, distances, and motions of the stars through space, whereby the dimensions and structure of the stellar universe may be deduced.

All phases of the fundamental astrophysical research programs were actively advanced during the fiscal year, and reports on a large number of completed researches were published and distributed. Staff members participated in four important scientific congresses, delivered invited addresses, and presented numerous technical papers.

OBSERVING STATISTICS

The telescope was used on 177 nights, for a total observing time of 1,020 hours. The observing conditions during the autumn and winter quarters were poor due to a prolonged period of unusually heavy precipitation and cloudy weather, with the result that the total number of observing hours was 14 per cent below the 32-year average. The telescope was used exclusively for stellar spectroscopy and 1,075 spectrograms were obtained.

Quarterly Summary of Observations

	Nights	Hours	Spectrograms
Spring quarter	48	239	181
Summer quarter	74	481	575
Autumn quarter	25	123	130
Winter quarter	30	177	189
Totals 1950–51	177	1,020	1,075
32-year Average	193	1,184	1,266

STELLAR RADIAL VELOCITIES

A total of 1,359 spectrograms was measured for radial velocity. This work is designed to obtain more accurate and detailed knowledge of the dynamics of the galactic system, thus extending the information previously obtained to greater distances from the sun.

The reduction of measures of the radial velocities of 110 F-M-type stars was completed and the results are being prepared for publication.

The program of 70 bright, class B stars, principally in the winter sky, whose line-of-sight velocities required revision, was completed and the catalogue is in press.

The radial velocities of 60 A-F-type stars in the region of the pole of the Milky Way were determined. Provisional values of the spectroscopic absolute magnitudes of these stars were deduced from the estimated intensities of seven critical pairs of spectral lines according to the Victoria criteria.

Good progress was made in an investigation of the effective wave-lengths of the helium-type stars. After eliminating many lines ill-suited for general use, a provisional list of 25 lines has been adopted as the basis for future measurement.

SPECTROSCOPIC BINARY INVESTIGATIONS

Orbital elements have been computed for a number of systems in the program of determining the masses, dimensions, and physical characteristics of spectroscopic binary systems.

Epsilon Ursae Minoris. An investigation of this well-known, solar-type binary was undertaken to substantiate the unusual photometric results of Professor Guthnick of Berlin. He concluded that the system was similar to that of Zeta Aurigae, with the additional feature of a peculiar gaseous ring, and his light curve suggested that the secondary spectrum should be observed. A careful search for spectroscopic evidence of the secondary on ultraviolet spectrograms extending to λ3400 failed to show any evidence of the fainter

star. Emission lines of ionized calcium were observed, not an unusual characteristic of solar-type binaries, and their velocities were in excellent agreement with the absorption lines of the primary star. No evidence was found for the presence of a gaseous ring as suggested by Guthnick. The 1950 orbital elements are in substantial agreement with those found by Plaskett in 1910, showing that no appreciable changes in the orbit had occurred during the past 40 years.

H.D. 25132. Preliminary elements for this class B binary were derived, satisfying the recent series of Victoria spectrograms and the early Mount Wilson observations. A few additional observations at selected phases will be obtained during the 1951 season to complete the orbit.

H.D. 44701. The absolute dimensions of a new and important eclipsing variable were derived from 18 spectrograms on which the velocities of both stars were measured. The observations obtained during the years 1927 to 1951 extend over 8,710 cycles of the binary, whose period was determined to be 1·190241 days. The relative luminosities and the radii of the components were deduced from a microphotometric analysis of the spectra by a new method recently devised by R. M. Petrie, Assistant Dominion Astrophysicist. The stars have temperatures of 17000°K and 13000°K, masses of 6·8 and 4·5, radii of 2·4 and 1·7, and densities of 0·5 and 0·9 times the sun, respectively. These stars have normal masses but smaller radii and, therefore, are considerably denser than stars of this spectral class. Photometric observations made recently at the Commonwealth Observatory at Canberra, Australia, detected the shallow eclipses of this dwarf binary system.

H.D. 100018. The investigation of this visual binary star, whose period is 84 years, was continued. The recent high-dispersion plates reveal the presence of a third component, heretofore undiscovered, thus making this star a triple system. A period of 7·4 days has been determined for the spectrographic binary and it is now possible to obtain the elements of the short-period binary and to proceed to a complete determination of the dynamics of this interesting and rare system.

H.D. 192909-10. The orbital elements of this long-period K-type binary, recently discovered to be an eclipsing system similar to Zeta Aurigae, were deduced from a series of 97 Victoria observations between 1936 and 1950. The elements are in agreement with those determined by Cannon in 1918 from 40 spectrograms obtained at the Dominion Observatory, Ottawa, if a correction of 5 km/sec. is applied to the earlier observations. Although this difference may represent a real change in the systemic velocity, it can probably be attributed to the different wave-length standards employed.

H.D. 228854. A new, very massive, O-type binary was discovered by J. A. Pearce, Dominion Astrophysicist. Thirty-eight spectrographic observations of this 9th magnitude star in the constellation of Cygnus were obtained, satisfactorily covering all phases of the velocity curves. The observations are consistent with the period of 1·885497 days recently announced by Petrov. The relative velocities of the two components exceed 500 km/sec., indicating that the mass of the system is of the order of 30 times the sun.

Investigation of Cepheid Variables. Dr. T. S. Jacobsen, Professor of Astronomy at the University of Washington, spent 2 months at the Observatory redetermining the orbits of Eta Aquilae and Delta Cephei. Although the spectrographic observations showed that no detectable changes in the so-called elliptic elements of the orbits of these stars had occurred during the past 30 years, a very interesting discovery was made in the spectrum of Eta Aquilae, namely, the presence of emission lines of ionized calcium at the critical phase of

maximum compression of the pulsating star. The emission feature is evident for but a few hours at this phase, but reappears at intervals of 7·2 days. No such effect was detected in the spectrum of Delta Cephei. The theoretical explanation of the phenomenon remains in doubt.

STELLAR PHYSICS DIVISION

Studies of Flash Spectrum

Dr. S. A. Mitchell, former Director of the Leander McCormick Observatory, Charlottesville, Virginia, spent 2 months at the Observatory collaborating in a study of the flash spectrum. The films were obtained by him at the 1930 and 1937 solar eclipses. Photometric tracings were made corresponding to chromospheric heights of 400, 600, 800, 1,200, and 2,000 km. The observed intensities of the TiII lines from λλ3300-4200 were determined and compared with the theoretical intensities, from which data an estimate of the distribution of atoms in the chromosphere may be made. It is proposed to study also the FeI and H lines, as these films, though not calibrated, are considered to be the finest spectrograms ever obtained at solar eclipses.

Spectroscopic Absolute Magnitude of the A-Type Stars

The total absorption of Hy has been measured in the spectra of 165 stars of spectral types B8 to A3. A pronounced variation, well established from visual estimates, was found. A tenfold increase in hydrogen absorption is measured from the supergiant to the dwarf stars, the present study covering the luminosity range of $M = -6$ for the giants to $M = +2$ for the normal dwarfs. The mean relation between the absolute magnitude and Hy strength is determined through the media of trigonometric parallaxes, visual and eclipsing binaries, and the moving and galactic clusters. The research provides a criterion for determining the distances of the A-type and late B-type stars.

Luminosity Effects in the O-type Stars

An investigation is under way of the relative shapes of higher members of the Balmer series in the O stars, to establish the presence of a luminosity effect. The II prism ultraviolet spectrograph is being used to obtain ultraviolet spectra of typical O-type stars. The equivalent widths of the lines Hy to H15 have been measured, and the observations indicate that the predicted luminosity effects are quite marked at H9, H10, and H11, although not so evident at Hy, as previous observations have shown.

Investigation of Shell Stars

A spectrophotometric comparison of the shell spectra of Zeta Tauri in 1938 and 1950 was made. The spectrum of the underlying star, reclassified as B2n, showed no indications of change, but the shell spectrum showed a greater degree of ionization in 1950 than in 1938. The lines of the ionized metals were weak in 1938 but were strong in 1950. The observed spectral changes are attributed to an increase in pressure by a factor of 50 to 100. No evidence of stratification in the shell of Zeta Tauri was found, which suggests that the body of gas giving rise to the shell spectrum does not spherically surround the central star but lies in a detached equatorial ring possessing a rotational speed of 250 km/sec. The central B-type star was found to have a rotational velocity of approximately 350 km/sec.

Isotopes in Stellar Spectra

In a continuation of studies of the cool red giant stars, 57 tracings of the main and isotopic C_2 bands in the spectra of 18 N-type of stars were analysed to obtain the C^{12}/C^{13} isotopic abundance ratio.

SEISMOLOGY

Many earthquakes were recorded on the three teleseismic seismographs and the records were transmitted to the Dominion Observatory for detailed analysis. Estimates of the distances and probable positions of the major shocks were made on request of the daily papers in Victoria and Vancouver.

SEMINARS

Thirty-one seminars on research problems were conducted by members of the staff and visiting astronomers from Australia, Belgium, Greece, eastern Canada, and United States.

VISITORS

The Dominion Astrophysical Observatory was visited by more than 28,000 persons during the fiscal year. In addition, more than 3,900 persons attended the 2-hour public observation periods on Saturday evenings from April to November and were shown selected celestial objects through the 73-inch reflecting telescope. Many organizations and societies were addressed by members of the staff on the research work in progress.

GEOGRAPHICAL BRANCH

J. W. Watson, Director

FIELD SURVEYS

The Branch made a survey of the ports of Vancouver, New Westminster, and Victoria to obtain information on the relation of the commercial and industrial activities of these ports to the physical features and climate of the region, and to the economic development of their hinterlands. This study is part of an international survey of ports sponsored by the International Geographical Union, and the results will be made available to the British Columbia Government who facilitated the survey.

In co-operation with the Provincial Government, a study was continued of the effect of aridity on the occupations and uses of land in the interior valleys of central British Columbia. This study was undertaken in connection with the UNESCO Arid Zone Project, the last report of which stressed the need for information on the problems of aridity in Canada.

Three sample areas of the northern fringe of Alberta were surveyed in detail to determine the effect of topography, drainage, vegetation, and climate on occupation, transportation, and settlement. The results will be of use to the Provincial Government in planning future settlement.

Recent changes in the geographical patterns of land use and settlement in the Truro-Stellarton-Tatamagouche area, Nova Scotia, were investigated in co-operation with the Nova Scotia Research Foundation. Three similar surveys were made in Newfoundland, one along the railway belt, another in the Avalon Peninsula, and a third along the coast between St. Anthony and Hebron. The results of the surveys will be of use to the two provinces in planning for an improvement of their economies.

For use of the Department of National Defence a survey was made of the physical conditions of the land in relation to drainage and vegetation cover in an area in central Labrador, and a similar study was made of islands in Hudson Bay.

The Branch regrets to record the death of Dr. D. Kirk, one of its geographers, the result of an aircraft accident on Ellesmere Island while he was engaged in ice reconnaissance in the Arctic.

OTHER SURVEYS

A survey-inventory of ice distribution in the waters of northern Canada was organized. This involves the completion of a card index of information from all overt sources on ice conditions in the mainland of the western Arctic.

A systematic survey was begun of the physical conditions of the land in Canada north of the 60th parallel of latitude on a sheet by sheet basis. Two sheets, on the scale of 8 miles to 1 inch, were completed.

ATLAS OF CANADA

The Branch acts as the co-ordinating agency empowered by the Inter-Departmental Atlas Committee to facilitate the production of a new atlas for Canada. During the fiscal year it compared 35 existing national atlases; drew up proposals for the general format of the Canadian atlas; received data from provincial and federal departments; prepared 20 dummy sheets showing in outline the regions and sections of Canada that can be used to include a

study of new methods of presenting such data in atlas form; and prepared 30 draught sheets for depicting information on transportation, fisheries, and certain aspects of industrial geography.

FOREIGN GEOGRAPHY STUDIES

A geographical study of Bolivia was prepared at the request of the Chairman of the United Nations Commission for Technical Assistance to Underdeveloped Countries. Similar studies were prepared on Czechoslovakia and Yugoslavia at the request of the Department of External Affairs.

GEOGRAPHICAL COMPILATION OF INFORMATION

The Branch produced 333 maps, graphs, and charts, of which 191 were drawn to illustrate publications it has issued or proposes to issue. Fifty-eight of the maps, graphs, and charts were made at the request of the Northern Administration and Lands Branch, Department of Resources and Development, and three for the Yukon River Diversion Scheme Committee of that department. Ten maps were drawn for the Department of External Affairs, three for use in the Atlas of Canada, and two for the Prime Minister's office. The others were prepared to meet specific needs of the Department of National Defence, the Royal Commission on Transportation, and several other government departments and agencies.

LIBRARY

The Library added 12,000 sheets to its collection of Canadian and foreign maps. It had 642 maps on loan to outside departments and agencies. There was a great increase in the demand for reference services, especially in connection with foreign geography.

The annual contribution of maps was sent to the Bibliothèque Nationale, Paris, for its use in building up a world map reference.

New exchanges were initiated with the Government of Switzerland and with the Directorate of Colonial Surveys, Great Britain.

Approximately 1,810 books were obtained, which included special gifts of 1,000 volumes from the Canadian Board on Geographical Names, over 100 volumes from the governments of various South American countries, and an important collection of geographical material, books and maps, presented by the Italian Touring Club. This brings the total number of volumes in the library to about 6,000.

The Branch loaned 500 books to other government departments and prepared six special bibliographies.

ATTENDANCE AT MEETINGS

The Branch was represented at the Geographical Commission of the Pan-American Institute of Geography and History in Rio de Janeiro, Brazil, and later at the Fifth General Assembly of the Institute in Santiago, Chile. It was also represented at the 46th and 47th annual meetings of the Association of American Geography at Worcester, Mass., and Chicago, Illinois, respectively.

PUBLICATIONS

Department of Mines and Technical Surveys

English Publications

Report No.

Annual Report for the Fiscal Year Ended March 31, 1950.
Emergency Gold Mining Assistance Act for the Fiscal Year Ended March 31, 1950.
**Summary of Activities in 1950.*
17 *The Storage of Explosives.*
The Blaster's Safety Alphabet.

French Translations

Annual Report for the Fiscal Year Ended March 31, 1950.
Emergency Gold Mining Assistance Act for the Fiscal Year Ended March 31, 1950.
**Summary of Activities in 1950.*
18 *The Storage of Explosives.*

Surveys and Mapping Branch

HYDROGRAPHIC SURVEY

English Publications

B.C. Pilot, Vol. II, Supplement No. 1.
St. Lawrence River Pilot below Quebec (seventh edition).
1 *Tide Tables for Atlantic Coast, etc., 1951.*
2 *Tide Tables for Quebec, Chicoutimi, and Father Point for 1951.*
3 *Tide Tables for Charlottetown and Rustico, P.E.I., and Pictou, N.S., for 1951.*
4 *Tide Tables for Halifax and Sydney, N.S., for 1951.*
5 *Tide Tables for Saint John, N.B., Yarmouth, N.S., and Windsor, N.S., for 1951.*
10 *Tide Tables for Pacific Coast for 1951.*
11 *Tide Tables for Vancouver and Point Atkinson, B.C., for 1951.*
12 *Tide Tables for Prince Rupert, B.C., for 1951.*
13 *Tide Tables for Port Alberni and Clayoquot, B.C., for 1951.*
14 *Tide Tables for St. John's and Argentia, Nfld.*

GEODETIC SURVEY

English Publication

23 *Precise and Secondary Levelling in Alberta*, by L. O. R. Dozois.

LEGAL SURVEYS

English Publications

Canada Air Pilot:

Vol. I. Amendment Nos. 69 to 91.
Vol. II. Amendment Nos. 76 to 100.

Geological Survey of Canada

English Publications

2491 Memoir 253. *Fiedmont Map-area, Abitibi County, Quebec*, by L. P. Tremblay.
2492 Memoir 254. *Alexo and Saunders Map-areas, Alberta*, by O. A. Erdman.
2493 Memoir 255. *Callum Creek, Langford Creek, and Gap Map-areas, Alberta*, by R. J. W. Douglas.
2494 Memoir 256. *Pleistocene Geology of the Lake Simcoe District, Ontario*, by R. E. Deane.
2475 Memoir 242. (Reprint) *Cypress Lake Map-area, Saskatchewan*, by G. M. Furnival.
Bulletin 15. *Actinocamax from the Upper Cretaceous of Manitoba*, by J. A. Jeletzky, and *Sciophyllum, a New Rugose Coral from the Canadian Arctic*, by P. Harker and D. J. McLaren.

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*Mimeographed.

Bulletin 16. *The Groundhog Coalfield, British Columbia*, by A. F. Buckham and B. A. Latour.
*Geophysics Paper 24. *Morinville, Alberta.* (Map.)
*Geophysics Paper 25. *Redwater, Alberta.* (Map.)
*Geophysics Paper 26. *Bruederheim, Alberta.* (Map.)
*Geophysics Paper 27. *Willingdon, Alberta.* (Map.)
*Geophysics Paper 28. *Edmonton East, Alberta.* (Map.)
*Geophysics Paper 29. *Edmonton West, Alberta.* (Map.)
*Geophysics Paper 30. *Snake Hills, Alberta.* (Map.)
*Geophysics Paper 31. *Two Hills, Alberta.* (Map.)
*Geophysics Paper 32. *Leduc, Alberta.* (Map.)
*Geophysics Paper 33. *Cooking Lake, Alberta.* (Map.)
*Geophysics Paper 34. *Mundare, Alberta.* (Map.)
*Geophysics Paper 35. *Astotin Lake, Alberta.* (Map.)
*Paper 50-2. *Matthews Lake, Northwest Territories*, by R. E. Folinsbee and J. C. Moore. (Map and descriptive notes.)
*Paper 50-3. *Northwest Dasserat Townships, Témiscamingue County, Quebec*, by K. R. Dawson.
*Paper 50-4. *Walmsley Lake, Northwest Territories*, by R. E. Folinsbee. (Map.)
*Paper 50-5. *Weldon Bay, Manitoba*, by J. Kalliokoski. (Map and descriptive notes.)
*Paper 50-7. *Geology of Bonavista Map-area, Newfoundland*, by A. M. Christie.
*Paper 50-8. *Mount Head, Alberta*, by R. J. W. Douglas. (Map and structure sections.)
*Paper 50-9. *Zeballos, British Columbia*, by J. W. Hoadley. (Map and descriptive notes.)
*Paper 50-10. *Aylmer Lake, Northwest Territories*, by C. S. Lord and F. D. Barnes. (Map and descriptive notes.)
*Paper 50-11. *Orillia-Brechin and Beaverton, Ontario*, by J. F. Caley and B. A. Liberty. (Two maps and descriptive notes.)
*Paper 50-12. *Daniels Flats Map-area, Alberta*, by E. J. W. Irish.
*Paper 50-13. *Ghost Lake Map-area, Northwest Territories*, by G. M. Wright.
*Paper 50-14. *Potential Mineral Resources of Yukon Territory*, by H. S. Bostock.
*Paper 50-15. *Reliance, Northwest Territories*, by I. C. Brown. (Map and notes.)
*Paper 50-16. *Mineralogy of the Goldfields District, Saskatchewan*, by S. C. Robinson.
*Paper 50-17. *Little Rattling Brook, Newfoundland*, by M. E. Hriskevitch. (Map.)
*Paper 50-18. *Northeast Part of Giauque Lake Map-area, N.W.T.*, by L. P. Tremblay.
*Paper 50-19. *Salmo Map-area, British Columbia*, by H. W. Little.
*Paper 50-20. *Keno and Galena Hills, Yukon*, by K. C. McTaggart. (Maps.)
*Paper 50-21. *Christie Bay, Northwest Territories*, by I. C. Brown. (Map and notes.)
*Paper 50-22. *Fogo Island Map-area, Newfoundland*, by D. M. Baird.
*Paper 50-23. *Devonian Sections in the Rocky Mountains between Crowsnest Pass and Jasper, Alberta*, by R. de Wit and D. J. McLaren.
*Paper 50-24. *Torbay, Newfoundland*, by E. R. Rose. (Map.)
*Paper 50-25. *Ile-à-la-Crosse Map-area, Saskatchewan*, by M. J. Frarey.
*Paper 50-27. *The Late Palæozoic Formations of Southwestern Alberta*, by F. W. Beales.
*Paper 50-28. *Fort Resolution, Northwest Territories*, by I. C. Brown. (Map and descriptive notes.)
*Paper 50-30. *Macamic, Abitibi County, Quebec.* (Map.)
*Paper 50-31. *Desboues, Abitibi County, Quebec.* (Map.)
*Paper 50-32. *Kinojevis, Témiscamingue and Abitibi Counties, Quebec.* (Map.)
*Paper 50-33. *Taschereau, Abitibi County, Quebec.* (Map.)
*Paper 50-35. *Clericy, Abitibi and Témiscamingue Counties, Quebec.* (Map.)
*Paper 50-37. *Stratigraphy of the West Coast of Vancouver Island between Kyuquot Sound and Esperanza Inlet, B.C.*, by J. A. Jeletzky.
*Paper 50-38. *Pointe Verte, Restigouche and Gloucester Counties, New Brunswick.* (Map.)
*Paper 51-2. *LaMotte, Abitibi County, Quebec.* (Map.)

French Publications

Report No.

2495 Memoir 233. *Clericy and La Pause Map-areas, Quebec*, by J. W. Ambrose.
Bulletin 4. *Echinodermata of the Ottawa Formation of the Ottawa-St. Lawrence Lowland*, by Alice E. Wilson.

*Mimeographed.

Mines Branch

English Publications

828 *The Mining Laws of Canada*, compiled by A. Buisson.
829 *The Canadian Mineral Industry in 1948.*

Memorandum Series

*106 *Use of High-pressure Ionization Chamber in Assaying Uncrushed Ore Samples*, by J. L. Horwood and C. McMahon.
*107 *Peat Moss Industry in Canada, 1950*, by A. A. Swinnerton.
*108 *Notes on Antimony Deposits and Occurrences in Canada*, by W. R. McClennan.
*109 *Determination of Uranium in Ores, Review of Chemical Methods*, by F. T. Rabbitts.
*110 *The Chemical Determination of Thorium in its Ores*, by John C. Ingles.
*111 *Recent Investigations into the Beneficiation of Canadian Gypsum*, by A. R. MacPherson.
*112 *Gasoline Survey for Summer 1950*, by H. McD. Chantler, P. B. Seely, and R. G. Draper.

Lists of Mines and Mine Operators

4-1. Coal Mines in Canada, 1950.
5-2. Petroleum Refineries in Canada, 1950.
6-1. Cement Mills in Canada, 1950.
6-3. Clay Products in Canada, 1950.

Reprints

The Cold Water Method — Applied to Separation of Oil from Alberta Bituminous Sand, by T. E. Warren, E. J. Burrough, and L. E. Djingheuzian.
The Coal-fired Gas Turbine Locomotive, by T. E. Warren.
An Outline of Field Operations for Processing Alberta Bituminous Sands, by T. E. Warren.
Progress in Coal Mining Technology, by A. Ignatieff.
Progress in Coal Technology — Combustion and Heat Utilization, by C. E. Baltzer.

French Translation

**The Canadian Mineral Industry in 1948.*

Dominion Observatories

Dominion Observatory

English Publications

Report No.	
Vol. VII, No. 10.	*The St. Lawrence Earthquake, March 1, 1925*, by E. A. Hodgson.
Vol. XI, No. 8.	*Phenomenological Theory of Radar Echoes from Meteors*, by D. W. R. McKinley and Peter M. Millman.
Vol. XIV, No. 5.	*Bibliography of Seismology, January to June 1949*, by W. J. Milne.
Vol. XIV, No. 6.	*Bibliography of Seismology, July to December 1949*, by W. J. Milne.
Vol. XIV, No. 7.	*Bibliography of Seismology, January to June 1950*, by W. J. Milne.
Vol. XVI, No. 1.	*Gravimetric and Magnetic Anomalies on Traverses in Canadian Shield in Northern Ontario*, by George Garland.

Reprints

Vol. 1, No. 5.	*Measurements of Gravity in the Canadian Arctic and Greenland*, by Michael Beer.
Vol. 2, No. 8.	*Meteoric Ionization*, by Peter M. Millman.
Vol. 2, No. 6.	*On the Use of Crystal Controlled Synchronous Motors for the Accurate Measurement of Time*, by V. E. Hollingsworth and J. P. Henderson.
Vol. 2, No. 7.	*Photographic Study of Draconid Meteor Shower, 1946*, by Luigi Jacchia, Zdenek Kopal, and Peter M. Millman.

*Mimeographed.

ASTROPHYSICAL OBSERVATORY

English Publications

Vol. VIII, No. 6. *A Redetermination of the Spectrographic Orbits of Iota Pegasi and 25 Serpentis*, by R. M. Petrie and Edgar Phibbs.

Vol. VIII, No. 7. *Spectrographic Observations of the Eclipsing Binaries DI Herculis and RY Geminorum*, by Andrew McKellar.

Vol. VIII, No. 8. *Absolute Magnitudes of Early A-type Stars*, by R. M. Petrie and C. D. Maunsell.

Vol. VIII, No. 9. *Line Intensities in the Spectra of K-type Stars I Alpha Bootis and Gamma Draconis*, by K. O. Wright.

Vol. VIII, No. 10. *Magnitude Difference between the Components of Eighty-two Spectroscopic Binaries*, by R. M. Petrie.

Vol. VIII, No. 11. *Mass Luminosity Relation Determined from Spectroscopic Binaries*, by R. M. Petrie.

Reprints

Contribution No. 21. *The Extent of the Chromosphere of the K-type Component of Zeta Aurigae*, by H. L. Welsh.

Contribution No. 22. *Radial Velocity Curves for Eta Aquilae from Lines of Different Chromospheric Levels*, by T. S. Jacobsen.

GEOGRAPHICAL BRANCH

Geographical Bulletin No. 1 (English and French).