CANADA

Department of Mines and Technical Surveys

Annual Report

Fiscal Year Ended
March 31, 1952

Price, 50 cents

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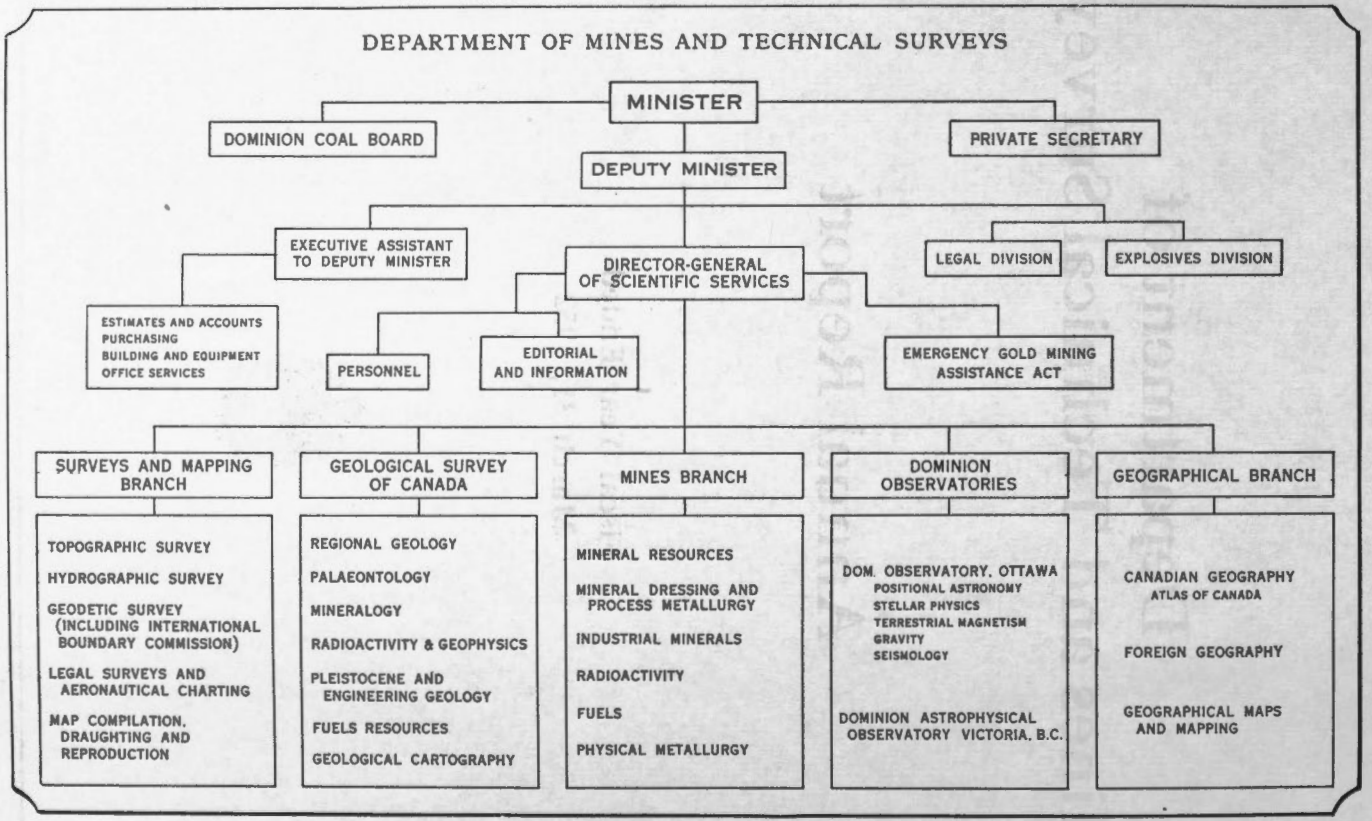

Organization Chart.

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

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to lay before Your Excellency the Annual Report of the Department of Mines and Technical Surveys for the fiscal year ended March 31, 1952.

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, 1952.

Your obedient servant,

MARC BOYER,
Deputy Minister.

REPORT OF THE DEPARTMENT OF MINES AND TECHNICAL SURVEYS FOR THE FISCAL YEAR 1951-52

As the nature, purposes, and scope of the Department's activities are determined largely by the trend of developments in the industry it serves, a review of these developments is given first as a means of indicating the range of the requirements of industry for the variety of services rendered. This is followed by an outline account of the principal activities, which in turn is followed by more detailed accounts of the work.

Notable headway was again recorded by the mineral industry in 1951, the value of its production reaching a record of $1,245,483,595, compared with $1,045,450,073 in 1950. The index of the physical volume of production for the industry as a whole based on 100 for the 1935-39 average rose from 148·6 in 1950 to a record 161·7 in 1951. The industry continued to figure prominently in Canada's export trade, the total value of exports of metals and minerals and their products in 1951 being $1,088,200,000, an increase of $245,600,000 over the previous year and accounting for about 27 per cent of the value of Canada's export trade in 1951. Reflecting the country's industrial growth, new records were established in the post-war domestic consumption of several of the metals and minerals. Capital investment, especially in the base metals, and in crude petroleum and natural gas was higher than in any previous year.

Of increasing significance to the national economy is the marked expansion Canada has been witnessing in the development of its crude petroleum and natural gas resources. Expenditures in excess of $200,000,000 were made in 1951 on the exploration and development of these resources. By the end of the year exploratory activity, in addition to covering large areas in Alberta, Saskatchewan, and Manitoba, had spread northwestward into the Peace River areas of Alberta and British Columbia and into areas south and west of Great Slave Lake in the Northwest Territories. Several important oil discoveries were made, the most outstanding being the Wizard Lake and Bonnie Glen fields, south of the Leduc field in Alberta. Of significance, also, are two discoveries of medium grade crude oil in southern Saskatchewan and two in southwestern Manitoba. Recoverable reserves of crude oil in Alberta at the end of the fiscal year were estimated at approximately 1,500,000,000 barrels.

The production of crude petroleum, which largely reflects market outlet capacity, rose 68 per cent over the 1950 output to 48,000,000 barrels following the opening of the 1,127-mile pipeline from Edmonton to Superior, Wisconsin, at the commencement of navigation in 1951. Daily production from the wells in Alberta reached a peak of 189,423 barrels during the week ended August 20 and dropped to a low of 81,377 barrels during the last week of 1951. Present marketing capacity will be further increased with the expansion under way at the end of the fiscal year in the capacity of the Interprovincial pipeline and with completion of the 700-mile Trans-Mountain pipeline from Edmonton to Vancouver. The latter line will have a capacity of 120,000 barrels a day, using three pumps. Three additional pumps would bring the capacity to 200,000 barrels a day.

Storage capacity was being increased at Superior, Wisconsin, at the end of the fiscal year, and two new lake tankers were under construction. To keep pace with increasing production, refinery capacity was increased at Edmonton, Winnipeg, Sarnia, and Montreal, and two oil products pipelines in Ontario are scheduled for completion in 1952.

Natural gas continued to be discovered in increasing quantities in western Canada, mainly in conjunction with the search for oil, and by the end of the fiscal year reserves were being built up at a rapid rate.

In Alberta, more than sixty gas strikes resulted in important extensions to previously known fields, particularly around Medicine Hat, Provost, and Bonnyville, or in the establishment of new potential areas. Most of these discoveries were capped pending market outlets. Jumpingpound went on gas production for the first time in May with the completion of a scrubbing plant in Calgary, and gas was distributed to southern Alberta and, later in the year by a new pipeline, westward to Exshaw and Banff.

Ninety-five per cent of the output of 64,112,000 M cubic feet of natural gas in Alberta in 1951 came from five fields—Turner Valley, Viking Kinsella, Leduc, Jumpingpound, and Medicine Hat-Redcliff.

Proposals for the export of natural gas from Alberta continued to be of major interest. In March 1952 the Alberta Petroleum and Natural Gas Conservation Board presented to the Alberta Government its report respecting applications for permission to remove gas from the province. In the report the Board estimates the established reserves of natural gas in Alberta as of December 31, 1951 to be 6·8 trillion cubic feet. The Board estimated that established reserves of natural gas of the order of 6·5 trillion cubic feet are necessary to meet the annual and peak-day requirements of the province from 1952 to 1981 inclusive.

By the close of the fiscal year the importance of the discoveries of natural gas in the Peace River area of British Columbia had not become fully apparent. Since then, however, huge quantities have been disclosed.

Increasing defence needs heightened the demand for the principal non-ferrous base metals and Federal Government allocation of supplies was continued. Prices continued to rise during 1951: copper increased from 26 cents in January to 28·15 cents in December; lead from 17·95 to 19·50 cents; zinc from 19·33 to 21·35 cents; and nickel from 51·75 to 58·5 cents. Early in 1952, however, there were indications of some easing of supplies particularly for lead and zinc.

Exports of the principal non-ferrous base metals in all forms during 1951 rose in value to $353,700,000, an increase of $80,000,000 over 1950, and was 32·5 per cent of the value of all exports of mineral origin. Most of the exports went to the United States, but increasing amounts of lead, zinc, and nickel were shipped to England.

Exploratory and development work on base metal properties and prospects reached record levels. New mines were brought into production, there was a revival of interest in many dormant properties, and extensive expansion of mine, mill, and refinery capacity was under way. Major projects included: the entry into production of Hudson Bay Mining and Smelting Company's zinc fuming plant and zinc oxide treatment plant at Flin Flon, Manitoba, which are designed to increase zinc recovery by the fuming of zinc-bearing slag from the copper smelter; preparation by Sherritt Gordon Mines Limited of its Lynn Lake copper-nickel deposits in northern Manitoba for production, expected to commence in 1953, by Barvue Mines Limited of its zinc-silver property in Barraute township, western Quebec, by Gaspe Copper Mines Limited of its copper property in Gaspe, Quebec, and by Mindamar Metals Corporation Limited of its zinc-lead-copper mine in Nova Scotia; the $65,000,000 program of The Consolidated

Mining and Smelting Company of Canada Limited for power development and to modernize and expand its productive facilities; the steady change over by The International Nickel Company of Canada Limited from open-pit and underground operation to entirely underground operation; and the discovery by Falconbridge Nickel Mines Limited of what appears to be a major orebody at Fecunis Lake in the Sudbury area, Ontario.

A great aluminium industry began to take shape in British Columbia where work on Aluminum Company of Canada's Kitimat project was proceeding. The project, which will cost an estimated $550,000,000, will result eventually in doubling Canada's present output of 500,000 metric tons of aluminium annually.

Also in British Columbia the discovery by Canadian Exploration Limited of tungsten ore on its Dodger property in the Salmo area, coupled with the reserves of this ore in the nearby Emerald mine, brought to an end the shortage of tungsten in Canada.

Canadian supplies of cobalt, another strategic metal, were increased following a raise in price by the Federal Government and the resultant stimulation of production from the Cobalt-Gowganda area of Ontario.

Canada's status as a producer of iron ore was further enhanced during the year mainly as a result of devolpments in Ontario, the Quebec-Labrador region, and Newfoundland. These gave indications of an overall production of from 30,000,000 to 40,000,000 tons of high-grade iron ore a year, possibly within the next 10 to 15 years. In northwestern Ontario the potentialities of the Steep Rock deposits continued to unfold. Commenting on the potential tonnage, the company, Steep Rock Iron Mines Limited, has stated that the combined length of these deep-seated deposits is believed to be about 4 miles, and the average width of about 250 feet suggests a prospective ore potential of possibly half a million tons per thousand feet of depth. Geological evidence indicates that each of the several deposits should extend with undiminished grade and area possibly to depths of 3,000 feet or more. Work has been proceeding on developing the company's Errington mine, now an open-pit operation, into a complete underground operation with an annual output of 1,500,000 tons. Concurrently with this, the Hogarth mine is being prepared for production by open-pit methods, and is expected to enter production in 1953 at a rate of 1,000,000 to 1,500,000 tons a year. Studies by the company of its various deposits in the area, including those under option to other companies, suggest an eventual overall production of from 10,000,000 to 15,000,000 tons a year.

Meantime, in the Michipicoten area, Ontario, Algoma Ore Properties reported a record production of 1,800,000 tons of ore in 1951, from which 1,200,000 tons of sinter was produced, the source of all the output being the company's Helen mine.

Work on Bethlehem Steel Corporation's magnetite deposits at Marmora in Hastings county, Ontario, proceeded apace, a main operation at present being removal of the 110-foot capping of limestone. Production, now expected to commence in 1954, is to be at a rate of 500,000 tons of concentrate a year. This will be shipped to Picton on Lake Ontario and from there by water to Bethlehem Steel Corporation's operations at Lackawana near Buffalo.

Notable progress was made toward preparing the Quebec-Labrador deposits for production. By the end of 1951, 10 miles of track had been laid and 125 miles of grading had been completed on the 360-mile railroad to connect the deposits with the port of Seven Islands on the Gulf of St. Lawrence, construction of which will possibly be completed before the close of 1953. Arrangements at this terminus will permit either direct loading onto ships or storage in one of four stockpiles, each having a capacity of 440,000 tons. Ore-loading equipment at the terminus is designed to handle 6,000 tons an hour when

loading onto stockpiles and 8,000 tons when loading directly into ships. Two 30,000-ton ore carriers were under construction. No attempt was made by the company in 1951 to increase ore reserves, which at the end of that year remained at 417,707,000 tons of proved ore. Although present plans call for the production of 10,000,000 tons a year, these take into consideration the possibility of an eventual annual output of 20,000,000 tons or more a year.

Shipments from Dominion Steel and Coal Corporation's Wabana hematite mines in Newfoundland in 1951 increased 47 per cent over those in 1950, due mainly to a 700,000-ton increase in overseas shipments, chiefly to Great Britain. Present commitments are directly responsible for the mechanization and modernization program designed to raise production to 2,500,000 tons a year in 1952. Great Britain has placed orders for 1,000,000 tons a year for 5 years, Germany 500,000 tons a year for the same period, and the company's steel mills at Sydney, Nova Scotia, have called for 900,000 tons a year.

British Columbia also shared in the iron ore developments during 1951, among the more important of these being the commencement by Argonaut Company Limited of steady production of iron ore from its magnetite deposits near Quinsam Lake on the east coast of Vancouver Island. Output was expected to reach a rate of 50,000 tons monthly in the near future. Production from the magnetite deposits of Texada Iron Mines Limited on Texada Island was expected to commence in 1952.

The gold mining industry was again faced with high production costs and a declining price for gold, the latter resulting from the improved position of the Canadian dollar in relation to the United States dollar. The search for gold was considerably less active than in 1950, largely because of the greater interest in base metals and uranium. No new mines were brought into production during 1951, but development work was continued on a number of prospects, several of which appear to have definite promise of becoming producers. New orebodies were discovered at several producing mines and at least five companies expanded milling capacity or increased the daily tonnage milled.

Commencing October 1, 1951, Canadian producers of gold were given the choice by the Federal Government of selling their production on premium markets under Government regulation, or, for those eligible, of continuing to receive cost aid under the Emergency Gold Mining Assistance Act. In December 1951, the Minister of Finance announced that the Federal Government proposed to introduce legislation in Parliament to extend the operation of the Act to the end of 1953.

A substantial increase in Canada's production of uranium ore is assured as a result of recent developments in the Beaverlodge area north of Lake Athabasca in Saskatchewan. The Crown-owned Eldorado Mining and Refining Company's mill at its Ace property is scheduled to enter production in the spring of 1953 at an initial rate of 500 tons a day. The company has much favourable ground in the area that has still to be explored, and in the meantime underground exploration of its Fay and Ura zones shows promise of disclosing important reserves of ore. The deposits of several private companies operating in the region appear to contain sufficient ore for shipping. Such ore would be treated at the aforementioned Eldorado plant. The plant will use a new leaching process that gives a high recovery, and which was developed in the Department's Mines Branch.

Increased competition from the use of oil and natural gas was a main reason for the decline in the Canadian output of coal from its all-time peak of 19,139,112 tons in 1950 to 18,579,108 tons in 1951. Alberta contributed about 41 per cent of the total in 1951, Nova Scotia 34 per cent, Saskatchewan 12 per cent, and British Columbia 9 per cent. Although output decreased, consumption, at 44,839,204 tons, remained about the same and close to 60 per cent of it was

supplied by imports, chiefly from the United States. It may be noted that, for railway use, the consumption of coal in Canada in 1951 was only slightly greater than that in 1941, whereas the consumption of fuel and diesel oil showed close to a fourfold increase during the same period. In the case of domestic and building heating the use of coal showed a small percentage decline during the 1941-51 period whereas that of fuel oil in 1951 was about three and a half times greater than in 1941.

The coal industry in the meantime is continuing its effort to improve the quality of its products by the use on an increasing scale of the most modern methods of coal beneficiation. This program has been necessary not only because of the increased competition from oil and natural gas, and to a lesser extent from imported solid fuels, but owing also to the general deterioration in the quality of coals as mined, brought about by increasing mechanization and the steady depletion of some of the best coals. The program during 1951 resulted in the establishment of several cleaning, drying, and briquetting plants in Alberta, Nova Scotia, and New Brunswick. Thus, by way of illustration, two pneumatic cleaning plants were installed in Alberta, one in the Coalspur area and the other in the Drumheller area, and the installation of other dry cleaning plants was under consideration in those areas where non-caking bituminous and sub-bituminous coals are mined.

Gains over the previous year in both volume and value of output were recorded by most of the industrial minerals in 1951, notably by asbestos, fluorspar, salt, sodium sulphate, and sulphur, the total value of output at $257,272,202 being 13 per cent higher than in 1950. Output of asbestos, the principal mineral of the group, established a record for the second successive year and was valued at $81,584,345, the gain of 24 per cent over 1950 being mainly a reflection of the higher prices obtained for all fibre groups. The output came principally from the Eastern Townships of Quebec, but also from the Matheson area in northern Ontario where the new mine of Canadian Johns-Manville Company Limited completed its first full year of production. Although foreign sources, especially in Africa, have grown in importance, Canada maintains its leading position, and in 1951 accounted for about 70 per cent of the world output. Canadian mines for the most part operated at capacity.

Developments in the asbestos industry during the year included the proposed erection by Asbestos Corporation Limited of a 5,000-ton mill to treat the ore from its Normandie mine in the Eastern Townships where a new orebody is being developed; the erection by Johnson's Company Limited of a new and larger mill at its Black Lake property, and acquisition of the chrysotile deposit in the McDame Lake area of northern British Columbia by Cassiar Asbestos Corporation Limited, which plans to erect a mill to recover fibre from the deposit.

Canadian salt plants operated at higher capacities in 1951 and output increased to 964,525 tons from 859,000 tons in 1950. A newly formed company, Canadian Salt Company Limited, took over the plants of the Salt Division of Canadian Industries Limited at Windsor, Ontario, and at Neepawa, Manitoba, and also the plant of Alberta Salt Company Limited at Lindbergh, Alberta.

The demand for sodium sulphate, particularly for use in the pulp and paper industry, continued to outstrip supply, and imports to meet industrial needs in eastern and western coastal areas of Canada rose to 22,700 tons compared with 18,000 tons in 1950.

Sales of mica of all classes in Canada increased 28 per cent in volume and about 100 per cent in value compared with 1950. Exports, mostly to the United States, increased 23 per cent in volume and nearly 200 per cent in value. The production came from Ontario, Quebec, and British Columbia, in that order.

The output of clay products continued to increase in spite of a smaller volume of sales for certain ceramic products such as low tension electrical insulators, domestic tableware, and sanitary ware, caused by credit restrictions or other exigent economy measures.

Although production of cement reached a record 17,007,812 barrels, imports of 2,327,429 barrels were necessary to meet the domestic requirements. However, expansion programs now nearing completion will add upwards of 5,320,000 barrels to present capacity, an amount, together with present production, considered sufficient to meet domestic needs for some time ahead.

Several projects were undertaken during 1951 that will make Canada less dependent upon outside sources of supply for its requirements of elemental and other forms of sulphur. In one of these, Shell Oil Company of Canada brought a plant into operation early in 1952 in the Jumpingpound field in Alberta that will recover elemental sulphur at the rate of 10,000 tons annually from the scrubbing of sour natural gas from that field. In another, at Turner Valley in Alberta, Royalite Oil Company will recover the same amount from the Turner Valley field in a plant that is scheduled to enter production in 1952.

At Copper Cliff, Ontario, Canadian Industries Limited is building a $1,500,000 plant to produce about 90,000 tons of liquid sulphur dioxide a year from stack gases obtained from flash smelting units developed recently by The International Nickel Company of Canada Limited in its adjacent plant.

At Valleyfield in Quebec, Nichols Chemical Company Limited began an expansion program in 1951 designed to double its 100,000 tons annual output of sulphuric acid by late 1952. At Kimberley in British Columbia, The Consolidated Mining and Smelting Company of Canada Limited proposes to build a fertilizer plant that will include a sulphuric acid plant to have an annual capacity of 100,000 tons of this acid.

ACTIVITIES OF THE DEPARTMENT

In its endeavour to meet the many requirements of the rapidly growing industry it serves the Department carried out one of the largest programs of topographical and geological mapping in its history in 1951. Likewise, it had under way a many-sided program of tests and investigative work on ores and minerals intended in the main to develop new and cheaper processing methods, and, where possible, to improve existing methods. Its facilities for research on metals and alloys were again used in the main to meet the metallurgical requirements of the Department of National Defence and of the Atomic Energy project at Chalk River, Ontario.

The growth of the mineral industry in recent years, and particularly the attention being given to the search for and development of prospects in new areas, has resulted in heavy and increasing demands on the mapping services of the Department. To keep abreast of these demands the Department has not only greatly enlarged the scope of its field work in recent years, but to speed up its work, has been making increasing uses of new techniques and equipment in the field and in the office. Thus, in its geodetic work in northern Canada it has been making extensive use of an electronic method known as shoran in measuring distances up to 300 miles with a resultant high degree of accuracy. It has been using the helicopter with considerable success in the topographical mapping of mountainous and remote areas, and in the 1952 field season it proposes to make use of the helicopter for the first time in its geological mapping, the region concerned being a large section of the Canadian Shield in the Northwest Territories where a reconnaissance survey of the geology is to be made.

In the topographical field work ground surveys for control of mapping from aerial photographs were established in various parts of Canada over areas totalling 168,223 square miles. This coverage was greater than in any previous year and was accomplished despite a substantial reduction compared with 1950 in the number of parties assigned to field work. It was made possible by the greater use of the helicopter and of photogrammetrical methods. A feature of the topographical work in 1951 was the high altitude vertical photography that was carried out in Ontario, British Columbia, and Yukon. Such photography is of great assistance in the mapping program, particularly in territory difficult of access, and through it, for instance, the mapping of the ice-covered area in southwestern Yukon was made possible, a project that would have been prohibitive in cost by regular methods.

A main aim of the geological field work was to help meet the increasing need for information on sources of mineral raw materials. The program included also systematic mapping of areas of potential interest, and studies of ground-water supplies in various parts of Canada. Standard geological mapping on scales of 1 inch to 1 mile or 4 miles was carried out on thirty-four areas across Canada. Reconnaissance surveys were continued on Cornwallis Island and in southern Baffin Island and on the coast of Labrador, the work on the Arctic islands being part of a long range program of mapping the geology of areas that hold promise of occurrences of oil, natural gas, and coal.

Geological studies of structures in the foothills and plains of western Canada again received major attention. Thus, five parties were assigned to such work in Alberta, one in Saskatchewan, one in Saskatchewan and Manitoba, and two in Manitoba. The results of the work will provide a background of stratigraphic data that should prove of great value in the discovery and development of oil and natural gas fields.

As a service to prospectors, more than 5,000 mineral samples were tested quantitatively by the Geological Survey of Canada for radioactivity, and the results on 97 per cent of these were reported on within a day of receipt of the samples. To guide prospectors in their search for uranium ores the Survey issued a handbook "Prospecting for Uranium in Canada". X-ray fluorescence equipment installed during the year has proved useful for rapid analyses of minerals, particularly for determining uranium, thorium, columbium, tungsten, tantalum, and molybdenum. Geological field work on radioactive minerals was confined to uranium-bearing areas in northern Saskatchewan and to a general examination of uranium-bearing deposits in Northwest Territories, Saskatchewan, Ontario, and Quebec.

Seventy-four maps were published by the Geological Survey during the fiscal year, consisting of 34 aeromagnetic maps, 26 preliminary geological maps, 13 lithographic maps, and a special map on a scale of 120 miles to the inch showing the principal mining areas and producing mines in Canada. Approximately 160,000 reports, maps, and other publications were distributed during the fiscal year.

The activities of the Department's Mines Branch reflect the increased requirements of a rapidly expanding industry for the various services provided. A major requirement is for tests and investigation work on ores, some of them from new properties entering production where the aim is to devise suitable methods of treatment, and others from producing mines that encounter difficulties in obtaining high recoveries of the valuable product. The Branch carried out 69 investigations of this kind during the fiscal year compared with 48 in the previous year, 19 of these being on base metal ores and 14 on gold ores.

In its work on ores and minerals it has been devoting increasing attention in recent years to research activities, a case in point being its research on uranium ores, the need for which is evident particularly in view of recent

developments in northern Saskatchewan. Two new leaching methods were developed during the fiscal year, one of which is ready for testing on a pilot plant scale and is particularly suitable for ores containing carbonate minerals, and the other, also ready for pilot plant tests, is especially suitable for the granitic ores of the Charlebois Lake area in northern Saskatchewan.

Another research problem receiving attention concerns the recovery of lithium from its common ore, spodumene, large undeveloped deposits of which occur in Manitoba and Quebec. Lithium, the lightest of all metals, has many uses, one of the most important being in the production of highly desirable alloys for structural airframe parts. The research by the Branch, though on a laboratory scale, has indicated the commercial possibility of a 98 per cent recovery of lithium from spodumene.

Research on the industrial minerals dealt chiefly with the processing of material from low-grade deposits and with the development of new mineral products such as light-weight aggregates from domestic clays and shales. These aggregates are being used to an increasing extent in the construction industry, and work to date has shown that deposits of clay or shale suitable for making them occur in the vicinities of most of the principal Canadian cities.

A few years ago the Branch disclosed the existence of large deposits of vermiculite near Perth, Ontario. It has since devised a flowsheet that has proved satisfactory on a commercial scale for the utilization of low-grade material from these deposits.

It had developed two processes for producing pure silica sand from relatively impure sandstone, with the expectation that commercial plants will be built to use both processes.

In its research on the fuels the Branch concentrated its attention chiefly on the technical problems of the coal industry, the primary aim being to help the industry maintain its markets in competition with oil and natural gas. In one of its major projects it has been studying the rock pressures on several coal mines in western Canada in co-operation with the Geological Survey of Canada, with special attention to the avoidance of violent pressure "bumps" and "gas outbursts", which are hazardous to mining and thus interfere greatly with production. The bituminous coking coal obtained from the mines is in heavy demand for use in making metallurgical coke, thus emphasizing the practical importance of the project.

In co-operation with McGill University, the Branch continued its efforts to develop a satisfactory coal-fired gas turbine engine, and trials of the complete engine using coal as fuel are expected to commence by the spring of 1953. Development of such an engine to a state suitable for incorporation into a locomotive would bring major benefits to the coal industry, but it should be emphasized there is no sound basis as yet for predicting the time when it will be in commercial use, nor is it certain that the project will reach that status. There is some assurance, however, in the fact that no technically insurmountable difficulty has yet been encountered. The project is being financed by the Department.

At the request of the Defence Research Board, which is assisting in financing the project, the Branch made a start on developing metallurgical methods to process titanium metal. Titanium has properties that make it highly suitable for various military and industrial uses, but it has other characteristics that have made it difficult for metallurgists to develop commercial products at reasonable cost.

In other metallurgical projects for the Department of National Defence the Branch continued its research dealing with welding under Arctic conditions, participated in work on a guided missile project, and continued with the development of high temperature metal for jet engine applications. Though primarily for use of the Defence Services, the welding project is of considerable interest to industry as well in view of the widespread use of welding in building construction in Canada.

The foregoing activities of the Department are primarily in the nature of services to the mining and metallurgical industries. Quite different in character and purposes, for the most part, are the activities of the Dominion Observatories and of the Geographical Branch.

A main function of the Dominion Observatory at Ottawa is provision of the daily time service throughout Canada. With the installation during the fiscal year of a photographic zenith tube for determining time by photographic methods Canada now has one of the most modern and powerful instruments in the world for time determination.

In the field of stellar physics, initial preparations were completed for a major program of photographic triangulation of meteors at Meanook and Newbrook observatories in northern Alberta where two specially designed cameras have been installed. Weighing about 3 tons each, the cameras can take meteor photographs approximately fifty times as fast as the best cameras previously available. The program will mark the commencement of Canada's participation in a co-operative program with the United States that has been 6 years in the making, to determine the physical characteristics of the upper atmosphere at several different latitudes. The region to be studied, which is from 30 to 80 miles up, is the realm of future activity in high flying aircraft, guided missiles, rockets, and radio transmission of all types.

In the Dominion Astrophysical Observatory at Victoria, British Columbia, the research work was mainly in the nature of investigations into the physical and chemical processes occurring in stellar atmospheres, the motions of the stars, and the mechanics of double star systems. A major project completed during the fical year has shown how to find the true brightness of the high-temperature stars. As a result of this work it is now possible for the first time to assign with some assurance distances to every hot star under observation. In another project new information was gained on the structure and turbulent nature of the outer layers of the hotter stars.

Preparation of a new atlas of Canada continued as a main project of the Geographical Branch. The atlas will be published in loose-leaf form and in effect, the hundreds of maps it will contain will depict the wealth of information on the Canadian economy acquired by the Federal Government during the taking of the 1951 census. Field work by the Branch included special studies in northern Manitoba, northern Ontario, and northern Quebec and the Northwest Territories for use of the Department of National Defence; continuation of systematic geographical surveys in the Maritime Provinces that are designed to provide guidance in the economic and social development of the areas concerned; settlement studies of fifty-two centres in the Ottawa Valley for use of the Civil Defence Division, Department of National Health and Welfare, and the collection of data on ice conditions in the eastern Arctic.

In connection with the administration of the Explosives Act, it is gratifying to note that, although the volume of commercial explosives manufactured in Canada again reached a record, not a single fatality occurred in a commercial explosives plant. However, playing with detonators and other explosives resulted in the deaths of five persons and injuries to thirty-six, most of the victims being children.

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

SUMMARY OF REVENUE AND EXPENDITURES FOR THE FISCAL YEAR 1951-52

—	Revenue	Ordinary Expenditures
Minister of Mines and Technical Surveys	.....	$ 12,000.00
Departmental Administration	$ 1,255.93	363,870.28
Explosives Act	5,034.03	77,950.28
Mines Branch	10,405.82	2,221,755.24
Geological Survey of Canada	9,071.41	1,515,435.44
Surveys and Mapping Branch	83,819.32	4,966,743.89
Geographical Branch	464.05	209,484.78
Dominion Observatories	863.37	527,839.46
Emergency Gold Mining Assistance	.....	11,840,655.15
Payment to Royal Canadian Air Force and commercial companies for air photography, and to defray the expenses of the Interdepartmental Committee on Air Surveys	.....	880,803.00
	$110,913.93	$22,616,537.52

EXPLOSIVES DIVISION

The Division administers the Explosives Act (1946), which regulates the manufacture, testing, storage, sale, and importation of explosives. The distribution of factory buildings, the quantity of explosives in each, the conduct of operations, and other factors bearing on the safety of personnel and the public are dealt with in the licences issued and are checked by frequent inspection. The establishment of magazines and registered premises for small stocks of explosives for resale is also subject to licensing and inspection. Persons carrying small stocks of explosives for private use and storekeepers stocking ammunition are bound by regulations, the enforcement of which calls for much inspection work. The conveyance of explosives by road is also subject to regulation.

Explosives Regulations Part VI, dealing with transportation of explosives by boat, was amended by Order in Council P.C. 2626 on May 22, 1951, to permit an increase in the maximum quantity of explosives that can be carried by boat from the former amount of 50,000 pounds to 250,000 pounds. Part VI was also amended by Order in Council P.C. 1647, on March 21, 1952, to permit certain relaxations dealing with the transportation of explosives in northern Alberta and Northwest Territories.

A total of 107,339,504 pounds of commercial explosives was produced in Canada in 1951, an increase of 13,849,287 pounds over the previous year.

A new commercial explosives factory near Calgary is nearing completion and is expected to be operating early in 1952. Defence Industries (1951) Limited, formed early in the year, is operating the Crown-owned Canadian Arsenals factory at Valleyfield, Quebec. North American Cyanamid Limited reopened the plant near Niagara Falls, Ontario, for the production of nitroguanidine used to make propellants.

The "Blaster's Safety Alphabet", a pamphlet issued in English in 1950 for the promotion of safety in the handling and use of explosives, was published in French.

Valuable assistance in making inspections, investigating accidents and thefts, and carrying out prosecutions under the Act was given by the Royal Canadian Mounted Police, members of which force are appointed Deputy Inspectors of Explosives.

LABORATORY

The testing and analysis of explosives, required in the administration of the Explosives Act and for research, is carried out by the Division in the National Research Council's explosives laboratory.

During the fiscal year 370 samples were received for chemical and physical examination and reports were prepared on the results.

Samples of 12 high explosives, including new types of commercial explosives, nitroguanidine for use in military explosives, cartridges for lightning arrestor insulators, and safety fuse, were submitted by Canadian manufacturers for approval. Samples of five fireworks submitted by Canadian manufacturers were approved.

Seven high explosives and thirty-five fireworks submitted from outside of Canada were accepted. However, a number of fireworks were rejected because of prohibited ingredients, fire hazards, or dangerous functioning.

Projects and Investigations

Investigation of the hazards attending the storage and shipment of ammonium nitrate fertilizer was continued. The original Interagency Committee on Ammonium Nitrate Fertilizer was replaced by the New Test Committee on Ammonium Nitrate Fertilizer under the chairmanship of Dr. Clyde Davis, Washington, D.C.

The Division standardized the Bichel gauge, an instrument used to determine the proportions of the gaseous products of explosives, and the products of a test sample of gelatine were analysed for comparison with values reported in the United States. Reasonable agreement between the Division's results and those of the United States Bureau of Mines was obtained.

FACTORIES

In 1951 there were 18 licensed factories in Canada, one more than in the previous year.

MAGAZINES—REGISTERED AND UNLICENSED PREMISES

There were 389 permanent and 819 temporary magazine licences in force at the end of 1951 compared with 391 permanent and 690 temporary licences at the end of 1950. Registered premises increased from 62 to 74.

The records of several thousand dealers selling small arms ammunition were checked. Numerous unlicensed premises where small quantities of blasting explosives were kept for private use were inspected.

INSPECTIONS

Factories	Magazines	Registered premises	Unlicensed premises
33	1,170	104	4,316

IMPORTATION PERMITS

Fire hundred and forty permits and 14 special permits were issued for the importation into Canada of such items as fireworks, distress signals, nitrocotton for use in paints and lacquers, propellant powders used in ammunition, and explosives used in seismograph exploration for oil.

ACCIDENTS

Despite increased activity in construction work in 1951 there were fewer accidents involving explosives, although the number of fatalities was greater than in 1950.

Although commercial explosives manufactured in Canada in 1951 again reached a record, there was not a single fatality in a commercial explosives plant. However, five men were killed in a serious accident at a shell filling plant on February 7, 1951. An investigation was conducted and reported upon by the Chief Inspector of Explosives. Ten persons were injured, none of them seriously, in minor explosions and flashes that occurred in manufacturing. Eighteen were killed and 81 were injured in accidents involving explosives in mining, logging, and construction work.

Playing with detonators and other explosives resulted in the deaths of 5 persons and injuries to 36, most of the victims being children who had access to explosives through the carelessness or neglect of adults to lock up explosives securely.

—	Accidents	Killed	Injured
Mines and quarries	40	5	48
Elsewhere in industry	28	13	33
Playing with detonators	12	1	15
Playing with other explosives	13	3	18
Miscellaneous	3	1	3
Manufacture, keeping, and conveyance	8	5	10
Total	104	28	127

PROSECUTIONS

Prosecutions for breach of the Explosives Act and Regulations were instituted in nine cases. Convictions were obtained in seven and fines were imposed. A charge of trespassing, and another of improper storage were dismissed on the grounds of insufficient evidence.

Infractions of the regulations were as follows:

Failure to show a red flag or red light on a conveyance transporting explosives	1
Improper storage	6
Storing explosives in excess of the amount permitted by licence	1
Trespassing	1

Two men were fined for improper use of explosives under provincial mining laws.

Two men were sentenced under the Criminal Code for causing damage to property with explosives.

DESTRUCTION

The Division is responsible for the destruction or disposal of abandoned or deteriorated commercial explosives. In 1951 there were 2,185 pounds of blasting explosives, 140,177 detonators, and 648 cases of fireworks destroyed.

SURVEYS AND MAPPING BRANCH

W. H. Miller, Director

The continued expansion of Canadian industry and the widespread development of mineral and other natural resources, combined with defence requirements, resulted in maintaining the demand for surveys, maps, and charts at a high level.

By use of modern equipment and new techniques more field control for mapping from aerial photographs was established than in any previous year. By means of shoran trilateration the Branch, with the co-operation of the Royal Canadian Air Force, the National Research Council, and the Meteorological Service of the Department of Transport, continued to extend geodetic control to the Far North and an additional 340,000 square miles of northern Canada was covered by the shoran net that was commenced in 1949. Much of the work of the Canadian Hydrographic Service was centred on obtaining information for new hydrographic charts made necessary by the opening up of unfrequented parts of coastal regions for industrial projects and the development of strategic localities for defence and scientific purposes.

Co-operation was maintained with the Army Survey Establishment, Department of National Defence, in the production of topographical maps, and with provincial authorities engaged in similar or related work to avoid duplication of effort.

Reports on the activities of the Branch follow.

TOPOGRAPHICAL SURVEY

The Topographical Survey carries out field control surveys and completes the resultant map manuscripts 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 indexes, preserves, and distributes prints for all air photography done by or for the Federal Government; and it provides funds for and administers the Canadian Board on Geographical names.

The Survey has two major units, namely, the Topographical Mapping Section, which carries out 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.

An extensive program of field and office work was carried out during the fiscal year and, despite a reduction in the parties assigned to field work, from seventy-eight in 1950-51 to seventy-one in 1951-52, ground control was extended over more territory than in any previous year. This was made possible by greater use of the helicopter and of photogrammetrical methods.

The advantages of employing helicopters for field transport became more apparent following their use on two projects with highly satisfactory results both in speed and economy. In northern Yukon reconnaissance control was extended by this method over 19,000 square miles of unmapped country between Porcupine and Mackenzie Rivers, and two helicopters were used to map areas totalling 20,516 square miles in Gaspe, New Brunswick, Cape Breton, and Newfoundland.

Wider and more efficient use was made of mechanical plotting equipment through adjustments in organization and plotting techniques. A new instrument that may revolutionize the multiplex method of plotting topographical detail was developed for topographical mapping in conjunction with the multiplex.

High altitude vertical photography, which has proved to be of great assistance to the mapping program, particularly in territory difficult of access, was carried out in areas in Ontario, British Columbia, and Yukon. Through it, for instance, the mapping of the ice-covered area in the southwest corner of Yukon was made possible, a project that has long been under consideration but which appeared by regular methods to be prohibitive in cost.

Approximately 11,500 advance information prints were distributed to various Federal and Provincial authorities and to others interested in new mapping.

TOPOGRAPHICAL MAPPING

This Section did original ground surveys for control of mapping from aerial photographs over widely distributed areas totalling 168,223 square miles, compared with 132,645 square miles during the previous fiscal year. Fifteen of the seventy-one 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.....	.....	.....
	3	Triangulation control Mackenzie River.		220-mile net
Yukon and Northwest Territories.....	7	Photo-topographical.....	1 in. to 4 miles....	34,600
British Columbia.....	8	Photo-topographical.....	1 in. to 4 miles....	18,099
	6	Photo-topographical.....	1 in. to 1 mile.....	4,507
British Columbia and Northwest Territories	3	Winter traverse (chain).....	.....	820 lin. miles
Alberta.....	4	Topographical.....	1 in. to 1 mile.....	2,737
Saskatchewan.....	1	Topographical.....	1 in. to 1 mile.....	1,949
	1	Winter traverse (chain).....	.....	120 lin. miles
	1	Planimetric.....	1 in. to 1 mile.....	753
Manitoba.....	.....	Field interpretation.....	4 map-sheets.....	
Quebec.....	5	Topographical.....	1 in. to 1 mile.....	11,388
Quebec.....	.....	.....	.....	2,382
New Brunswick.....	5	Topographical (helicopter)....	1 in. to 1 mile.....	9,210
Nova Scotia.....	.....	.....	.....	950
Newfoundland.....	.....	.....	.....	7,974
New Brunswick.....	1	Topographical.....	1 in. to 1 mile.....	401
	1	Vertical control (levels).....	.....	243 lin. miles
		Field interpretation.....	2 map-sheets.....	.....
Nova Scotia.....	5	Topographical.....	1 in. to 1 mile.....	3,432
		Field interpretation.....	3 map-sheets.....	.....
Newfoundland.....	3	Topographical.....	1 in. to 1 mile.....	3,121
	56			101,503

Army Survey Establishment

Province or territory	Number of parties	Type	Scale	Area (square miles)
Ontario	1	Topographical (helicopter)	1/250,000	22,400
			1/50,000	1,020
Manitoba	2	Topographical winter traverse	1/250,000	7,400
Alberta	2	Topographical	1/50,000	4,000
British Columbia	5	Photo-topographical	1/50,000	9,000
	1	Photo-topographical	1/250,000	5,500
Yukon Territory	1	Photo-topographical	1/50,000	900
Northwest Territories	1	Photo-topographical (helicopter)	1/250,000	16,500
	1	Triangulation	2nd order	160 lin. miles
	1	Base line measurement		
	15			66,720

Topographical detail was plotted on areas totalling approximately 20,000 square miles on which the planimetry had been drawn by the Air Survey Section.

In December 1951, six field officers began a series of transit and chain traverses in the area around Fort Nelson, B.C., and north to Fort Simpson, N.W.T. This net of control was tied to geodetic positions, thus establishing a sound basis for mapping in an area where swamp and muskeg make summer traverse impracticable. Two other field officers completed basic control for detailed mapping in the Goldfields area in northern Saskatchewan at the request of the Geological Survey, and two winter parties, provided by, and under the direction of, Army Survey Establishment, continued surveys in the Fort Churchill area. Another party established and measured a triangulation base line on the ice near Wrigley in Northwest Territories.

A senior officer carried out special investigations in the Arctic islands.

AIR SURVEY

The following mapping was completed:

Province or territory	Number of map-sheets	Scale of publication	Area (square miles)
1. *Planimetry*—			
Northwest Territories	4	1 in. to 4 miles	16,566
Yukon	4	1 in. to 4 miles	13,611
British Columbia	4	1 in. to 4 miles	12,991
Alberta	9	1 in. to 1 mile	3,111

Province or territory	Number of map-sheets	Scale of publication	Area (square miles)
Saskatchewan	22	1 in. to 1 mile	7,170
Manitoba and Saskatchewan	4	1 in. to 1 mile	1,157
Manitoba	13	1 in. to 1 mile	4,728
Quebec	14	1 in. to 1 mile	5,567
	3	1 in. to 4 miles	12,895
Quebec and Labrador	1	1 in. to 4 miles	5,703
New Brunswick	7	1 in. to 1 mile	2,437
Coastal areas (for Hydrographic Service and miscellaneous mapping)—			
Northwest Territories	2	1 in. to ½ mile	630
	8	1 in. to 1 mile	3,736
	2	1 in. to 2 miles	27,080
	1	1:25,000	450
Yukon	1	1 in. to 1 mile	300
Saskatchewan	1	1 in. to 1 mile	900
Labrador	1	1 in. to 3,000 feet	1,200
Quebec	1	1 in. to ½ mile	4
Grand total of planimetric mapping			120,596
2. *Contoured maps*—			
Ontario	3	1 in. to 1 mile	546
Quebec	9	1 in. to 1 mile	2,920
Newfoundland	4	1 in. to 1 mile	130
Nova Scotia	1	1 in. to 1 mile	426
Quebec and Labrador	2	1 in. to 1 mile	691
Coastal areas (for Hydrographic Service, Army Survey Establishment, and miscellaneous plotting)—			
Northwest Territories	11	1 in. to ½ mile	2,313
Yukon	1	1:15,000	48
	1	1 in. to 666 feet	2
British Columbia	1	1:12,500	20
Manitoba	1	1 in. to 4 miles	80
Grand total of contoured mapping			7,176
3. *Mosaics*—			
Yukon	2		29,287
British Columbia	2		534
Saskatchewan	1		752
Quebec	10		7,897
Newfoundland	14		25,814
Grand total, mosaics			64,284

Bi-camera Photography

A new method was developed of reducing the amount of ground control required for mapping from vertical photography. A test of the method indicated that it may solve the problem of intermediate control between widely spaced shoran stations.

Topographical Plotting

A new instrument for plotting contours was developed for use with multiplex projectors and a pilot model is under construction. It is believed that this instrument will greatly increase the speed and accuracy of mapping by multiplex.

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.

Map-sheets Forwarded for Reproduction

Province or territory	1:50,000	1:250,000	Total	Area (square miles)
Newfoundland	6	.....	6	840
Quebec–Newfoundland	1	.....	1	347
Quebec	4	2	6	11,969
New Brunswick	6	.....	6	1,797
Nova Scotia	4	.....	4	1,494
Ontario	1	.....	1	20
Manitoba	15	.....	15	5,478
Manitoba–Saskatchewan	3	.....	3	1,062
Saskatchewan	8	.....	8	3,080
Alberta	11	.....	11	3,878
British Columbia	2	.....	2	656
Yukon	.....	3	3	13,525
Northwest Territories	1	5	6	22,414
	62	10	72	66,560

Special Map Projects Forwarded to Army Survey Establishment

Province or territory	Projects	Area (square miles)
Northwest Territories (installations)	14	1,400

Map-sheets Inked or Traced for Advance Information Prints

Newfoundland	5
Newfoundland–Quebec	3
Nova Scotia	9
New Brunswick	14
Quebec	40
Ontario	2
Manitoba	21
Saskatchewan	32
Alberta	15
British Columbia	8
Yukon	4
Northwest Territories	14
	167

Three hundred and twenty-five projections were drawn to various scales, and 300 manuscripts were mounted on metal. Numerous index maps, charts, and special drawings were prepared.

COMPUTING AND CONTROL

This Section does the computations and adjustments of data supplied by the field parties, and provides the geographical or universal transverse mercator co-ordinates required for the compilation of map manuscripts. It computed the geographical positions of township corners lying between the 1st and 17th base lines from the fourth to the fifth meridian, and between the 1st to the 4th base lines from the principal to the fourth meridian and adjusted them to the most recent ties made by the Geodetic Survey.

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 geographical location. The library now has on file for reference purposes 2,312,380 prints of air negatives covering approximately 90 per cent of the land area of Canada. During the fiscal year, 57,672 new photographs covering an area of 340,000 square miles were added to the collection. These included 125,000 square miles covered by trimetrogon photography and 215,000 square miles by vertical photography. Approximately 140,000 square miles of the area covered by vertical photography was taken at an altitude of 35,000 feet above sea-level.

That aerial photography plays an important role in the development of Canada's natural resources was amply illustrated during the year by the demand for and interest taken in these photographs, with various agencies and individuals purchasing 411,807 prints compared to 395,851 prints during the previous fiscal year. Index maps showing the locations of the flight lines were supplied in almost every case.

The library prepares index maps of all new photography, maintains complete records concerning the conditions under which the aerial negatives were exposed, and makes available facilities for stereoscopic study of prints. In addition, it annually compiles an *Air Photographic Coverage Map of Canada*, which shows, in colour, areas covered by various types of aerial photography.

CANADIAN BOARD ON GEOGRAPHICAL NAMES

The Board adopted names for 142 maps and 15 hydrographic charts and considered many new names, name changes, and other items of related business. It continued the preparation of the forthcoming Gazetteer of Canada series, the first volume, Southwestern Ontario, having been completed during the fiscal year.

Five provincial members or their representatives attended the February 1952 meeting of the Board at which several items of particular interest to the provinces were discussed. Three members of the Geographic Board of Alberta were also present.

The present membership of the Board is:

Chairman	P. E. Palmer
Executive Committee	C. H. Smith
	R. J. Fraser
Members	Norman Fee
	A. McFarlane
	J. G. Wright
	C. E. Cairnes
	N. L. Nicholson
	E. D. Baldock
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.

CANADIAN HYDROGRAPHIC SERVICE

The Canadian Hydrographic Service charts Canadian coastal and inland waters, investigates tides and tidal currents, and records the water-level fluctuations of the Great Lakes-St. Lawrence Waterway. It publishes standard Canadian navigation charts, volumes of Sailing Directions, Tide and Tidal-current Tables, and Water-level Bulletins pertaining to inland waterways. The Service has four main operating sections, namely, Charts and Sailing Directions, Hydrography and Ships, Tidal and Current Survey, and Precise Water-levels.

The headquarters at Ottawa is 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 is the principal distributing centre for nautical publications pertaining to that seaboard.

Charting activity during 1951-52 was largely centred about the opening up of unfrequented parts of the coasts for industrial projects, and the development of strategic localities for defence and scientific purposes. In carrying out this and other charting activity on coastal and inland waters, the Service operated a hydrographic fleet consisting of two large vessels on the Pacific and four on the Atlantic coasts, a chartered vessel in northern waters, three motor cruisers and one launch, and 24 motor boats and other small craft attached to the survey vessels. The 300-ton motorship, *Marakell*, was purchased for tidal and hydrographic surveys on the west coast, bringing the strength of the fleet to 9 principal survey ships and 35 motor launches.

On April 1, 1951, Canada became a States Member of the International Hydrographic Bureau and the Dominion Hydrographer was appointed Canadian representative to the Bureau. The main functions of this organization are the standardization of nautical publications, technical procedure, and instrumental equipment, and the international exchange of important hydrographic information for the protection of life and property at sea.

CHART PRODUCTION

The scarcity of trained personnel proved to be a major problem in coping with the steadily increasing demand for hydrographic aids to navigation. To overcome this the Service instituted a policy of student training. In addition, it increased the output of charts through the adoption of advanced cartographic methods.

Production during the fiscal year was as follows:

Standard charts (first editions)	22
New editions of existing charts	38
Reprints	6
Special and provisional Arctic charts	35

A new catalogue of Canadian Hydrographic Service nautical charts, Tidal and Current Publications, Sailing Directions, and other Government publications of interest to mariners, was published and distributed to the seafaring trades.

PILOTS AND SAILING DIRECTIONS

The Service continued with the preparation of two new volumes of Sailing Directions for Newfoundland, including Labrador, the compilation of a new publication "Nautical Distance Tables", and the collection of nautical information pertaining to northern waters.

HYDROGRAPHY

Hydrographic information was obtained for several new charts as a result of charting operations carried on during the fiscal year. These were conducted in widely separated areas, on the Pacific coast, in Arctic waters, on the Atlantic coast, in the Gulf of St. Lawrence, and in inland waters.

Pacific Coast and Arctic Waters

The *Wm. J. Stewart* made a survey of Bedwell Harbour in the Pender Islands and completed the charting of Queen Charlotte Strait at the northern end of Vancouver Island. It conducted investigations at Nanaimo Harbour and at Bella Coola in relation to the berthing of steamers. Farther north it extended the coastal surveys around Banks Island and Browning Passage and made an exploratory survey of the long inlets and of Douglas Channel and Gardner Canal in connection with the aluminium power development and the proposed port at Kitimat. This reconnaissance is preliminary to a complete charting of the hundred miles of deep fiord-like waterways in which few soundings have been made. The vessel also carried out an important chart revision survey in Fraser River.

Hydrographic work consisted of:

Ship sounding	735	linear	nautical	miles
Boat sounding	2,566	"	"	"
Coastlining	284	"	"	"
Shoals examined	1,344			
Oceanographical stations	40			

The smaller ship *Parry* made a detailed survey of Discovery Passage, Hoskyn Channel, and Johnstone Strait between Vancouver Island and the mainland.

Hydrographic work consisted of:

Boat sounding	579	linear nautical miles
Coastlining	80	" " "
Shoals examined	147	

Western Arctic. The Service carried out a co-operative hydrographic-oceanographic project with the Department of National Defence in the Beaufort Sea area. The charting was of a reconnaissance nature and much useful data was obtained.

Eastern Arctic. To accelerate the production of improved charts of far northern harbours a party of hydrographers was attached to the Department of Transport vessel *C. D. Howe*, which was especially equipped with surveying and sounding apparatus. The vessel was accompanied by the echo-sounding launch *Grebe.* Considerable hydrographic data was obtained from fourteen of the nineteen harbours visited and soundings for chart purposes were taken over much of the ship's track.

Hydrographic work consisted of:

Ship sounding	5,527	linear nautical miles
Launch sounding	164	" " "

The chartered vessel *Algerine* charted harbours and approaches in Hudson Strait and in Frobisher Bay, Baffin Island. On Frobisher Bay it also piloted cargo ships, surveyed and developed new channels, and erected permanent steel navigation beacons. On the south shore of Resolution Island at the Atlantic end of Hudson Strait, it charted a new harbour found to be superior to Acadia Cove, which has been used for many years by supply and patrol ships.

Work accomplished consisted of:

Ship sounding	262	linear nautical miles
Launch sounding	858	" " "
Coastlining	167	" " "
Shoals examined	21	
Oceanographical stations	17	

Atlantic Coast

Nova Scotia. The motor launch *Anderson* resumed the charting of the southeast coast of Nova Scotia by carrying out charting operations in the neighbourhood of Liverpool. This is a long term project that was interrupted by the war. At the request of the provincial Department of Trade and Industries, the *Anderson* sounded the harbour and river leading to Antigonish in George Bay on the northeast coast to determine the practicability of using this inlet as a shipping port for the salt and limestone produced in the area.

The season's work included:

Boat sounding	139	linear nautical miles
Coastlining	26	" " "

Pictou, N.S., Miramichi Bay, N.B., and Havre St. Pierre, Que. The *Cartier* made a detailed survey of the Pictou waterfront in Nova Scotia and resurveyed the outer part of Miramichi Bay on the northern coast of New Brunswick. The action of tidal currents and ice on this coast over a number of years has caused erosion of islands and sand bars, altering the courses of some channels and, in one instance, actually cutting a new channel directly through an island. The

resultant changes in depth and in current have caused concern to local fishing interests, and to the Federal Department of Public Works, which is responsible for the improvement and maintenance of these channels.

The *Cartier* commenced a resurvey, including the various channels of approach, of Havre St. Pierre on the northern shore of the Gulf of St. Lawrence, which is being used by larger vessels in connection with the shipment of titanium ore. The *Cartier* also investigated the navigational changes taking place at Seven Islands, the proposed shipping port for iron ore from the Quebec-Labrador deposits.

The season's work included:

Launch sounding	507 linear nautical miles
Oceanographical stations	4

Bay of Islands, Nfld.-Strait of Canso, N.S. The *Kapuskasing* completed an extensive survey of Bay of Islands, which, with Humber Arm, forms the port for the industrial city of Corner Brook. The bay is a refuge for vessels proceeding up and down the west coast of Newfoundland. During the course of the survey, the *Kapuskasing* charted several new shoals, which proved of great interest to fishermen, and completed sounding surveys in the Strait of Canso, which will provide information for the construction of proposed ferry crossings, bridges, and causeways, as well as aid navigation of that passage. Enroute to Halifax it calibrated a section of the radio-direction finding station at Canso. The Service will publish two new charts of the Bay of Islands area to replace the present chart, which is based on surveys of 70 years ago.

Hydrographic work accomplished consisted of:

Ship sounding	1,425	linear	nautical	miles
Boat sounding	2,110	"	"	"
Coastlining	165	"	"	"
Shoals examined	76			
Oceanographical stations	12			

Placentia Bay, Nfld. The *Fort Frances* assisted by the large motor launch *Dawson,* charted the waters and shores of Placentia Bay on the south coast of Newfoundland, thus extending the hydrographic surveys commenced there by the United States during World War II. It examined the harbours of Burin and Great St. Lawrence on the east shore of the Burin Peninsula to determine the need for modern harbour charts to aid in the shipment of minerals, and located several dangerous shoals not shown on existing charts but referred to in caution warnings. The *Fort Frances* also located on Merasheen, White Sail, and Oderin Banks a considerable number of uncharted shoals with depths of less than 8 fathoms, which break in heavy weather.

Hydrographic work accomplished consisted of:

Ship sounding	1,691	linear	nautical	miles
Boat sounding	2,483	"	"	"
Coastlining	160	"	"	"
Shoals examined	305			
Oceanographical stations occupied	7			

Conception Bay-Battle Harbour, Nfld. The *Acadia* continued extensive charting operations in the Conception Bay area on the east coast of Newfoundland and carried out shoal examinations in the vicinity of Botwood Harbour and Lewisporte. As its main charting project it extended the Labrador survey from Cape St. Charles to Mary Harbour where, as a result of detailed sounding operations, it disclosed a number of important and hitherto uncharted shoals. At the request of the Department of Transport it calibrated the direction-finding stations at St. Paul Island, Belle Isle, and St. John's, Nfld.

Hydrographic work accomplished consisted of:

Ship sounding	975	linear nautical miles
Boat sounding	1,645	" " "
Coastlining	127	" " "
Shoals examined	95	
Oceanographic stations	12	

INLAND WATER OPERATIONS

Hydrographic work on the Great Lakes was confined mostly to the commencement of a sounding survey on Lake Erie, from Pelee Passage to the mouth of Detroit River, by the echo-sounding launch *Bayfield*, which systematically sounded the waters for old wrecks. The data thus obtained will be helpful in revising shipping routes for the heavy traffic in the area.

In co-operation with the *Radel* of the National Research Council, the *Bayfield* experimented in radar fixing to develop a system of locating a sounding vessel in waters such as those of Lake Erie where hazy weather causes poor visibility and low-lying shores offer few suitable landmarks.

It investigated a number of places in the Bay of Quinte region of Lake Ontario in connection with the possible development of industrial ports, especially for the use of the iron ore project near Marmora. The *Bayfield* also made reconnaissance surveys of the waterfront facilities and seaward approaches to industrial plants near Belleville in Ontario, where new charts are required for deep-draft vessels.

Hydrographic work accomplished consisted of:

Launch sounding	472	linear nautical miles
Shoals examined	4	
Wrecks found	4	

PRECISE WATER-LEVELS

This Section systematically records, tabulates, and co-ordinates the water-level fluctuations of inland navigable waters of Canada. The tabulated data, which are supplied in the form of graphs and bulletins, constitute the basis for regulatory measures for the maintenance of adequate water-levels for navigation, waterpower, and municipal purposes. Various investigations of lake and river levels were undertaken for special purposes. Gauging stations were maintained at 48 locations on the Great Lakes, and the St. Lawrence and Ottawa Rivers, and twelve monthly, five annual, six general data, and five graphic bulletins were issued. The five hydrographs of water-levels since 1860 prepared during the previous fiscal year remained in heavy demand.

TIDAL AND CURRENT SURVEY

This unit conducts tidal and tidal current investigations in Canadian coastal waters and produces the official tidal publications for navigation, engineering, and scientific purposes. Such data along with the information supplied by the Precise Water-levels section are essential to the engineers of the St. Lawrence Seaway Authority.

The unit maintained the series of 15 standard tidal gauging stations on the Atlantic and Pacific coasts and carried out preliminary tidal work required for the establishment of sounding and levelling datums at Kitimat and Kemano on the coast of British Columbia. It also made surveys of currents in the North Channel, which leads from the vicinity of Kingston into the Bay of Quinte. This, and a survey of currents in the St. Lawrence River, near Prescott, were required in the planning of new industrial plants.

The study of oceanographical techniques and instruments was continued and the major survey ships obtained a large number of water samples and bathythermograph records.

Hydrographic publications distributed during the year were as follows:

Catalogue of Charts, Sailing Directions, and Tidal Information with index maps	2,110
Navigation charts	52,057
Instructional charts, special charts, etc.	4,261
Pilots and Sailing Directions	1,097
Supplements to Pilots	797
Tide Tables	58,069
Water-level bulletins, graphs, etc., exclusive of those distributed through Notices to Mariners	10,491

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. The total world circulation is, therefore, greatly in excess of the 1951 figures given above.

GEODETIC SURVEY

The Geodetic Survey provides the original surveys that form the framework or basic control for mapping throughout Canada and for engineering and surveying projects related to natural resources development. To establish control to a degree of accuracy and density commensurate with the needs of various public and private agencies, the Division determines latitudes and longitudes of carefully selected and marked points, and elevations above mean sea-level.

Twenty-one parties were assigned to field work in various parts of Canada compared with thirty during the previous fiscal year. Approximately 90 per cent of the work was related directly or indirectly to the defence effort. Increasing use was made of shoran, the new method of survey that has rendered possible the extension of control into remote areas in a much shorter time than would be required by the conventional type of triangulation. Although it does not attain the degree of accuracy of first-order triangulation, shoran makes it possible to place the relative positions of isolated points much more accurately than by astronomic methods.

During the past three field seasons an extensive shoran net has been established in northern Canada with the co-operation of the Royal Canadian Air Force, the National Research Council, and the Meteorological Service of the Department of Transport. This net now provides control for an area extending from southern Manitoba to northern Saskatchewan, thence to the Mackenzie River watershed and down it to the Arctic Ocean. To satisfy the widespread demand for information concerning the application of shoran to geodetic control twelve semi-technical papers were published in the Canadian Surveyor and a comprehensive report concerning Canada's efforts in the development of shoran was given by the Dominion Geodesist at the Ninth General Conference of the International Union of Geodesy and Geophysics held at Brussels during the year.

As a result of field operations during 1951, the following information was added to the available system of control: first-order triangulation, 425 miles, 46 stations; second-order triangulation, 315 miles, 99 stations; precise levelling, 816 miles, 619 bench marks; precise and exploratory astromonic stations 10; base lines 4; shoran, 65 measured lines, 20 stations.

Over 1,500 level publications were distributed in response to the numerous requests for level data, mainly for use in connection with geophysical investigations for oil in the Prairie Provinces.

TRIANGULATION

Control was established over more territory than in previous seasons because the shortage of university undergraduates gave rise to the employment of seasonal labour on field parties. This in turn led to the prolongation of the field season and thus to the completion of establishments.

Seven field parties carried out primary and secondary triangulation in widely separated areas.

In northern British Columbia a party completed 125 miles between Watson Lake and Fort Nelson of the gap of 375 miles in the primary net that was started at Whitehorse in 1945 to provide control for surveys and mapping of the Alaska Highway and the area adjacent to it. Two parties successfully completed the highly important primary net, 210 miles in length, between Prince George and Dawson Creek, which forms a connecting link in a number of extensive triangulation loops.

In Ontario a party operating between Schreiber and Port Arthur in the Thunder Bay district completed 90 miles of the main primary net of southern Canada, which when finished will extend from St. John's, Newfoundland, to the Pacific coast. A gap of 375 miles of this net remains to be completed between Lake Nipigon and the triangulation net along the International Boundary in southeastern Manitoba.

In northern Quebec and Labrador the 630-mile net inaugurated in 1945 was carried to Fort Chimo. This net, which extends southward to Seven Islands on the Gulf of St. Lawrence, provides a basis from which further control may be carried to other parts of this area of iron ore and possible base metal interest and for topographical mapping of the area. The party also obtained control for five topographic sheets in the Wabush Lake area.

In Newfoundland a party extended a secondary triangulation net along the southern coast and Burin Peninsula, tying control to four stations on St. Pierre and Miquelon established by a commission of the National Geographic Institute of France, and to stations in Argentia established by the United States Coast and Geodetic Survey.

At the request of Dominion Steel and Coal Corporation Limited, Sydney, Nova Scotia, a scheme of second order accuracy was developed in the Sydney area to ensure against error in underground and under-the-sea surveys. The positions of a large number of control points were established and lines of accurate bearing were opened to meet company requirements.

At the request of the Defence Research Board, a party carried out a special project comprising a combined precise traverse and triangulation to determine the relative positions and elevations of four kino-theodolite stations in Prince Edward county in Ontario. The resultant computed and adjusted information indicated an accuracy of 1 in 30,000.

GEODETIC ASTRONOMY AND ISOSTASY

Four field parties measured base lines in the Alaska Highway net at Lower Post and at Rolla, British Columbia, and obtained precise astronomical observations for Laplace data at six stations to control the primary and secondary triangulation nets. Four stations were observed by the exploratory method in connection with the reconnaissance for the shoran net.

Two base lines at Fort Mackenzie and at Fort Chimo were measured by the triangulation party engaged in completion of the second-order net between the Gulf of St. Lawrence and Ungava Bay.

At the request of the National Research Council, precise astronomical observations were carried out relative to the installation of a cosmic ray reflector at Goth Hill near Ottawa.

Two stations were established during winter operations along the 60th parallel to demarcate the boundary between British Columbia and the Northwest Territories.

MATHEMATICAL ADJUSTMENTS

A readjustment of the primary arc between Williams Lake and Smithers, British Columbia, was undertaken, which closes a large loop with an axial length of 1,400 miles.

PRECISE LEVELLING

In Yukon a party completed 285 miles of precise levelling from near Whitehorse on the Alaska Highway to Mayo Landing and Mayo Lake via the new Mayo road and established the elevations of 143 bench marks. It also completed an additional 31 miles of levelling and established the elevations of 15 bench marks in Alberta.

A single unit party operating along the north shore of the St. Lawrence River in Quebec ran a line of precise levels between St. Simeon and Baie Comeau, a distance of 152·6 miles, and along a spur line from Kenogami to Chutes aux Galets. It also re-established with geodetic accuracy the elevations of five tidal bench marks previously established by the Canadian Hydrographic Service.

Another party established the elevations of a large number of bench marks and natural features in the Ottawa and Hull area in co-operation with the Topographical Survey, which was engaged in obtaining horizontal and vertical control for an air photographic test range.

In Newfoundland a double unit party ran a line of precise levels 234 miles and established 114 bench marks between Quarry and Port-aux-Basques on the main line of the Canadian National Railways, thus completing the precise levelling program inaugurated in that province during the 1949-50 field season. The party also levelled 9·4 miles and established 8 bench marks on the branch line to the Ernest Harmon Air Force Base.

The total mileage of levelling by provinces in the Canadian net at the end of the fiscal year was as follows:

—	Primary	Secondary	Public works	Total
Newfoundland	905	.....	.....	905
Prince Edward Island	284	.....	.....	284
Nova Scotia	779	.....	309	1,088
New Brunswick	1,106	.....	403	1,509
Quebec	4,509	1,431	1,750	7,690
Ontario	7,307	1,324	2,012	10,643
Manitoba	2,963	468	113	3,544
Saskatchewan	4,203	5,098	.....	9,301
Alberta	4,199	3,799	.....	7,998
British Columbia	5,608	52	.....	5,660
Northwest Territories	93	.....	.....	93
Yukon	1,423	26	.....	1,449
Minnesota, U.S.A.	89	.....	.....	89
Vermont, U.S.A.	6	.....	.....	6
New York State, U.S.A.	15	.....	.....	15
	33,489	12,198	4,587	50,274

Mileage and Bench Marks by Provinces, 1951

Province	Mileage		Bench marks	
	Primary	Secondary	Primary	Secondary
Newfoundland	243	.....	122	.....
Quebec	187	70	104	235
Alberta	31	.....	15	.....
Yukon Territory	285	.....	143	.....
	746	70	384	235

INTERNATIONAL BOUNDARY COMMISSION

The function of the International Boundary Commission is to provide for the maintenance of an effective boundary line between Canada and the United States and Canada and Alaska. The Canadian and United States sections of the Commission each 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 in Ottawa or Washington to co-ordinate the work of the two Sections, to sign letters of transmittal, certificates for their annual joint reports, and statements of divisible expenditures, and to discuss boundary matters in general.

CONFERENCES OF THE COMMISSIONERS

At conferences held in Ottawa, February 20-23 and May 15, the Commissioners agreed upon matters concerning the west off-shore range tower at Point Roberts, the Tongass Passage-Mount St. Elias report, and boundary maintenance operations during the summer of 1951. At a third conference, held in Washington, November 26-29, the Commissioners signed the topographical maps Nos. 1 and 2 that are to be included in the atlas of 13 topographical maps to accompany the Tongass Passage-Mount St. Elias report; revised certain parts of the galley proofs of the report; and reviewed the entire boundary situation between the two countries.

MAINTENANCE OF THE BOUNDARY

A contract was let for the removal of the leaning 60-foot steel range tower off the west shore of Point Roberts to a new location near the middle road at Point Roberts and its re-erection on a 30-foot steel substructure on a concrete foundation, thus increasing its height from 60 to 90 feet. Late in March 1951, the engineers of each section of the Commission met in Vancouver, British Columbia, to survey a site the correct distance south from the boundary line for the tower to serve as a rear range mark to range the boundary across both the Strait of Georgia and Boundary Bay. The reconstruction of the tower was completed on July 31. A lighting system was installed on the top of the tower, consisting of a 100-watt bulb affixed at the centre of the tower, which shines in all horizontal directions, and a red light with a 100-watt bulb on the railing at the same elevation as the centre light. All wires on the tower are enclosed in metal conduits.

The east and west range towers on Point Roberts were similarly wired. The wiring on the east tower had been contrary to provincial regulations as the wires had not been insulated and there was no switch box to prevent a short circuit from affecting the main line. The lamp on the west tower that had been operated by wet batteries was converted to take a 20-watt bulb.

A daylight beacon was constructed on the concrete base from which the leaning tower had been removed.

Approximately 33 miles of the British Columbia-Washington section of the International Boundary from Columbia Valley near Chilliwack to the Strait of Georgia was inspected. About 25 miles of vista was recleared to the prescribed 20-foot sky line width and 55 monuments were inspected, all of which were found in good condition. During the previous inspection in 1948 most of these monuments had been scraped and painted with aluminium paint for the preservation and better visibility of the metal shafts. Many of these monuments were repainted and a few that had not been done in 1948 were scraped and painted.

Maintenance operations started in 1950 on the southwest section of the Quebec-Maine boundary were resumed. Starting near St. Pamphile, work was completed on the southwest line, the south line, and the southwest branch of St. John River to the Quebec-Maine Highlands section of the boundary, a distance of about 80 miles. About 39 miles of sky-line vista was recleared on the land section and 12 miles of cross-line vista on the river section. Of the 82 monuments inspected on the southwest and south lines, 10 were repaired and one was re-established in a new position. Two new monuments were placed at the sides of a new road crossing the boundary. On the southwest branch of St. John River, 98 monuments which reference the boundary turning points in the river were inspected and found in good condition.

OFFICE

Field reports of the above-mentioned operations were completed, including the re-establishment of the determinations on the 1927 North American geodetic datum of boundary monuments and the establishment during the year of new boundary monuments and other boundary markers. The first galley proof of the Tongass Passage-Mount St. Elias report was received from the printers early in November and work on the report, which is completed to the first page-proof stage, is proceeding on the running heads and index.

The present Canadian member of the Commission, J. E. R. Ross, Dominion Geodesist, was appointed as of December 19, 1951, to replace J. Leslie Rannie, whose retirement took effect on the previous day.

LEGAL SURVEYS AND AERONAUTICAL CHARTS

The Division makes legal surveys of Crown lands in the right of Canada or under the administrative control of the Federal Government in Yukon, Northwest Territories, national parks, and Indian lands and reserves; examines and records survey returns; plots planimetric base maps from tri-camera aerial photographs; records terrain profile by radar altimeter; prepares aeronautical flight manuals, landing charts, and electrical maps; and distributes maps, publications, and aeronautical charts.

Legal Surveys

Provincial Boundary Surveys

The spread of oil exploration north from the Peace River area into Northwest Territories has emphasized the need for the demarcation of provincial and territorial boundaries on the ground.

The Alberta-Northwest Territories boundary was surveyed and monumented during the fiscal year from the Mackenzie highway westerly 105 miles to its terminus at longitude 120° W. One hundred and ten miles of this boundary remains to be surveyed.

The survey of the Alberta-British Columbia Boundary was continued northerly for 37 miles, leaving the 48 miles to its junction with the Alberta-Northwest Territories boundary to be surveyed.

Indian Reserve Surveys

At the request of the Indian Affairs Branch, Department of Citizenship and Immigration, miscellaneous surveys were carried out on the following Indian reserves:

New Brunswick	Woodstock
Quebec	Pierreville and Caughnawaga
Ontario	Sarnia, Kettle Point, Tuscarora, Golden Lake, Saugeen, Mattagami, Sand Point, Nipigon
Manitoba	Fairford, Lizard Point, The Pas, Carrot River
Saskatchewan	Assiniboine, Sakimay
Alberta	Swan River, Peigan
British Columbia	Nanaimo, Cowichan, Musqueam, Metlakatla, Qualicum, Seechelt, Upper and Lower Nicola, Saanich

Territorial Land Surveys

Yukon. Two parties operated in Yukon. One completed the survey of 100 claims in the Galena-Keno Hill area and the second carried out the following surveys:

A proposed Indian reserve in the vicinity of Burwash Landing.

An extension to the city of Whitehorse, a school site within the city limits, and a cemetery site adjacent to the city.

Three homestead lots in the vicinity of Carmacks.

A repeater station site for the Department of Transport.

Telephone line rights-of-way at Watson Lake and at Haines Junction.

An area of land on the Alaska Highway for the Department of Resources and Development.

A hydro-electric power development at Fish Lake.

An oil pipeline right-of-way through three lots along the Alaska Highway.

The intersection of the Alaska Highway right-of-way with the boundaries of a lot near Burwash Landing.

Other Surveys. At the request of the Department of Resources and Development, surveys were made in the following national parks: Point Pelee, Ontario; Riding Mountain, Manitoba; Prince Albert, Saskatchewan; Elk Island, Alberta; Yoho, British Columbia; and historic sites were surveyed at Cobden, Ontario, and at Batoche, Saskatchewan.

Ninety-two and one-half miles of the west boundary of Wood Buffalo Park was surveyed, the cost of that part of 75 miles lying within Alberta being borne in equal parts by the Provincial and Federal Governments.

At the request of the Department of Justice, the boundaries of the Royal Canadian Mounted Police barracks at Rockcliffe, Ontario, were delineated and a survey was made on the penitentiary reserve at New Westminster, British Columbia.

Office

The Division made 189 miscellaneous plans, tracings, and Indian location ticket sketches; prepared 13 maps showing the boundaries of Indian agencies in British Columbia; added information to 271 plans and to 1,038 blue-prints of plans, chiefly of Indian reserves; prepared field notes of 96 mineral claims in Yukon for record purposes; examined field notes of the 1950-51 survey of the Alberta-British Columbia boundary and prepared abstracts from records of monuments, elevations, and azimuth observations thereon, and processed the returns of miscellaneous surveys in Indian reserves and Crown lands.

It recorded 102 plans and 33 field books in the survey records of the Indian Affairs Branch, Department of Citizenship and Immigration, and 160 plans and 53 field books in Legal Surveys records; deposited 74 plans for registration in the Land Titles Office at Dawson, Yukon, and 4 for registration in the Land Titles Office for Northwest Territories at Ottawa; examined 340 plans and 153 field books of legal surveys; dispatched 2,484 letters, 3,593 blue-prints and "OGE" prints and 1,165 photostatic copies of survey records; prepared 319 legal descriptions for use in land conveyances, 102 descriptions of mineral claims and 120 descriptions for petroleum and natural gas permit applications.

It revised the article on "Computation of the Tables of the Altitude and Azimuth of Polaris" for a new supplement to the Manual of Instructions for the survey of the public lands of Canada.

AERONAUTICAL CHART

The Division supplies topographical material from tri-camera photography for the construction of aeronautical charts required for civil and military use and compiles all air information shown on these charts.

Air Photogrammetry

Plots from tri-camera photographs at scales of 1 mile and 1½ miles to 1 inch were made of the following areas:

National Topographic Series Index No.	Area plotted Square miles
46	1,800
53	5,000
56	27,668
64	600
65	18,560
66	56,989
75	2,787
76	50,493
78	10,158
79	840
Total	174,895

The Division indexed and filed 10,000 tri-camera photographs and prepared operational flight line maps covering 170,000 square miles for completion of the tri-camera photography program for Canada.

The plot of the northern section of Frobisher Bay was revised at the request of the Canadian Hydrographic Service and several small plots were prepared to facilitate legal surveys in Indian reserves.

Chart Construction and Air Information

The Division prepared 15 new air information plates and revised 147 plates of the 8 miles to 1 inch series of aeronautical charts, and prepared 11 new plates and revised 34 plates of the 1:1,000,000 scale. To date, 43 map-sheets of the latter series have been printed, leaving 22 sheets to complete the 65 charts necessary to cover all Canadian territory, as required by the International Civil Aviation Organization.

Seven aeronautical charts were revised for the Royal Canadian Navy.

The compilation was completed of a new World Aeronautical Planning Chart, scale 1:5,000,000, the base of which has been taken from the 100-mile map of Canada.

At the request of the Royal Canadian Air Force, a special Georef 10-minute grid was prepared for overprinting on those sheets of the World Aeronautical Chart 1:1,000,000 series falling within the Air Defence identification zone. To date six of this series have been overprinted for the Air Defence Command.

Canada Air Pilot

Amendments to "The Canada Air Pilot" are sent to subscribers fortnightly.

Compilation was completed on a full revision of the seaplane base synoptic pages for Volume I of "The Canada Air Pilot".

Four new aerodrome pages were published and 446 pages, including the instrument approach procedure for 120 aerodromes, were revised.

Sixteen new approach and landing charts were published and 18 were revised; 15 new radio facility charts were published and 25 were revised; and 9 let down charts for the instrument landing system were revised.

Columbia River Basin

Thirty-two of the 89 detailed and contoured topographical map-sheets requested by the Engineering Board, Canadian Section, International Joint Commission, on a scale of $\frac{1}{2}$ mile to 1 inch, have been printed or proofed. During the fiscal year 5 sheets were printed and the compilation of another 7 sheets was completed. Field parties obtained data for 14 sheets leaving 14 sheets for the completion of the field work.

Radar Altimetry

Recordings of 8,671 line miles of ground profile were received from commercial companies in completion of contracts connected with radar altimetry surveys of a 70,000-square mile area in Quebec-Labrador and a 78,832-square mile area in Alberta-Northwest Territories. An additional 5,000 line miles of profile was recorded by personnel of the Division during Royal Canadian Air Force photographic operations in scattered northern areas, bringing the year's total to 13,671 line miles, and the grand total, since the work began in 1948, to 33,073 line miles.

By the end of March 1952 spot heights and 500-foot contours had been obtained from ground profile records over areas totalling 164,981 square miles in Quebec, Labrador, and Ontario. In addition, profiles are available for 201,963 square miles, covering all of Newfoundland and an area south of Great Slave Lake in Northwest Territories.

A final report on a research operation carried out to determine the value of radar altimetry to mapping in general is awaiting analysis by National Research Council photogrammetrists.

SURVEY RECORDS AND ELECTORAL MAPS

Survey Records

The Division records survey returns and supplies information from records to mapping services of the Federal and Provincial Governments, private mapping companies, and individuals.

During the fiscal year, 1,845 townships plans, 423 settlement plans, and 2,017 photostatic copies of survey records were dispatched.

Electoral Maps

A description of electoral districts in Northwest Territories and a map showing the boundaries thereof were prepared and supplied to the Chief Electoral Officer for the Northwest Territories Council elections being held in September 1952. Descriptions were also prepared of the five electoral districts of the Yukon Territorial Council for the Commissioner of Yukon.

Population maps of each province based on the 1951 census were prepared for the Chief Electoral Officer. Data were prepared for the Redistribution Committee being appointed to adjust representation in the House of Commons in accordance with the 1951 census.

The locations of all post offices opened in 1951 and to the end of March 1952 were added to the individual electoral district maps.

Miscellaneous

The original survey returns of the British Columbia-Yukon Boundary from Teslin Lake to Tatshenshini River were checked and a detailed report was prepared for the Boundary Commissioners. The geographical co-ordinates of all the permanent monuments along the Manitoba-Ontario boundary from the 12th base line to Hudson Bay were tabulated for the Boundary Commissioners.

Census divisions in Newfoundland were plotted, and areas of land and fresh water in the province were calculated for the Dominion Bureau of Statistics.

Astronomical field tables for the altitude and azimuth of the Pole Star and for the right ascension and declination of the sun for 1952 were prepared for reproduction.

A total of 387 air line distances were supplied as requested, mainly to the Post Office Department.

MAP DISTRIBUTION OFFICE

During the year 37,643 requests for maps, charts, and publications were dealt with, an increase of over 3,000 over that of 1950-51. The total volume of maps distributed shows an increase of 15,703 over the previous year. Two hundred and sixty-four new maps and 26 new aeronautical charts were received from the press.

The following material was distributed:

	1951–52	1950–51
National Topographic series maps	169,092	152,752
National Topographic series—National Defence maps	93,267	77,508
Aeronautical and plotting charts	331,278	169,034
Sectional maps	11,674	17,289
Old Geographic series	3,604	3,910
Miscellaneous maps	67,715	243,284
Forestry maps	5,004	43
Electoral district maps	4,338	8,219
Publications	5,789	4,019
Total distribution exclusive of Canada Air Pilot	691,761	676,058
Canada Air Pilot (Volumes I and II)—		
Volumes	259	189
Amendments	41,452	49,304
Sheets	29,333	20,768

BOARD OF EXAMINERS FOR DOMINION LAND SURVEYORS

The Board held three meetings: the first, under the provisions of the Dominion Lands Survey Act, was for the special purpose of exploring, along with R. G. Dick, Surveyor General of New Zealand, the possibility of establishing reciprocity in regard to qualification and employment among land surveyors throughout the British Commonwealth of Nations. The second, held under the provisions of the Canada Lands Surveys Act, was to recommend to the Minister the appointment of special examiners. The third was the regular annual meeting called for by Section 10 of the Canada Lands Surveys Act. During this meeting examinations were held at Ottawa, Saskatoon, Edmonton, and Vancouver.

Eleven out of 32 candidates were successful in the preliminary examination; 10 out of 17 in the final examination; and 1 out of 4 in part one of the examination for Dominion Topographical Surveyors.

Thirteen final candidates were commissioned as Dominion Land Surveyors. Certificates were issued to ten preliminary candidates, and four Dominion standard measures of length were supplied to Dominion or Provincial land surveyors.

MAP COMPILATION AND REPRODUCTION DIVISION

The Division prepares, draughts, and reproduces maps, charts, and plans for lithographic printing and multi-colour. This work includes the compilation, draughting, and photo-reproduction of air chart bases; the reproduction and printing of air information for Canadian aeronautical charts; the revision, draughting, and printing of all topographical maps of the Branch except those printed by the Army Survey Establishment; and the reproduction and printing of all hydrographic charts. The Division also reproduces and prints some of the maps prepared by other units of the Department and provides a service to government departments for photographic reproductions, photostats, and black and blue-line printing.

New methods of reproduction involving the use of plastics were put into use during the past fiscal year.

The Division printed 567 maps and charts and produced 1,311,872 copies of these compared with 568 maps and charts and 1,011,425 copies during the previous fiscal year. These included 11 new Canadian sheets of the World

Aeronautical Charts series at 1:1,000,000 (approximately 16 miles to 1 inch) scale, produced under Canada's agreement with the International Civil Aviation Organization; 25 revisions of 8 miles to 1 inch aeronautical charts of areas in Canada; 3 new navigation plotting charts at 1:3,000,000 (approximately 48 miles to 1 inch) scale, covering the whole of Canada for the R.C.A.F.; 11 new and 11 revised topographical maps at 4, 2, and 1 mile to 1 inch; 5 additional new sheets of the Columbia River Basin series; 86 hydrographic charts of coastal and inland waters; a revision of the 100-mile natural resources map of Canada; and 14 geological maps or figures.

COMPILING

New compilations included: 4 World Aeronautical Charts at 1:1,000,000; 2 special 8-mile aeronautical charts for the R.C.A.F.; 19 National Topographic series maps; and 2 of a new series of 13 aeronautical route charts at 1:1,000,000 covering the more heavily travelled air routes in Canada. Full or part revisions compiled included twenty-eight 8-mile aeronautical chart bases, and 15 National Topographic series maps.

Summary of Compilation

—	Scale	First edition	Revised editions
Standard aeronautical charts	8 mi.	.....	12
Preliminary aeronautical charts	8 mi.	.....	16
Special aeronautical charts	8 mi.	2	.....
National Topographic series	1:250,000	19	8
National Topographic series	2 mi.	.....	3
National Topographic series	1 mi.	.....	4
World aeronautical charts	1:1,000,000	4	.....
Aeronautical route charts	1:1,000,000	2	.....
Miscellaneous	.....	.....	2

COMPUTING

The Division provided co-ordinates for 27 different map-sheets on various projections and at various scales. It computed the location of the military grid for over 100 maps at a scale of 1:50,000 and for 21 maps at a scale of 1:250,000 and supervised the placing of this grid on the 1:50,000 fair copies. It also computed the angle of deviation between true north and grid north for about two hundred 1:50,000 scale maps, and for six Lambert conformal conical projections covering the coastal areas of northern Canada for the Canadian Hydrographic Service.

New and revised maps for which drawings were completed:

—	Scale	Number
Standard aeronautical charts	8 mi.	12
Preliminary aeronautical charts	8 mi.	25
Special aeronautical charts	8 mi.	2
National Topographical series (Map Compilation and Reproduction)	1:250,000, 2 and 1 mile	35
National Topographical series (Topographical Survey)	1:250,000, 2 and 1 mile	94
World aeronautical charts	1:1,000,000	7
Columbia River basin series	1:31,680	4
Overprints	.....	129
Miscellaneous	.....	6

Summary of Work

Photo Processing	
Wet plate negatives (sq. ft.)	1,368
Film negatives (sq. ft.)	8,977
Photo-litho plates	878
Mounted blue lines (F.P.)	494
Multilith plates	434
Photography	
Infra red (plates developed)	3,483
Infra red (enlargements)	3,931
Roll film (developed)	145
Bromide enlargements	3,369
Velox prints	8,767
Transaloid	1,522
Sensitized linen	3,100
Photostats (sheets)	21,065
Contact and Blue Printing	
Blue prints (sq. ft.)	132,778
Vandyke (sq. ft.)	26,266
OCE prints (sq. ft.)	165,419

LITHOGRAPHIC

The new and revised maps printed during the fiscal year are listed in the table at the end of the Division's report. Reprints include nine World Aeronautical charts; fifty-two 8-mile aeronautical charts; seven 4-, 2-, or 1-mile sheets of the National Topographical series; and 29 miscellaneous reprints, including the 35-mile maps of Canada, the 100-mile map of Canada, and maps of 4 national parks.

Summary of Printing

—	Maps published	Total copies	Impressions
New maps printed	25	96,455	641,430
Revised maps printed	53	203,445	906,415
Maps reprinted	108	461,945	1,934,770
Hydrographic charts	86	107,891	466,141
Overprints	295	442,136	442,036
	567	1,311,872	4,390,892

The Army Survey Establishment, in addition to printing the new maps produced by the Topographical Survey, also occasionally assists Map Compilation and Reproduction by printing maps prepared by that Division. In the past year this amounted to 28 maps, made up of 3 new maps, 9 revisions, and 16 reprints.

MULTILITH

A total of 376 jobs were turned out. These included a large number of small maps and charts in three or four colours, such as RF charts and instrument approach and landing charts for the Canada Air Pilot handbook.

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1951-52

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(i) Aeronautical Charts—National Topographic Series				
Quebec	33 NW.	Great Whale	8 mi.	54°00′ to 56°00′	76°00′ to 80°00′	Prelim. edn.—revision
Quebec	34 SE.	Lake Minto	8 "	56°00′ " 58°00′	72°00′ " 76°00′	" "
Quebec	34 SW.	Belcher	8 "	56°00′ " 58°00′	76°00′ " 80°00′	" "
Quebec	34 NE.	Payne Lake	8 "	58°00′ " 60°00′	72°00′ " 76°00′	" "
Quebec	34 NW.	Port Harrison	8 "	58°00′ " 60°00′	76°00′ " 82°00′	" "
Ontario	31 SW.	Toronto-Ottawa	8 "	43°00′ " 46°00′	76°00′ " 80°00′	Stan. edn.—revision
Ontario–U.S.A.	51 NE.	Duluth–Houghton	8 "	46°00′ " 48°00′	88°00′ " 92°00′	" "
Ontario–Manitoba	54 SE.	Cape Tatnam	8 "	56°00′ " 58°00′	88°00′ " 92°00′	Prelim. edn.—revision
Alberta	84 NW.	Hay Lake	8 "	58°00′ " 60°00′	116°00′ " 120°00′	" "
B.C.–Alaska	103 N.	Prince Rupert–Stewart	8 "	54°00′ " 56°00′	128°00′ " 133°00′	Stan. edn.—revision
B.C.–Alaska	114 NE.	Alsek River	8 "	58°00′ " 60°00′	136°00′ " 140°00′	Prelim. edn.—revision
N.W.T.	26 N.	Nettilling Lake	8 "	66°00′ " 68°00′	64°00′ " 72°00′	" "
N.W.T.	27 S.	Home Bay	8 "	68°00′ " 70°00′	64°00′ " 72°00′	" "
N.W.T.	36 N.	Foxe Basin South	8 "	66°00′ " 68°00′	72°00′ " 80°00′	" "
N.W.T.	37 S.	Foxe Basin North	8 "	68°00′ " 70°00′	72°00′ " 80°00′	" "
N.W.T.	37 N.	Cockburn Land	8 "	70°00′ " 72°00′	72°00′ " 80°00′	" "
N.W.T.	38 S.	Pond Inlet	8 "	72°00′ " 74°00′	72°00′ " 80°00′	" "
N.W.T.	45 N.	Southampton I. South	8 "	62°00′ " 64°00′	80°00′ " 88°00′	" "
N.W.T.	46 S.	Southampton I. North	8 "	64°00′ " 66°00′	80°00′ " 88°00′	" "

N.W.T.	46 N.	Melville South	8 "	66°00′ " 68°00′	80°00′ " 88°00′	" "
N.W.T.	47 S.	Melville North	8 "	68°00′ " 70°00′	80°00′ " 88°00′	" "
N.W.T.	47 N.	Bernier Bay	8 "	70°00′ " 72°00′	80°00′ " 88°00′	" "
N.W.T.	48 S.	Admiralty Inlet	8 "	72°00′ " 74°00′	80°00′ " 88°00′	" "
N.W.T.	57 N.	Boothia	8 "	70°00′ " 72°00′	88°00′ " 96°00′	" "
N.W.T.	75 N.	Artillery Lake	8 "	62°00′ " 64°00′	104°00′ " 112°00′	" "
N.W.T.	97 N.	Amundsen Gulf	8 "	70°00′ " 72°00′	120°00′ " 128°00′	" "

(ii) Other National Topographic Series Maps

Quebec	31 K/NE.	Tomasine	2 mi.	46°30′ to 47°00′	76°00′ to 77°00′	Revision
Quebec	31 I/NW.	St. Michel	2 "	46°30′ " 47°00′	73°00′ " 74°00′	"
Ontario-Quebec	31 F/NE.	Fort Coulonge	2 "	45°30′ " 46°00′	76°00′ " 77°00′	"
Ontario	41 H/SE.	Parry Sound	2 "	45°00′ " 45°30′	80°00′ " 81°00′	"
Ontario	53 B	North Cariboo Lake	1:250,000	52°00′ " 53°00′	90°00′ " 92°00′	New
Ontario	53 C	North Spirit Lake	1:250,000	52°00′ " 53°00′	92°00′ " 94°00′	"
Manitoba-Ontario	53 E	Island Lake	1:250,000	53°00′ " 54°00′	94°00′ " 96°00′	"
Manitoba	62 I	Selkirk	4 mi.	50°00′ " 51°00′	96°00′ " 98°00′	Revision
Manitoba	63 H	Norway House	4 "	53°00′ " 54°00′	96°00′ " 98°00′	"
Saskatchewan	73 N	Dillon	1:250,000	55°00′ " 56°00′	108°00′ " 110°00′	"
B.C.	92 L/7	Nimpkish	1 mi.	50°15′ " 50°30′	126°30′ " 127°00′	"
B.C.	93 M	Hazelton	1:250,000	55°00′ " 56°00′	126°00′ " 128°00′	"
B.C.	94 D	McConnell Creek	1:250,000	56°00′ " 57°00′	126°00′ " 128°00′	New
N.W.T.	75 M	McKay Lake	1:250,000	63°00′ " 64°00′	110°00′ " 112°00′	"
N.W.T.	75 N	Walmsley Lake	1:250,000	63°00′ " 64°00′	108°00′ " 110°00′	Revision
N.W.T.	75 O	Artillery Lake	1:250,000	63°00′ " 64°00′	106°00′ " 108°00′	New

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1951-52—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
			(ii) Other National Topographic Series Maps—Concluded			
N.W.T.	76 C	Aylmer Lake	1:250,000	64°00′ to 65°00′	108°00′ to 110°00′	New
N.W.T.	76 D	Lac de Gras	1:250,000	64°00′ " 65°00′	110°00′ " 112°00′	"
N.W.T.	85 H	Fort Resolution	1:250,000	61°00′ " 62°00′	112°00′ " 114°00′	"
N.W.T.	86 A	Fort Enterprise	1:250,000	64°00′ " 65°00′	112°00′ " 114°00′	"
N.W.T.	86 E	Leith	1:250,000	65°00′ " 66°00′	118°00′ " 120°00′	Revision
N.W.T.	86 F	Camsell River	1:250,000	65°00′ " 66°00′	116°00′ " 118°00′	New
			(iii) World Aeronautical Charts			
Manitoba–Sask.	2142 (64)	Cochrane River	1:1,000,000	56°00′ to 60°00′	96°00′ to 104°00′	First edition
B.C.	2215 (92)	Fraser River	1:1,000,000	48°00′ " 52°00′	120°00′ " 129°00′	"
B.C.	2186 (93)	Parsnip River	1:1,000,000	52°00′ " 56°00′	120°00′ " 128°00′	"
B.C.	2139 (94)	Beatton River	1:1,000,000	56°00′ " 60°00′	120°00′ " 128°00′	"
B.C.–Alberta	2216 (82)	Kootenay River	1:1,000,000	48°00′ " 52°00′	112°00′ " 120°00′	"
N.W.T.	2058 (27-37)	Rowley River	1:1,000,000	68°00′ " 72°00′	64°00′ " 80°00′	"
N.W.T.	2037 (38-28)	Eclipse Sound	1:1,000,000	72°00′ " 76°00′	64°00′ " 80°00′	"
Y.T.–N.W.T.	2115 (95)	Redstone River	1:1,000,000	60°00′ " 64°00′	120°00′ " 128°00′	"
Y.T.–N.W.T.	2116 (105)	Macmillan River	1:1,000,000	60°00′ " 64°00′	128°00′ " 136°00′	"
Y.T.–N.W.T.	2078 (106-116)	Peel River	1:1,000,000	64°00′ " 68°00′	128°00′ " 145°00′	"
Y.T.–N.W.T.	2062 (107-117)	Firth River	1:1,000,000	68°00′ " 72°00′	128°00′ " 144°00′	"

(iv) Columbia River Basin Series

B.C.	15	Lower Arrow Lake area	1:31,680	49°19′ to 49°28′	117°44′ to 118°09′	First edition
B.C.	16	Lower Arrow Lake area	1:31,680	49°28′ " 49°52′	118°04′ " 118°11′	"
B.C.	19	Upper Arrow Lake area	1:31,680	50°18′ " 50°34′	117°50′ " 117°58′	"
B.C.	23	Lower Arrow Lake area	1:31,680	48°59′ " 49°07′	117°13′ " 117°30′	"
B.C.	52	Upper Kootenay River area	1:31,680	49°16′ " 49°24′	115°05′ " 115°25′	"

(v) Miscellaneous

Canada		Natural Resources of Canada	100 mi.			Revision
Saskatchewan		Prince Albert Park	2·37 mi.	53°35′ to 54°20′	105°35′ to 106°45′	"

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment, Fiscal Year, 1951-52

Location	Number	Name	Scale	Latitude	Longitude	Remarks
N.S.	11 K/6	Margaree	1 mi.	46°15′ to 46°30′	61°00′ to 61°30′	First edition
N.S.	21 A/15	Gaspereau Lake	1 "	44°45′ " 45°00′	64°30′ " 65°00′	"
N.S.	21 B/9	Centreville	1 "	44°30′ " 44°45′	66°00′ " 66°30′	"
N.B.	21 I/4	Chipman	1 "	46°00′ " 46°15′	65°30′ " 66°00′	"
N.B.	21 J/1	Minto	1 "	46°00′ " 46°15′	66°00′ " 66°30′	"
Quebec	32 A/16	Dolbeau	1 "	48°45′ " 49°00′	72°00′ " 72°30′	"
Ontario	41 G/10	Great Duck Island	1 "	45°30′ " 45°45′	82°30′ " 83°00′	"
Ontario	41 G/14	Meldrum Bay	1 "	45°45′ " 46°00′	83°00′ " 83°30′	"

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment, Fiscal Year 1951-52—Continued

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Ontario	41 G/15	Silverwater	1 mi.	45°45′ to 46°00′	82°30′ to 83°00′	First edition
Ontario	41 H/12	Manitowaning	1 "	45°30′ " 45°45′	81°30′ " 82°00′	"
Ontario	41 H/13	Little Current	1 "	45°45′ " 46°00′	81°30′ " 82°00′	"
Manitoba	52 L/5	Pointe du Bois	1 "	50°15′ " 50°30′	95°30′ " 96°00′	"
Manitoba-Ontario	52 L/14	Garner Lake	1 "	50°45′ " 51°00′	95°00′ " 95°30′	"
Manitoba-Ontario	52 M/13	Aikens Lake	1 "	51°00′ " 51°15′	95°00′ " 95°30′	"
Manitoba	62 H/1	Sundown	1 "	49°00′ " 49°15′	96°00′ " 96°30′	"
Manitoba	62 H/2	Tolstoi	1 "	49°00′ " 49°15′	96°30′ " 97°00′	"
Manitoba	62 H/9	Richer	1 "	49°30′ " 49′45°	96°00′ " 96°30′	"
Manitoba	62 H/10	Ste. Anne	1 "	49°30′ " 49°45′	96°30′ " 97°00′	"
Manitoba	62 H/16	Vivian Station	1 "	49°45′ " 50°00′	96°00′ " 96°30′	"
Manitoba	62 I/1	Molson	1 "	50°00′ " 50°15′	96°00′ " 96°30′	"
Manitoba	62 I/7	Red River Delta	1 "	50°15′ " 50°30′	96°30′ " 97°00′	"
Manitoba	62 I/8	Lac du Bonnet	1 "	50°15′ " 50°30′	96°00′ " 96°30′	"
Manitoba	62 I/16	Black River	1 "	50′45° " 51°00′	96°00′ " 96°30′	"
Manitoba	62 N/3	Roblin	1 "	51°00′ " 51°15′	101°00′ " 101°30′	"
Manitoba	62 N/6	Angling Lakes	1 "	51°15′ " 51°30′	101°00′ " 101°30′	"
Manitoba	62 N/14	Durban	1 "	51°45′ " 52°00′	101°00′ " 101°30′	"
Manitoba	62 N/15	Pine River	1 "	51°45′ " 52°00′	100°30′ " 101°00′	"
Manitoba	62 P/5	Harwill	1 "	51°15′ " 51°30′	97°30′ " 98°00′	"

Manitoba	62 C/8	Camping Islands	1 "	52°15′ " 52°30′	100°00′ " 100°30′	"
Saskatchewan	63 L/16	Annabel Lake	1 "	54°45′ " 55°00′	102°00′ " 102°30′	"
Manitoba	64 C/6	Kadeniuk Lake	1 "	56°15′ " 56°30′	101°00′ " 101°30′	"
Manitoba	64 C/7	Watt Lake	1 "	56°15′ " 56°30′	100°30′ " 101°00′	"
Manitoba	64 C/8	Turnbull Lake	1 "	56°15′ " 56°30′	100°00′ " 100°30′	"
Manitoba	64 C/11	McGavock Lake	1 "	56°30′ " 56°45′	101°00′ " 101°30′	"
Manitoba	64 C/12	Laurie Lake	1 "	56°30′ " 56°45′	101°30′ " 102°00′	"
Manitoba	64 C/14	Lynn Lake	1 "	56°45′ " 57°00′	101°00′ " 101°30′	"
Manitoba	64 F/3	Goldsand	1 "	57°00′ " 57°15′	101°00′ " 101°30′	"
Manitoba	64 F/1	Melvin Lake	1 "	57°00′ " 57°15′	100°00′ " 100°30′	"
Manitoba	64 K	Whiskey Jack Lake	4 mi.	58°00′ " 59°00′	100°00′ " 102°00′	"
Manitoba	64 L	Wollaston Lake	4 "	58°00′ " 59°00′	102°00′ " 104°00′	"
Saskatchewan	73 K/8	Island Hill	1 mi.	54°15′ " 54°30′	108°00′ " 108°30′	"
Saskatchewan	73 K/9	Waterhen Lake	1 "	54°30′ " 54°45′	108°00′ " 108°30′	"
Saskatchewan	73 K/10	Flotten Lake	1 "	54°30′ " 54°45′	108°30′ " 109°00′	"
Saskatchewan	73 K/13	Primrose Lake	1 "	54°45′ " 55°00′	109°30′ " 110°00°	"
Saskatchewan	73 K/14	Kesatasew	1 "	54°45′ " 55°00′	109°00′ " 109°30′	"
Alberta	73 L/6	Maloy	1 "	54°15′ " 54°30′	111°00′ " 111°30′	"
Saskatchewan	73 P/7	Stanley	1 "	55°15′ " 55°30′	104°30′ " 105°00′	"
Saskatchewan	73 P/8	Nistowiak Lake	1 "	55°15′ " 55°30′	104°00′ " 104°30′	"
Saskatchewan	73 P/9	Guncoat Bay	1 "	55°30′ " 55°45′	104°00′ " 104°30′	"
Saskatchewan	73 P/10	Otter Lake	1 "	55°30′ " 55°45′	104°30′ " 105°00′	"
Saskatchewan	73 P/15	Forbes Lake	1 "	55°45′ " 56°00′	104°30′ " 105°00′	"
Saskatchewan	73 P/16	Settee Lake	1 "	55°45′ " 56°00′	104°00′ " 104°30′	"

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment, Fiscal Year 1951-52—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Alberta	83 L/3	Copton Creek	1 mi.	54°00′ to 54°15′	119°00′ to 119°30′	First edition
Alberta	84 D/SW.	Cherry Point	2 mi.	56°00′ " 56°30′	119°00′ " 120°00′	"
Alberta	84 I/11	Stovel Lake	1 mi.	58°30′ " 58°45′	113°00′ " 113°30′	"
Alberta	84 I/12	Buchanan Lake	1 "	58°30′ " 58°45′	113°30′ " 114°00′	"
N.W.T.	85 B/12	Sandy River	1 "	60°30′ " 60°45′	115°30′ " 116°00′	"
N.W.T.	85 B/13	Hay River	1 "	60°45′ " 61°00′	115°30′ " 116°00′	"
N.W.T.	86 B/11	Origin Lake	1 "	64°30′ " 64°45′	115°00′ " 115°30′	"
B.C.	93 P/NE.	Dawson Creek	2 mi.	55°30′ " 56°00′	120°00′ " 121°00′	"
B.C.	93 P/NW.	Moberley Lake	1 "	55°30° " 56°00′	121°00′ " 122°00′	"
B.C.	94 A/NW.	Blueberry River	1 "	56°30′ " 57°00′	121°00′ " 122°00′	"
B.C.	94 A/NE.	Rose Prairie	1 "	56°30′ " 57°00′	120°00′ " 121°00′	"

GEOLOGICAL SURVEY OF CANADA

W. A. Bell, Director

Eighty-eight parties were assigned to field work throughout Canada, approximately the same number as in the previous fiscal year. In addition, local investigations were made in various parts of the country in connection with reported occurrences of radioactive or other strategic minerals. The field program was designed mainly to help meet the growing need for information on sources of mineral raw materials, but included also the systematic mapping and investigation of areas of potential interest and studies of ground water supplies in a number of areas.

The increasing importance of oil and gas developments in western Canada caused the Survey to again direct much of its field and office work to problems relating to present and future explorations for these two fuels. The various services of its Calgary office, established in 1950, were used extensively by company geologists and others actively interested in the search for oil and gas. At Ottawa, visiting oil geologists employed in Canada were provided with temporary office accommodation, and the records and facilities were placed at their disposal.

Field investigations on radioactive mineral occurrences were concentrated mainly in northern Saskatchewan, where important deposits have been discovered, some of which are being developed toward production. A handbook on "Uranium Prospecting in Canada" was published as a convenient and comprehensive guide to prospectors searching for uranium ores.

Much information was collected on various other strategic minerals, including mica, and ores of tungsten, manganese, chromium, antimony, cobalt, and molybdenum, for use in reports that are to be published on available resources of these minerals.

To aid in the search for minerals about 10,000 specimens submitted for examination were identified and reported on, and more than 88,000 mineral and rock specimens were distributed. As agent for the Atomic Energy Control Board, the Geological Survey tested more than 5,000 samples for radioactivity and supplied several hundred identifications of radioactive minerals.

Approximately 160,000 reports, maps, and other publications were distributed to the public during the fiscal year.

Many visitors from other countries were made acquainted with various phases of the work of the Geological Survey, and ideas were exchanged on comparable efforts abroad. Several of its geologists presented papers at the Annual Meeting of the Canadian Institute of Mining and Metallurgy held in Ottawa in January 1952 and at other scientific meetings in Canada and the United States.

The second report on current geological research in Canada was prepared at the request of the National Advisory Committee on Research in the Geological Sciences. The report is essentially an annual compilation or bibliography of the geological research being conducted by Federal and Provincial Government agencies, by mineral exploration companies, by individuals, and by Canadian universities and other institutions.

Through their retirement on superannuation in February 1952, the Geological Survey lost the services of Dr. B. R. MacKay and Dr. F. H. McLearn, two outstanding Canadian geologists.

Dr. MacKay joined the Survey in 1910 and during most of his career in the government service had been closely associated with the coal industry in his capacity of senior coal geologist. The Report of the Royal Commission on Coal, published in 1946 bears the imprint of his wealth of knowledge of this industry for it was he who worked out the estimates it contains of the

coal resources of Canada, a painstaking task requiring a specialized knowledge of the many formations and the ability to give proper weight to the many technological and economic factors involved.

Dr. McLearn was chief of the Survey's Palæontological Division on his retirement. Like Dr. MacKay, his work brought him honoured recognition from various learned societies and he recently won the highest scientific award granted by the Academy of Sciences, Washington, D.C. During the past decade in particular his work has been of inestimable value in the exploration for oil and gas in western Canada. He was succeeded as Chief of the Palæontology Division by Hans Frebold.

REGIONAL GEOLOGY DIVISION

Forty-four of the fifty-two geologists assigned to field work were engaged in the normal program of geological study and mapping in potential mineral and fuel areas of Canada, and eight carried on special detailed studies in relation to mineral deposits and strategic minerals. In the office, the filing of all available geological information on Canadian mineral occurrences was continued.

Field Work

Seven of the fifty-two parties operated in the Northwest Territories, 5 in Yukon, 13 in British Columbia, 2 in Alberta, 2 in Saskatchewan, 2 in Manitoba, 1 in Ontario, 3 in Quebec, 4 in Quebec and Labrador, 2 in New Brunswick, 1 in Nova Scotia, 6 in Newfoundland, and 4 in two or more provinces or territories.

Standard geological mapping on scales of 1 inch to 1 mile or 4 miles was conducted in 34 areas across Canada. Reconnaissance surveys were made in three regions in the Arctic islands and one on the coast of Labrador. Detail mapping was continued in the Yellowknife gold belt, Northwest Territories, and in Dasserat township, Quebec, and was commenced in the Gatineau National Park, Quebec. Other field activities included mineralogical studies of uranium-bearing deposits in northern Saskatchewan and investigations of occurrences of strategic minerals in western, eastern, and northern regions of Canada.

NORTHWEST TERRITORIES AND ARCTIC

F. Q. Barnes commenced and completed geological mapping of the McLean Bay area (longitude 110° to 110° 30′, latitude 62° 15′ to 62° 30′) on the south shore of the east arm of Great Slave Lake. There are occurrences of radioactive minerals in this and adjacent areas.

R. W. Boyle continued a detailed study of mineral deposits in the Yellowknife gold belt, with special reference to the temperature of formation of vein quartz and other minerals, to determine the mineralization sequence and zonal relationships of the orebodies, and the directional source of the mineralizing solutions.

I. C. Brown completed detailed geological mapping of the Yellowknife gold belt, which includes three producing gold mines and embraces a mineralized area about 2 miles wide and 20 miles long.

W. L. Davison completed geological mapping of the Lake Harbour area (longitude 69° 30′ to 70°, latitude 62° 45′ to 63°) in southern Baffin Island, and continued a reconnaissance along the south coast of the island westerly to the 74th meridian. Mineral occurrences, in rocks resembling the Grenville series of eastern Canada, include mica, graphite, lapis lazuli, iron and copper sulphides, magnetite, and some radioactive vein material.

A. B. Irwin, resident geologist at the Survey's Yellowknife office, visited active mining properties in western Northwest Territories to keep information up to date on mining developments. As supervisory petroleum engineer, he visited wells drilled by N.W.T. Petroleums Limited at Fort Providence and Mills Landing on Mackenzie River; made an inspection trip of staked oil permits in dispute south of Hay River; and visited the Alberta Petroleum and Natural Gas Conservation Board in Calgary, and offices and field establishments of oil companies in Alberta.

G. C. Riley conducted a geological reconnaissance of the west, north, and northeast shores of Cumberland Sound, Baffin Island (longitude 64° 38′ to 65° 17′, latitude 64° to 66° 01′). The rocks are mainly gneissic granitic types with some bands of metamorphosed limestone, the whole intersected by a few small basic dykes. No significant mineral deposits were observed.

R. B. Rowe made a detailed study of the mineral-bearing pegmatites of the Yellowknife-Beaulieu River area. These carry beryl, spodumene (a source of lithium), and columbite-tantalite, all of which are strategic minerals.

R. Thorsteinson continued a geological reconnaissance of Cornwallis Island, with particular reference to the stratigraphy and palæontology of its thick series of mainly Silurian dolomite and limestone. The strata are folded and appear to include petroliferous horizons.

YUKON TERRITORY

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.

J. E. Muller continued geological mapping of the Kluane Lake area (longitude 138° to 140°, latitude 60° to 61°), from which considerable placer gold is obtained and which contains coal and gypsum deposits and occurrences of copper minerals.

R. Mulligan continued geological mapping of the Teslin area (longitude 132° to 134°, latitude 60° to 61°), which is traversed by the Alaska Highway and includes parts of the Canol and Atlin roads. It has provided some placer gold.

W. H. Poole commenced geological mapping of the Wolf Lake area (longitude 130° to 132°, latitude 60° to 61°), traversed in the southeast by the Alaska Highway, from which some prospecting has been done and a variety of mineral occurrences discovered.

J. O. Wheeler completed geological mapping of the Whitehorse area (longitude 134° to 136°, latitude 60° to 61°), a potential source of a variety of ores and minerals, with a long and productive mining history.

BRITISH COLUMBIA

J. D. Aitken commenced geological mapping of the Atlin area (longitude 132° to 134°, latitude 59° to 60°). Placer operations for gold are in progress on Spruce and McKee Creeks, and for gold and tungsten on Boulder Creek. A lead-zinc mine is being developed, and some prospecting is in progress on wolframite (a source of tungsten) and asbestos showings.

J. E. Armstrong continued geological mapping of the Vancouver North area (longitude 123° to 123° 30′, latitude 49° 15′ to 49° 30′), and commenced geological mapping in the New Westminster area (longitude 122° 30′ to 123°, latitude 49° to 49° 15′). Evidence of mineralization is widespread in these areas.

R. L. Christie continued geological mapping of the Bennett area (longitude 134° to 136°, latitude 59° to 60°), which contains numerous occurrences of copper, copper-gold, gold telluride, gold-silver, lead-zinc, and antimony ores.

W. E. Cockfield, in charge of the British Columbia Office of the Geological Survey, visited several mining properties to obtain information for other government departments.

S. Duffell continued geological mapping of the Whitesail Lake area (longitude 126° to 128°, latitude 53° to 54°), which occupies part of the eastern flank of the Coast Range batholith, and where recent prospecting has revealed lead-zinc, gold, and tungsten-bearing deposits. Principal present activity in the area is the work of Aluminum Company of Canada Limited preparatory to driving a 10-mile tunnel westward from the head of Tahtsa Lake.

H. Gabrielse continued geological mapping of the McDame area (longitude 128° to 130°, latitude 59° to 60°), which is connected by road to the Alaska Highway on the north. Recent discoveries have included an important asbestos deposit, a variety of metallic mineral occurrences, and some coal.

L. H. Green studied wall-rock alterations of the lead-zinc deposits in the limestones of the Salmo area. Each deposit was found to be within a dolomite envelope, which knowledge should form a useful guide in the search for deposits and in the exploration and development of known deposits.

A. G. Jones completed geological mapping of the Revelstoke area (longitude 118° to 119°, latitude 50° to 51°) in which are located the Cherry Creek gold placers, several gold-bearing quartz deposits, a gold-antimony property in the vicinity of Monashee Pass, and the Big Ledge zinc deposit west of Upper Arrow Lake. Elsewhere in the area are abundant pegmatitic rocks carrying a variety of strategic minerals.

E. D. Kindle examined mineral deposits in the vicinity of Hazelton and Smithers preparatory to issuing a revised edition of a report (Memoir 223) on the mineral resources of these areas.

G. B. Leach continued geological mapping in the St. Mary Lake area (longitude 116° to 116° 30′, latitude 49° 30′ to 49° 45′), in which is the great Sullivan zinc-lead-silver mine and numerous other mines and prospects.

H. W. Little investigated the tungsten deposits of the Nelson district, in the course of which he devoted much of his attention to the detailed mapping of selected areas near Salmo, including the Emerald tungsten mine.

J. E. Reesor continued geological mapping of the Dewar Creek area (longitude 116° to 116° 30′, latitude 49° 45′ to 50°) 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.

J. A. Roddick continued geological mapping of the Coquitlam area (longitude 122° 30′ to 123°, latitude 49° 15′ to 49° 30′).

H. W. Tipper continued geological mapping of the Nechako area (longitude 124° to 126°, latitude 53° to 54°). Large parts of the area are drift covered and much of it is underlain by Tertiary volcanic rocks in which several occurrences of perlite have been noted. A dam being constructed by Aluminum Company of Canada Limited on Nechako River near the centre of the map-area will result in flooding the several main water routes to the west, and an effort has been made to study all outcrops along these routes before this occurs.

R. J. W. Douglas completed geological mapping in the Waterton area (longitude 113° 30′ to 114°, latitude 49° to 49° 15′) and measured three sections of the Rundle and upper Banff formations in the Moose Mountain area and one in the Mount Head area. The work is intended to assist present explorations for oil and gas in this general region.

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

SASKATCHEWAN

D. A. W. Blake mapped geologically the Nevins Lake area (longitude 107° 45′ to 108°, latitude 49° 45′ south to the north shore of Lake Athabasca), in which some prospecting has been done for uranium and nickel minerals. He also studied exposures of Athabasca sandstone and the formation of sand dunes on the south shore of the lake.

W. E. Hale mapped the Black Bay area (longitude 108° 45′ to 109°, latitude 59° 30′ to 59° 45′), which contains uranium-bearing deposits.

MANITOBA

J. C. McGlynn completed geological mapping of the Elbow Lake area (longitude 100° 30′ to 101°, latitude 54° 45′ to 55°) and commenced work on the eastern half of the adjoining Naosap Lake area (longitude 101° to 101° 15′, latitude 54° 45′ to 55°). Gold and base metal deposits, many of them old prospects, occur in these areas associated chiefly with north-trending shear zones. He also examined a tungsten property on Snow Lake.

T. Podolsky continued geological mapping of the Cranberry Portage area (longitude 101° to 101° 30′, latitude 54° 30′ to 54° 45′), in which are a producing gold mine and several gold and base metal properties and prospects.

QUEBEC

J. F. Henderson commenced a detailed study and mapping of Gatineau National Park north of Ottawa.

W. G. Johnston continued detailed geological mapping in Dasserat township in the region of the Cadillac-Larder Lake mineral belt, part of which is obscured by the overlying Cobalt sedimentary series. The entire township is staked and is being prospected in places by geophysical methods and by drilling.

A. S. MacLaren commenced remapping the geology of the Amos area (longitude 78° to 78° 30′, latitude 48° 30′ to 48° 45′), which is underlain mainly by acidic to basic volcanic rocks. The area contains gold and base metals and is traversed northerly by a wide esker ridge that has provided gravel for adjacent roads, and water for the town of Amos.

NEW BRUNSWICK

F. D. Anderson completed geological mapping of the Millville area (longitude 67° to 67° 30′, latitude 46° to 46° 15′) and commenced mapping the adjacent Woodstock area (longitude 67° 30′ to the Maine boundary, latitude 46° to 46° 15′), in which are manganese deposits.

R. Skinner commenced geological mapping of the Bathurst area (longitude 65° 30′ to 66°, latitude 47° 30′ to 47° 45′), which contains iron and lead-zinc-silver deposits.

NOVA SCOTIA

I. M. Stevenson completed geological mapping of the Truro area (longitude 63° to 63° 30′, latitude 45° 15′ to 45° 30′) in which are extensive deposits of limestone and gypsum; a lead-zinc deposit at Smithfield, which is under development; and a barite deposit at Brookfield, which was brought into production in June 1951. Iron and manganese deposits also occur in the area, and coal was mined in the past at Kemptown.

QUEBEC AND LABRADOR

K. E. Eade mapped geologically the Unknown River area (longitude 64° to 65°, latitude 53° to 54°), in which is the Grand Falls of Hamilton River.

W. F. Fahrig completed geological mapping of the Griffis Lake area (longitude 65° 30′ to 66°, latitude 55° to 55° 15′).

M. J. Frarey completed geological mapping of the Willbob Lake area (longitude 66° to 66° 30′, latitude 55° to 55° 15′), which is within the concession of Iron Ore Company of Canada Limited, and where prospecting has revealed a northwesterly trending zone containing a few occurrences of copper and zinc minerals.

J. M. Harrison continued a detailed study of the Burnt Creek range of the Ungava iron belt. He visited some iron properties near Ungava Bay and made a brief visit to Payne Bay on the west coast of Ungava Bay. He supervised the work and servicing of other field parties in the Quebec-Labrador region.

NEWFOUNDLAND

D. A. Bradley completed geological mapping of the 'Terrenceville' area (longitude 54° 30′ to 55°, latitude 47° 30′ to 48°) that was begun in 1947 and continued in 1948 for the Geological Survey of Newfoundland. A large fluorspar deposit lies just south of this area.

A. M. Christie continued a geological reconnaissance of the coast of Labrador commencing at Cape Chidley in the north and continuing south to Port Manvers. The rocks are mainly a complex of older gneisses and anorthosites, overlain unconformably by Proterozoic formations that resemble those of the iron ranges of Labrador and Quebec.

J. Kalliokoski completed geological mapping of the Gull Pond area (longitude 56° to 56° 30′, latitude 49° to 49° 15′). Extensive development work is planned by a subsidiary of Falconbridge Nickel Mines Limited on a large copper deposit at Mineral Point on Gull Pond.

W. D. McCartney commenced geological mapping of the Holyrod area (longitude 53° to 53° 30′, latitude 47° 15′ to 47° 30′). Manganiferous calcareous shales of Cambrian age outcrop in the area and probably extend along the coast east of Duffs to Kelligrews Brook.

T. O. H. Patrick continued geological mapping of the Comfort Cove (Campbellton) area (longitude 54° 50′ to 55°, latitude 49° 15′ to 49° 30′), in which some mineral prospects have been found. He also examined an antimony property at Moretons Harbour on New World Island north of the map-area.

J. W. Scott investigated Cambrian manganese deposits of eastern Newfoundland to acquire information on their grade, thickness, and distribution.

C. H. Smith commenced a study of the ultrabasic intrusive rocks of western Newfoundland and their contained chromite deposits.

GENERAL

J. W. Hoadley examined a large number of mica deposits in Ontario and Quebec preparatory to the compilation of a report on mica in Canada.

H. A. Quinn examined chromite deposits in the Eastern Townships, Quebec, and in the Bird River area, Manitoba, preparatory to the compilation of a report on chromite in Canada.

T. L. Tanton examined iron deposits in McNab and Torbolton townships, Ontario, and Hull township, Quebec.

L. P. Tremblay visited cobalt properties in Ontario in connection with the compilation of a report on the cobalt deposits of Canada.

L. J. Weeks supervised the work of geological field parties in the Maritime Provinces and Newfoundland. He also spent a brief period in southeastern Cape Breton Island to acquire information for a report on that region.

G. M. Wright examined a number of molybdenum deposits in Quebec and Ontario to obtain information for a report on molybdenum in Canada.

PALÆONTOLOGY DIVISION

Eighty-seven palæontological and stratigraphic reports were prepared, based on fossil collections submitted for examination by field officers of the Geological Survey, the Geographical Branch, the British Columbia Department of Mines, and the following commercial organizations: The California Standard Company, Canadian Gulf Oil Company, Hudson's Bay Oil and Gas Company Limited, Imperial Oil Limited, Phillips Oil Company Limited, Socony-Vacuum Exploration Company, Sohio Petroleum Company, Stanolind Oil and Gas Company, Industrial and Domestic Coal Limited, and the Photographic Survey Corporation.

Office work included various researches related to geological exploration and economic development, arising mainly out of the Division's field work. The results of some of these studies will be published during 1952-53.

Dr. F. H. McLearn and Dr. Alice E. Wilson, now retired, kindly undertook the identification of a number of collections, and the benefit of their advice and experience was of material assistance in the work of the Division.

Fossil collections were donated by the above companies and by certain palæontological institutions. Several loans and exchanges of fossil material for comparative study were arranged with university geological departments and other institutions in Canada and abroad.

Field Work

BRITISH COLUMBIA

J. A. Jeletsky continued detailed stratigraphic studies of the fossiliferous Mesozoic and Tertiary formations along the west coast of Vancouver Island between Kyuquot village west of Kyuquot Sound and St. Patrick Beach on the southeast shore of Flores Island.

The study will assist geological mapping in northern Vancouver Island and elsewhere in western Canada where formations of like age are encountered. Considerable thicknesses of marine Tertiary sediments were found in areas previously believed to be underlain by Cretaceous rocks, and their identification offers hope for the eventual discovery of oil-bearing zones similar to those in formations of the same age along the west coast of California and Mexico.

F. J. Wagner made collections of Pleistocene invertebrate fossils in the Vancouver-New Westminster and Horn Lake-Parksville areas of the southwestern mainland and Vancouver Island. The work will assist subsequent correlation of Pleistocene stages in other parts of Canada.

ALBERTA AND BRITISH COLUMBIA

Hans Frebold completed a stratigraphic study of, and fossil collections from, the Jurassic system of the Foothills and eastern Rocky Mountains of southern Alberta and British Columbia as represented by the Fernie group. Results of this study and subsequent investigations of the Fernie group in more northern regions should assist geological mapping and facilitate subsurface studies in the Interior Plains and Foothills.

ALBERTA

P. Harker completed a palæontological and stratigraphic study of Mississippian sections exposed along the eastern Rocky Mountain front between Kananaskis and Jasper. The work will assist geological mapping and should aid subsurface correlations in productive or potential oil and gas fields of western Canada.

D. J. McLaren continued a palæontological and stratigraphic study of exposed type sections of Devonian formations in the eastern Rocky Mountains. Results of these investigations will assist geological mapping, and should facilitate subsurface correlations in the productive or potential oil and gas fields of western Canada.

E. T. Tozer completed a study of non-marine invertebrate faunas from the Upper Cretaceous and early Tertiary formations of the southern plains and foothills of Alberta. The work is intended to assist geological mapping and exporation for coal, oil, and natural gas.

MANITOBA

S. J. Nelson completed a palæontological and stratigraphic field study of Ordovician and younger Palæozoic formations in the vicinity of Churchill, and their relation to possible occurrences of oil or natural gas in the Hudson Bay Lowland.

C. W. Stearn continued a palæontological and stratigraphic field study of Silurian and Devonian formations in the Lake Winnipegosis-Lake Manitoba 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.

QUEBEC

L. M. Cumming completed a field study of the palæontology and stratigraphy of Upper Silurian and Lower Devonian formations in the central Gaspe basin of eastern Gaspe Peninsula. Several oil test-wells are being drilled in the eastern part of the basin, and the Copper Mountain-York Lake area continues to be actively prospected for copper and other mineral deposits.

NEWFOUNDLAND

R. D. Hutchinson commenced a study of the stratigraphy and palæontology of the Cambrian formations of eastern Newfoundland. The work will assist geological mapping and exploration for any contained mineral deposits of economic value.

MINERALOGY DIVISION

Nearly 10,000 specimens of rocks and minerals sent in from all parts of Canada by prospectors and others were identified free of charge and their nature and commercial possibilities were summarized in 2,503 reports and letters. Similar information was provided for about 1,200 visitors.

During the fiscal year, 2,447 collections of Canadian rocks and minerals, comprising 88,224 specimens, were prepared and distributed to prospectors and various mining and educational institutions, and to provincial governments for

redistribution. This service has been maintained by the Geological Survey for more than 50 years, in which time over 2,000,000 specimens have been distributed. Details for the fiscal year follow:

—	Collections	Specimens
British Columbia and Yukon	368	13,962
Northwest Territories	125	3,690
Alberta	201	6,889
Saskatchewan	337	11,754
Manitoba	181	6,201
Ontario	672	23,631
Quebec	496	18,583
New Brunswick	60	2,205
Nova Scotia	37	1,309

Chemical analyses of rocks made to assist geological research included: 11 complete and 6 partial analyses of rocks from the uranium-rich Goldfields and Beaverlodge Lake areas of northern Saskatchewan; 5 from Griffis Lake in New Quebec; and 5 of carbonate rocks from near Yellowknife, Northwest Territories.

A collection of rare minerals was prepared for display in the British Columbia Office of the Geological Survey, Vancouver, and a large mineralogical collection owned by M. W. Maxwell, Chief of Development, Canadian National Railways, Montreal, was reclassified.

Mineral acquisitions during the fiscal year included: half of a meteorite (total weight, 552 grams) presented by Frank Anderson, and found by an Eskimo on the ice at Holman Island in the Canadian Arctic; 25 pounds of titaniferous iron sand from Taranakim, New Zealand, presented by the High Commissioner for Canada; and a very fine specimen of azurite from Chessy, France, presented by Professor Y. Viret, Directeur, Musée des Sciences Naturelles, Lyons, France.

RADIOACTIVITY RESOURCES DIVISION

The Division is concerned with the field and laboratory investigation of Canadian resources of radioactive raw materials, with the maintenance of free testing and advisory services for uranium prospectors, and with the recording of data on Canadian deposits. As agent of the Atomic Energy Control Board, the Geological Survey through the Division receives the results of analyses for uranium and thorium and monthly reports of development on radioactive mineral deposits. This information and other related data are incorporated in a confidential inventory, which is revised annually and which already deals with nearly 600 deposits or occurrences.

In the Radiometric Laboratory, 5,037 samples were tested quantitatively for radioactivity, and results were reported on more than 97 per cent of these within a day of receipt of each sample. Several hundred radioactive and associated minerals were identified and various research projects were undertaken.

In the X-ray diffraction laboratory a diffraction pattern card index covering about 700 mineral species was prepared to assist in future identification of minerals by this method.

The Division installed X-ray fluorescence analyses equipment, believed to be the first in Canada. It has proved especially useful for rapid qualitative and quantitative analysis of minerals, particularly so for the determination of heavy elements such as uranium, thorium, columbium, tantalum, tungsten, and molybdenum.

The spectrographic laboratory rooms were renovated preparatory to the installation of new and efficient equipment for this important type of research. Work in the electronics laboratory was concentrated mainly on rebuilding, improving, and redesigning portable Geiger counters and on servicing laboratory scaling equipment. Experimental work was done on alpha scintillation counters for field and laboratory use.

Field Work

SASKATCHEWAN

K. R. Dawson completed a field study and collection of samples illustrative of wall-rock alteration in uranium-bearing deposits near Goldfields, Lake Athabasca, to determine the relationships of such alteration to the deposition of pitchblende or other radioactive minerals. In addition, comparative studies were made of altered wall-rocks adjacent to other types of mineral deposits in this region.

S. C. Robinson continued field studies of the mineralogy of the various uranium-bearing deposits of northern Saskatchewan. About twenty-five deposits in the Goldfields district, four at Sucker Bay, and six at Charlebois Lake were examined for the first time and several others were revisited for more detailed study and the collection of representative sample material.

S. M. Roscoe examined uranium-bearing deposits in the Goldfields and Charlebois Lake-Black Lake areas of northern Saskatchewan. About thirty companies were active in the Goldfields area and four in the vicinity of Charlebois Lake.

GENERAL

A. H. Lang examined uranium-bearing deposits in the Northwest Territories, Saskatchewan, Ontario, and Quebec, and supervised the field work of parties in northern Saskatchewan.

PLEISTOCENE AND ENGINEERING GEOLOGY DIVISION

Studies of the widespread Pleistocene or glacial drift materials that cover the greater part of Canada are becoming increasingly important as a result of the rapid growth of the country. These materials are a source of road and ballast metal, industrial clays, and cement. They are a principal source of underground water supply that is in increasing demand in urban and industrial areas where a convenient or adequate surface supply is lacking.

Sixteen parties were engaged in the study and mapping of these materials in areas across Canada, or in collecting data on the water supply of these areas. The services of several geologists were required at intervals during the field season on engineering problems involving a knowledge of bedrock and overburden.

Field Work

YUKON TERRITORY

H. S. Bostock and E. B. Owen made a geological investigation of Mayo River Development for the Northwest Territories Power Commission. The Commission is developing a power site on Mayo River that will supply power to mining operations in the Mayo area and to the community of Mayo Landing.

BRITISH COLUMBIA

J. E. Armstrong continued geological mapping of the Pleistocene overburden in the Vancouver North and Vancouver South areas (longitude 123° to 123° 30′, latitude 49° to 49° 30′), and studied ground-water conditions in the Vancouver

South area. He supervised field work on the Pleistocene geology and water supply of the adjacent New Westminster area and in the Horne Lake area on Vancouver Island; and spent a week with provincial soils surveyors in their work in the Okanagan Lake district. He also undertook other work at brief intervals for the British Columbia Department of Agriculture.

W. L. Brown completed mapping the Pleistocene geology of Surrey municipality and about one-third of Langley municipality in the New Westminster map-area (longitude 122° 30′ to 123°, latitude 49° to 49° 15′), and obtained data on ground-water conditions. He visited other parts of the province to investigate ground-water resources and the character and extent of the glacial overburden.

It may be of interest to note that ground-water surveys in lower Fraser Valley, based to date on the completion of Surrey and parts of adjacent municipalities, have shown that ground reservoirs of potable water could supply several times the quantities now being used; that proper irrigation during the dry summer season, in Surrey municipality alone, could result in an annual increase in the value of the mixed crop of upwards of $5,000,000 for a capital expenditure of not more than $1,000,000 and an annual upkeep of $150,000; and that an adequate system of water wells would serve to control local streams and flood conditions more effectively than dykes.

Related studies of Pleistocene (glacial and marine) and Recent deposits in the Vancouver and adjacent areas is proving of great assistance to the important gravel and sand industry of this relatively highly populated region; to the peat and ceramic industries, the former the largest of its kind in Canada; to the many constructional and engineering problems both within and outside the metropolitan areas; to the mapping of soils in the richly agricultural Fraser Valley and Delta; to the problems of drainage and flood control; and to both town and rural planning projects.

R. L. Christie spent a few days in a study and mapping of the ground between Lindeman and Bennett Lakes in the Bennett area to determine the nature and extent of the overburden and the bedrock topography for use of the Northwest Territories Power Commission.

W. E. Cockfield assisted provincial soil survey parties in the Kootenay and Elk River Valleys and conducted ground-water surveys for other government departments in the Terrace and Vanderhoof areas.

J. G. Fyles continued mapping of the Pleistocene geology and a study of ground-water resources in the Horne Lake area (longitude 124°30′ to 125°, latitude 49° 15′ to 49° 30′), Vancouver Island, and extended this work into the adjoining Parksville area (longitude 124° to 124° 30′, latitude 49° 15′ to 49° 30′). The area was selected because of the opportunity it affords for acquiring basic geological data for use in similar studies in other areas.

E. Hall continued his work at Columbia River dam sites, examining and correlating drill cutting and cores for the Engineering and Water Resources Branch, Department of Resources and Development.

At the request of the Engineering and Water Resources Branch, Department of Resources and Development, A. G. Jones examined geological conditions at the Mica Creek proposed dam site on Columbia River between the Big Bend and Revelstoke. He was able to show that the character of the rocks is suitable for the construction of a dam, and in particular to prove that there has been no faulting along the river in the vicinity of the proposed site. In his report to the Department of Resources and Development he directs attention to the large quantities of rich kyanite schists that occur on either side of the dam site.

ALBERTA

B. G. Craig mapped the Pleistocene and Recent overburden in the Drumheller area (longitude 112° to 113°, latitude 51° to 52°). Evidence of at least two and possibly three distinct glaciations was obtained.

W. T. Hatfield continued mapping the Pleistocene geology, and collecting data on the ground-water supply, of the Rycroft-Grande Prairie area (longitude 118° to 119°, latitude 55° to 56°).

E. P. Henderson continued mapping the Pleistocene geology, and collecting data on the ground-water supply, of the Watino-Sturgeon Lake areas (longitude 117° to 118°, latitude 55° to 56°). Two tills were noted in the northern part of the area. Economic deposits are mainly clays and gravels for constructional purposes.

A. M. Stalker continued investigations of Pleistocene geology and ground-water supplies in south-central Alberta. Work has now been completed in the area between longitudes 112° and 114° and latitudes 52° and 53° or, approximately, tps. 43 to 46, rges. 15 to 28, W. 4th mer. Ground moraine covers most of this area, but the area also contains great quantities of pre-Glacial and considerable Pleistocene gravels. A principal feature is the pre-Glacial Red Deer Valley, which extends easterly across the area, has a width of 6 or 7 miles, and is the principal source of gravel and underground water.

MANITOBA

J. A. Elson continued mapping the Pleistocene geology in south-central Manitoba between longitudes 98° and 100° and latitudes 49° and 50° and mapped about fifty townships. He made a brief study of the glaciers of the Rocky Mountains and their deposits, and in addition spent a week in conference with Pleistocene and engineering geologists of the United States Geological Survey in North and South Dakota, learning something of their mapping methods and treatment of problems similar to those encountered in Manitoba.

E. C. Halstead investigated the ground-water resources of tps. 1 to 6, rges. 10 to 15, W. Princ. mer., in southwest Manitoba. He attended the Northern Missouri River Basin Field Conference in North and South Dakota, where he gained valuable information applicable to engineering problems in Manitoba.

ONTARIO

C. Gravenor mapped the Pleistocene and Recent overburden in the Rice Lake area (longitude 78° to 78° 30′, latitude 44° to 44° 15′). The northern third of the area is a drumlin belt; the central third is composed of an overridden interlobate Kame moraine; and the southern third is floored by Glacial Lake Iroquois beach and deep water sediments. The area contains abundant gravel deposits and there is no shortage of ground water.

E. B. Owen mapped the Pleistocene and Recent overburden in parts of Gloucester township, Carleton county, and conducted a ground-water survey of that township. He also obtained information on about 500 water wells within the limits of the city of Ottawa. Most of the township is floored by flat-lying marine sand and clay beds deposited by the Champlain Sea. His work, when completed, will afford information on: the nature and extent of the water-bearing formations and the quality and quantity of water available from each; on the position and probable fluctuation of the water-table; and on the nature, extent, and stratigraphic relationships of the various types of unconsolidated materials and their economic possibilities.

QUEBEC

N. R. Gadd continued a study of Pleistocene and Recent overburden and ground-water resources in Becancour area (longitude 72° to 72° 30′, latitude 46° 15′ to 46° 30′). The Quaternary history of the area is greatly complicated by the intercalation of glacial drift with widespread marine and fluviatile beds.

V. K. Prest commenced geological mapping of the Pleistocene and Recent overburden on the Island of Montreal. This mapping is of special significance in its relation to engineering and building projects within the metropolitan area and to the sources of constructional materials for many of these projects.

E. I. K. Pollitt commenced a detailed study of the ground-water resources of the Island of Montreal, the purposes of the work being to define the position and extent of the water-bearing formations and the quantity and quality of water available from each. The project was undertaken at the request of the local Civil Defence Committee.

NEW BRUNSWICK

H. A. Lee commenced a geological investigation and mapping of the Pleistocene and Recent overburden in the Fredericton area (longitude 66° 30′ to 67°, latitude 45° 45′ to 46°). Esker ridges 20 to 30 feet high can supply large amounts of road gravels. Extensive clay deposits, some suitable for the manufacture of brick and tile, underlie the city of Fredericton and extend westward for at least 3 miles, and bog barrens of sphagnum moss peat can be utilized to agricultural advantage in soils of low humus content.

NOVA SCOTIA

O. L. Hughes commenced geological mapping of the Pleistocene and Recent overburden in the Shubenacadie area (longitude 63° to 63° 30′, latitude 45° to 45° 15′). Two till sheets have been recognized and may represent ice movements from two directions. Gravel deposits and glacial clays in the area are being utilized.

FUELS RESOURCES DIVISION

This Division collects, organizes, and files records of, and samples from, wells drilled for oil and natural gas, and makes technical studies and interpretations of this material, for use by industry in connection with exploratory drilling.

A total of 1,593,874 drill samples are now available for study and reference. During the fiscal year 209,449 samples were received and 87,555 were prepared for examination. Of the samples received, 155,694 were from wells in Alberta; 446 were from a well drilled near Fort Providence, Northwest Territories; 1,260 were from British Cloumbia; 28,067 were from wells drilled in Saskatchewan; 8,019 were from wells drilled in southwestern Manitoba; 14,137 were from Ontario, mainly from wells in the southwestern part of the province; and 1,826 were from wells in the eastern Gaspe region of Quebec.

Acknowledgments are made to the following persons and organizations through whose co-operation information and samples were received: T. B. Williams, Controller of Coal, Petroleum and Natural Gas, British Columbia, for maps showing areas under exploration permit and for well samples; Alberta Petroleum and Natural Gas Conservation Board for periodical drilling reports, interim reports, electrologs, and maps showing drilling areas in Alberta and for well samples; the Department of Resources and Development, Ottawa, for samples of wells drilled in Northwest Territories, and for information on some

wells in Manitoba; the Saskatchewan Department of Natural Resources and Industrial Development for periodical drilling reports, for maps showing areas under lease, and for well samples; to Mrs. Lillian B. Kerr, Manitoba Department of Mines and Natural Resources, for well samples and other information; to R. B. Harkness, Ontario's Natural Gas Commissioner, for drillers' logs and well samples; to Paul Payette of Montreal, for information and well samples from eastern Gaspe; to I. W. Jones of the Department of Mines, Quebec, for descriptive logs of wells drilled in Quebec; to C. S. Evans, Union Gas Company of Canada Limited, Chatham, Ontario, and W. A. Roliff, Imperial Oil Limited, Toronto, for information on wells by their respective companies in Ontario; and to the officials of numerous oil companies for much useful information.

Samples from wells drilled in Ontario and Quebec were examined and descriptive and graphic logs were compiled. Maps showing locations of exploratory and development wells in western Canada were maintained, and special study and mapping of the bedrock topography and drift thickness in southwestern Ontario was initiated. Several articles on oil and gas developments in western Canada were prepared for outside publication.

In co-operation with the Mines Branch, the Geological Survey advises the Department of National Revenue regarding tax benefits on deep test wells. During the fiscal year the Division carried out technical examinations and appraisals of several applications for such benefits.

Its services were extended to visiting geologists of Union Gas Company of Canada Limited, Imperial Oil Limited, California Standard Company, Dominion Glass Company, and Anchor Petroleums Limited, who examined samples and records made available to them.

Western Oil and Natural Gas Office, Calgary

This office was established in 1950 primarily to work on problems of correlation of subsurface formations in western Canada, in order to make these basic geological data available to the oil industry and thereby to aid in the exploration for oil and natural gas. The Calgary office also makes drilling samples available for study and maintains a reference library for the use of the interested public. During the fiscal year geologists of the office continued their detailed studies of Cretaceous, Devonian, and Mississippian formations in Alberta, Saskatchewan, and Manitoba.

Coal Section

Work of this section included: detailed geological mapping of coal deposits in selected coalfields; the collection and compilation of available data on Canada's coal reserves; and assistance in the solution of problems connected with mining developments. An investigation was commenced on the practicability of detecting and correlating coal seams by means of electric logs of bore-holes drilled for oil in central Alberta.

Sydney Office

Coal research investigations were commenced at Sydney, Nova Scotia, in 1949, mainly to make a complete study of the Sydney coalfield. Detailed mapping and field studies of the various coal seams were continued until the end of 1951 when the geologist in charge of the work resigned. However, petrographic studies of the coal from these and other seams, both from eastern and western Canada, has continued. A study was commenced of plant microfossils of the coal deposits of Cape Breton Island.

The work of the Sydney office is intended essentially to assist development and prolong the productive life of the Sydney coalfield and is operated in co-operation with the Nova Scotia Department of Mines and the Nova Scotia Research Foundation.

Field Work

BRITISH COLUMBIA

W. S. Shaw made a detailed investigation of the Princeton and Tulameen coalfields in south-central British Columbia. The coal is of sub-bituminous rank and mid-Tertiary age.

ALBERTA AND BRITISH COLUMBIA

R. de Wit studied exposed sections of Devonian rocks along Clearwater and Athabasca Rivers near McMurray, Alberta, and of Devonian and Mississippian rocks on either side of Peace River west of Hudson Hope, British Columbia. He supplemented this work by a study of diamond-drill cores from formations of the same age drilled in northeastern Alberta.

B. A. Latour visited all operating coal mines in the Coal Branch (Robb, Mercoal, Cadomin, Sterco, Coal Valley, and Luscar), Edmonton, Camrose, Crowsnest Pass, Michel, and Fernie areas, and collected data on the coal seams at these mines.

Jointly with the Fuels Division, Mines Branch, D. K. Norris has been engaged in a detailed and systematic study of the character and distribution of stresses in the Crowsnest Pass collieries, as an aid to unlocking large coal reserves in highly stressed zones. The immediate aim is to interpret the control of observed geological structures over the stress zones delineated by convergence and precise levelling surveys, which necessitates detailed mapping of the structures in the coal measures.

ALBERTA

P. C. Badgley completed a study of the Lower Cretaceous formations in central Alberta, as represented by well cores, drill cuttings, and electric logs of wells, to assist explorations for oil and natural gas.

Helen R. Belyea collected and studied representative samples from well cores in Devonian formations and visited some exposed sections of these formations in the eastern Rocky Mountains.

SASKATCHEWAN

G. H. MacDonald completed examination of all available well cuttings and cores of wells in Saskatchewan that have penetrated Mississippian formations. The work was designed to assess the prospects of this general region for oil and natural gas or other minerals.

SASKATCHEWAN AND MANITOBA

R. T. D. Wickenden and L. L. Price studied and sampled cores at wells in Saskatchewan and Manitoba, to assist subsurface correlation of formations in these provinces.

ONTARIO

E. W. Best commenced a detailed study of the stratigraphy and palæontology of all exposures of pre-Hamilton Devonian formations in southwestern Ontario in order to clarify the stratigraphic position of the American Detroit River series and to facilitate the structural interpretation of these formations in relation to favoured sites for the accumulation of oil or natural gas.

T. E. Bolton completed a study of the Silurian stratigraphy of the Niagara escarpment on the Niagara and Bruce Peninsulas and Manitoulin Island. The work is intended to facilitate subsurface studies in potential oil and gas fields of southwestern Ontario where Silurian formations are not exposed.

J. F. Caley supervised the work of field parties in southern and southwestern Ontario and made an inspection trip to oil and gas fields in Alberta.

B. V. Sanford commenced the work of establishing the elevations of wells drilled for oil and natural gas since 1945 in southwestern Ontario. Such information is of use in preparing maps showing bedrock contours and drift thicknesses in this productive oil and natural gas region.

G. C. Winder commenced geological mapping of early Palæozoic formations in southern Ontario between longitudes of 77° and 78° 30′ and between Lake Ontario and the southern boundary of the Precambrian rocks of the Canadian Shield. The work will assist subsurface studies of these formations in the potential oil and gas fields of southwestern Ontario.

NOVA SCOTIA

T. B. Haites brought detailed study and mapping of the Sydney coalfield close to completion.

GEOPHYSICS

Surveys with the airborne magnetometer were continued and information on selected areas previously surveyed was plotted for publication. From the commencement of this work in 1947 to the end of March 1952, two hundred and twenty-six 15′ x 30′ map-sheets in different parts of Canada have been flown and sixty-four map-sheets published. Fifty-three map-sheets were prepared for publication during the fiscal year.

Field surveys in 1951 covered twenty-six map-areas in the Eastern Townships, Quebec. They required the flying of 38,900 line miles to obtain magnetic profile, and a flying time of 459 hours.

GEOLOGICAL CARTOGRAPHY DIVISION

Maps Published from April 1, 1951, to March 31, 1952

Publication number	Title	Remarks
	CANADA	
900A	Canada, Principal Mining Areas and Producing Mines (second edition); scale, 1 inch to 120 miles	Geology. For separate distribution.
	Geological Map of Canada (patterns); scale, 1 inch to 200 miles	Geology. For separate distribution.
	NORTHWEST TERRITORIES	
50–34	Yellowknife, sheet 4; District of Mackenzie; scale, 1 inch to 500 feet	Preliminary geological map. Paper 50–34.
51–6A	Snowdrift, District of Mackenzie; scale, 1:40,000.	Preliminary geological map. Paper 51–6.
51–8	Carp Lakes, District of Mackenzie; scale, 1 inch to 4 miles	Preliminary geological map. Paper 51–8.
51–14A	Courageous Lake, District of Mackenzie; scale, 1 inch to 1,500 feet	Preliminary geological map. Paper 51–14.
51–18	Giauque Lake (southwest sheet), District of Mackenzie; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 51–18.
51–25A	Christie Bay, District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 51–25.
51–26A	Reliance, District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 51–26.
39G	Yellowknife Bay, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
40G	Prosperous Lake, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
41G	Quyta Lake, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
49G	Preble Island, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
50G	Petitot Islands, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
51G	Wilson Island, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1951, to March 31, 1952—Con.

Publication number	Title	Remarks
	NORTHWEST TERRITORIES—*Concluded*	
52G	Hornby Channel, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
55G	Slave Delta, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
56G	Jean River, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
60G	Rat River, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
61G	Taltson Bay, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
62G	Thubun Lakes, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	BRITISH COLUMBIA	
1000A	Northeastern British Columbia; scale, 1 inch to 10 miles	Geology. For Memoir 259 and separate distribution.
1008A	Mineral Map of British Columbia (2 sheets); scale, 1 inch to 20 miles	Minerals. For separate distribution.
1010A	Ashcroft, Kamloops, Lillooet, and Yale Districts; scale, 1 inch to 4 miles	Geology. For Memoir 262 and separate distribution.
50–26	Vancouver North (East Half); scale, 1 inch to ½ mile	Preliminary geological map. Paper 50–26.
51–4A	Ymir, Kootenay District; scale, 1 inch to ½ mile	Preliminary geological map. Paper 51–4.
	ALBERTA	
996A	Pierre Greys Lakes, West of Sixth Meridian; scale, 1 inch to 1 mile	Geology. For Memoir 258 and separate distribution.
1002A	Geological Map of Alberta; scale, 1 inch to 20 miles	Geology. For separate distribution.
51–22	Pincher Creek, West of Fourth Meridian; scale, 1:40,000	Preliminary geological map. Paper 51–22.
	SASKATCHEWAN	
1007A	Mudjatik-Geikie; scale, 1 inch to 8 miles	Geology. For separate distribution.
1009A	Snake Rapids; scale, 1 inch to 1 mile	Geology. For separate distribution.
51–7A	Forget Lake, Northern Saskatchewan; scale, 1 inch to ½ mile	Preliminary geological map. Paper 51–7.

Maps Published from April 1, 1951, to March 31, 1952—Con.

Publication number	Title	Remarks
	MANITOBA	
1006A	Batty Lake, West of Principal Meridian; scale, 1 inch to 1 mile	Geology. For memoir and separate distribution.
51–3	Sipiwesk; scale, 1 inch to 4 miles	Preliminary geological map. Paper 51–3.
51–17	Cranberry Portage (East Half); scale, 1:40,000	Preliminary geological map. Paper 51–17.
	ONTARIO	
50–29	Perth, Lanark and Leeds Counties; scale, 1:40,000	Preliminary geological map. Paper 50–29.
50–36A	Fenelon Township, Victoria County; scale, 1 inch to 1 mile	Preliminary geological map. Paper 50–36.
51–12A	Cornwall-Cardinal Area, Stormont, Dundas, and Grenville Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 51–12.
45G	Lightning River, District of Cochrane; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
46G	Magusi River, Districts of Timiskaming and Cochrane; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
47G	Larder Lake, District of Timiskaming; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
48G	Aylen River, District of Cochrane; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
67G	Renfrew, Renfrew and Lanark Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
68G	Clyde, Renfrew, Frontenac, and Lanark Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
69G	Sharbot Lake, Frontenac and Lanark Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	QUEBEC	
994A	Magog–Weedon; scale, 1 inch to 2 miles	Geology. For Memoir 257 and separate distribution.
51–23	Griffis Lake (West Half), Territory of New Quebec; scale, 1 inch to ½ mile	Preliminary geological map. Paper 51–23.
36G	Fourniere, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
37G	Amos, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
38G	Kanasuta River, Abitibi and Témiscamingue Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1951, to March 31, 1952—Con.

Publication number	Title	Remarks
	QUEBEC—*Concluded*	
42G	Opasatica, Témiscamingue County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
43G	Desmeloizes, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
44G	Palmarolle, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
71G	Lamorandière, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
72G	Barraute, Abitibi County; scale, 1 inch to 1 mile.	Preliminary aeromagnetic map.
73G	Val d'Or, Abitibi County; scale, 1 inch to 1 mile..	Preliminary aeromagnetic map.
	NEW BRUNSWICK	
1003A	Minto; scale, 1 inch to 1 mile	Geology. For Memoir 260 and separate distribution.
1004A	Chipman; scale, 1 inch to 1 mile	Geology. For Memoir 260 and separate distribution.
1005A	Minto-Chipman (coal deposits); scale, 1 inch to 1 mile	For Memoir 260 and separate distribution.
51–15	Westfield, Kings, Queens, St. John, and Charlotte Counties; scale, 1:40,000	Preliminary geological map. Paper 51–15.
51–19	Hampstead, Queens, Kings, and Sunbury Counties; scale, 1:40,000	Preliminary geological map.
57G	Bathurst, Gloucester and Restigouche Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
58G	Nepisiguit Falls, Gloucester and Northumberland Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
59G	Tetagouche Lakes, Restigouche, Gloucester, and Northumberland Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
64G	Nepisiguit Lake, Restigouche, Northumberland, and Victoria Counties; scale, 1 inch to 1 mile.	Preliminary aeromagnetic map.
65G	Sevogle, Northumberland and Gloucester Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
66G	California Lake, Northumberland, Gloucester, and Restigouche Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	NOVA SCOTIA	
51–11	Springhill, Cumberland and Colchester Counties; scale, 1:40,000	Preliminary geological map. Paper 51–11.

Maps Published from April 1, 1951, to March 31, 1952—Con.

Publication number	Title	Remarks
	NEWFOUNDLAND	
51–1	Gull Pond; scale, 1 inch to 1 mile.....	Preliminary geological map. Paper 51–1.
51–5	Hodges Hill; scale, 1 inch to 1 mile.....	Preliminary geological map. Paper 51–5.
51–9	Harbour Grace, Avalon Peninsula; scale, 1 inch to 1 mile.....	Preliminary geological map. Paper 51–9.
51–13A	Southern Labrador Coast; scale, 1 inch to 4 miles	Preliminary geological map. Paper 51–13.
51–20	Marks Lake; scale, 1 inch to 1 mile.....	Preliminary geological map. Paper 51–20.
51–21A	Burlington Peninsula; scale, 1 inch to 1 mile...	Preliminary geological map. Paper 51–21.

Two maps were prepared to accompany water supply papers. Eighty-four maps and scientific figure drawings were draughted for reproduction by photolithography and by zinc-cut process for illustrating memoirs, reports, articles, and papers.

Three geological maps were at the Printing Bureau at the end of the fiscal year, and two map figures were at the Surveys and Mapping Branch for printing. Seven standard geological sheets, three gravimetric maps, eight preliminary geological maps, one water supply map, and eleven preliminary aeromagnetic maps were in progress in the Division.

BRITISH COLUMBIA OFFICE

The activities of the office increased greatly as a result of expanded interest in mineral development in the province. Close to 4,800 visitors registered at the office and many inquiries were handled by mail and telephone. Altogether, 7,033 reports and 2,845 separate maps were issued in response to requests by the public. Determinations were made of many rock and mineral samples. The office was moved to 300 Pender Street West.

YELLOWKNIFE OFFICE, N.W.T.

This office is in charge of a resident geologist who, in co-operation with the Department of Resources and Development, which administers the Northwest Territories, gives assistance in the prospecting and mining activities of the region and provides field supervision for explorations for oil and natural gas. Its reference library contains air photographs of favourable prospecting areas, and reports and maps relating particularly to the geology and mineral deposits of the Northwest Territories are available for distribution. The office co-operates with the Yellowknife Branch of the Canadian Institute of Mining and Metallurgy in the annual courses for prospectors that the Branch sponsors.

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LIBRARY

Acquisitions:

Books acquired by purchase	567
Books (complete unbound volumes by purchase)	550
Books by transfer, exchange, and gift	451
Canadian periodicals	1,586
Canadian Government publications	2,685
British and foreign Government publications	3,399
Proceedings, transactions, and bulletins of societies	3,965
British and foreign periodicals	6,202
Total	19,405

Other data:

Recorded loans of books, pamphlets, and periodicals	19,841
Inter-library and occasional loans	3,067
Books borrowed from other libraries	441
Maps and charts added to the library	1,834
Maps and charts borrowed from the library	378
Lantern slides borrowed	1,306
Lantern slides added to library	945
Cards added to slide catalogue	2,042
Photographs loaned (exclusive of albums)	1,398
Volumes bound	550
Volumes accessioned	1,568
Cards added to general catalogue	16,656
Cards added to map catalogue	498
Letters and cards received	3,854
Letters and cards sent	6,759
New serials received and catalogued	219

PHOTOGRAPHIC SECTION

This Section handles all the photographic work relating to field photography and airborne magnetometer surveys, and to the exacting requirements of reproducing for illustrations, mineral specimens, fossils and other scientific material. It also provides photographic work relating to geological map reproduction. The output of the Section included the following major items:

Kodalith and Vandyke negatives and prints	4,346
Exposures developed, field work	4,920
Contact prints, up to 40" x 49"	18,194
Bromide enlargements, up to 36" x 40"	5,347
Magnetometer film developed	41,475 feet
Magnetometer film printed	98,690 feet

REPRODUCTION PROCESSES

This Section produces, chiefly, the maps and reports that enter into the make-up of the Preliminary Papers, Geophysics Papers, Water Resources Reports, and other reports that provide special and immediate information to the public. The principal output comprised:

Blueprints, blue lines, etc.	468,796 square feet
Océ prints	19,535 square feet
Photostats (18" x 22")	8,402 sheets
Mimeograph	1,333,373 impressions

LAPIDARY

Mineral and rock specimens were prepared for scientific study, as follows:

Thin sections	4,146
Polished sections	80

MINES BRANCH

John Convey, Director

The number of research projects and investigations under way was greater than in any previous year owing chiefly to increased ore dressing tests on radioactive and other strategic minerals, an expanded program of research to assist the coal industry, coupled with an increased demand for metallurgical work arising out of the defence program, as well as from the Atomic Energy project at Chalk River, Ontario.

A pressure-leaching process for treating sulphide ores for the recovery of elemental sulphur and of by-product iron was developed on a laboratory scale. Should the process prove to be commercially suitable it would be applicable in particular to the treatment of the sulphide minerals, pyrite and pyrrhotite, that are available in large amounts in several Canadian base metal deposits. Two new leaching methods designed to reduce the costs of uranium extraction are under development and pilot-plant tests are planned. Extensive extraction tests were carried out for the Crown-owned Eldorado Mining and Refining (1944) Limited, and the company was aided in the design and installation of new mill equipment.

In the work on coal a field staff made preliminary studies of rock pressures in western coal mines. Strain-measuring apparatus was designed for use in obtaining data that will assist operators in reducing or overcoming the rock bursts that beset the extension of mining to greater depths. Field technical assistance to operators in the design of processes to improve the grade of their coal products was extended.

As noted in previous reports the Branch has been co-operating with McGill University in efforts to develop a satisfactory coal-fired gas-turbine engine. It is expected that trial runs of the complete prototype engine, with coal as fuel, will commence before the close of 1952. It should be emphasized, however, that the project is still in the development stage and there is as yet, no sound basis for predicting the outcome.

Continuing its efforts to develop new products from Canadian industrial minerals, the Branch, in one project, processed over 600 samples of shales and clays to show the possibilities for establishing new industries to produce bloated light-weight concrete aggregates. It made large-scale tests of processes developed in its laboratories for producing high-grade silica sand from available deposits of impure sandstone for use in making artificial abrasives and glass. The data obtained were made available to industry for use in the design of plants to produce the sand. Other work on the industrial minerals included the following:

Commencement of an investigation to determine the practicability of producing kyanite for special refractories from a deposit of granitic gneiss; investigation of anorthosite rock, abundant in Quebec, as a flux for ceramic products; experimental work on the production of ceramics for electronics uses; research to develop production of super-duty and high alumina firebrick not hitherto made in Canada; and continuation of a special survey of Newfoundland's mineral resources, and of the survey of the industrial water resources of Canada.

Research on titanium was in the forefront of the defence projects. Headway was made in three directions: a new pressure-leaching technique was applied successfully on laboratory scale to ilmenite ore to yield pure titanium dioxide; another process was developed on a similar scale that seems to show some promise of producing a method of reducing titanium dioxide to titanium metal; and experimental techniques were applied on a small scale that resulted

in working the metal into sheet, rod, and forgings. It is planned to develop these processes further in view of the importance of titanium metal in the defence effort and because Canada is now a leading producer of titanium ore as a result of recent developments in the Allard Lake area in eastern Quebec. The titanium product being recovered at present from this ore is in the form of a crude oxide slag that is exported to the United States. The recovery of titanium metal awaits the development of an economic method.

Work was continued on the development of alloy metals for prototype defence equipment. In the field of high-temperature alloys a modified "Kinsalloy" was produced for testing for jet engine use at temperatures higher than those for which the original alloy was designed. Further development of ZK61, an alloy of magnesium, zinc, and zirconium, has brought it into commercial use in aircraft construction.

Several projects were started for use of the Royal Canadian Navy, one of special importance, being related to metallurgical control over manufacture of rotors for escort vessels.

In another defence project the installation in a cold room of special control equipment designed in the Branch was completed in preparation for a series of tests to determine methods suitable for the welding of equipment and structures under Arctic winter conditions.

Work for the Atomic Energy project at Chalk River, Ontario, increased in scope and urgency because of metallurgical problems related to the materials for the new reactor. By the end of the fiscal year new laboratories to expedite this work were nearly ready for installation of equipment.

The steady upsurge of interest in the development of Canada's mineral resources has led to a marked increase in requests for information on undeveloped mineral occurrences and dormant mining properties throughout Canada. Toward meeting these requests the Branch from time to time issues mimeographed reports containing pertinent condensed information on Canadian occurrences of the separate metals and minerals currently to the forefront. During the fiscal year, for instance, it issued a report on pyrite deposits in Canada and is now preparing a report on iron ore occurrences in Canada that essentially brings up to date a report on this subject issued many years ago. Much of the information requested is contained in an inventory of Canada's mineral resources, which the Branch has been building up over the years with the co-operation of the provincial departments of mines. Extensive use was made of this inventory during the fiscal year, particularly by exploration companies interested in the re-examination of mineral properties.

Jointly with the Geological Survey of Canada, the Branch issued a revised map of Canada, on a scale of 120 miles to the inch, showing the principal mining areas and the locations of producing mines. Another map issued jointly with the Geological Survey shows the relationship of coal and iron ore areas and of major iron and steel producing areas to the proposed St. Lawrence waterway.

A special section with staff, space, and services, continued to be provided at the Mines Branch for producing and repairing anti-submarine equipment for the Canadian Navy. Processing of quartz for radio-frequency control units for the Armed Services was continued and research into the use of piezo-electric ceramics was begun. All quartz for governmental use was inspected and graded by this section.

MINERAL RESOURCES DIVISION

The Division is concerned with all matters of an economic nature pertaining to the development, utilization, and conservation of Canada's mineral resources, and more particularly of its metallic mineral resources.

Its basic activity in that connection is the collection and addition to its records, accumulated over many years, of all current significant data from all available sources on the exploration and exploitation of Canada's mineral deposits; on mine operators and operations; on the processing, uses, and marketing of minerals; on mining laws and taxation; and on all developments in and outside of Canada that may be of significance to the future development of Canada's mineral and allied industries. Based on this wealth of accumulating mineral and related data the Division provides general information and economic investigatory services that are used freely by prospectors and mine operators, by government departments, and by others interested in one or other of the many economic aspects of Canada's mineral development.

Since the end of the war special attention has been directed to the compilation of a Canadian mineral resources inventory in which is recorded significant information relative to the location and operational history of each mineral property that has at any time been under exploration or development. The Division has obtained the active co-operation of all provincial Departments of Mines in making available up-to-date mineral development data for the inventory. The practical value of the inventory was demonstrated during the year in the furnishing of leads to mining and mineral exploration companies and prospectors in their search for dormant strategic mineral properties that, under conditions arising from the defence needs, might warrant re-examination as prospective producers.

Field investigations included brief visits to the base metal operations of Quebec, to antimony prospects in the Maritime Provinces, and to iron ore deposits under exploration in eastern Ontario.

Special attention was given to the continuing economic difficulties of the gold mining industry arising from the increasing post-war costs of production with no compensating increases in the price of gold. The Division assisted the Director General of Scientific Services in administering the Emergency Gold Mining Assistance Act, which had been amended to apply to gold produced and sold in 1951. Two of its engineers comprise a small administrative unit that receives the applications for cost-aid under the Act, and with the co-operation of the Cost Inspection and Audit Division of the Office of the Comptroller of the Treasury processes them for approval for payment. Field inspectional work required to ensure observance of the regulations relating to allowable exploration and development expenditures was made of all lode gold mines receiving assistance, mostly by one of these engineers. Much time was given by another officer to special problems arising in the course of administration, and to related studies for the information of the Government in considering assistance policies.

The Division co-operated, through the Director General of Scientific Services, with the Department of National Revenue in administering sections of the Income Tax Act and Regulations relating especially to mine operators. Letters of comment and opinion were prepared on thirty-two applications addressed to that Department from mining companies under Section 74, Income Tax Act, which provides for a 3-year tax exemption of new metalliferous mines and of new industrial mineral mines certified by the Minister of Mines and Technical Surveys to be based on non-bedded deposits. Eight applications for certification by the Minister, of industrial mineral mines based on non-bedded deposits as required to qualify for percentage depletion allowance, were

examined and the necessary submissions for the Minister's consideration were prepared. The Geological Survey of Canada co-operated in all cases where the Minister's certification was required.

Submissions were prepared, also with the co-operation of the Geological Survey, for the Minister's information in considering six 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 wells as approved.

A senior engineer of the Division was the official Canadian representative at the First Inter-American Convention on Mineral Resources held at Mexico City from October 29 to November 4.

The Chief of the Division continued on loan throughout the year to the Non-Ferrous Metals Division, Department of Defence Production, for duties at Washington, D.C.; and at the request of the same Department another engineer was likewise on loan to its Non-Ferrous Metals Division, as from early November 1951.

In co-operation with other divisions of the Branch and with the Geological Survey, reviews for 1950 were issued on each of the metals and minerals produced in Canada in that year. Reflecting the heightened interest in Canadian mineral development, the demand for these annual reviews has shown a marked increase in recent years. A survey of the copper resources of Canada was issued in the form of a mimeographed report, and a survey of iron ore occurrences in Canada is in course of preparation. Substantial progress was made on the revision of "Summary Review of Dominion Tax and Other Legislation Affecting Canadian Mining Enterprises". The Division co-operated with the Geological Survey in the revision of its map of Canada showing the principal mining areas and producing mines; and in the preparation of a map of parts of North and South America showing the relationship of coal and iron ore areas and of major iron and steel producing areas to the projected St. Lawrence deep waterway.

Studies were made of Canada's non-ferrous base metals ore reserves, and of the productive potentialities of the known zinc deposits of eastern Canada.

LIBRARY

The Mines Branch Library is attached to the Division for administrative purposes. In addition to the normal library services, its research section conducts extensive searches for reference material required by the engineers and scientists of the Branch in their many and varied technological researches.

Acquisitions:	
Canadian Government documents	1,997
British and foreign Government documents	2,107
Scientific societies' publications	1,285
Periodicals	5,841
Books and pamphlets purchased	492
	11,722
Recorded loans, inclusive of Branch circulation of periodicals (11,818) and inter-library loans (borrowed 692, lent 240)	16,376
Cards added to reference catalogue	13,308
Cards added to general catalogue	1,460
Periodicals and annuals subscribed for	383
Volumes bound	346
Items accessioned	1,020

MINERAL DRESSING AND PROCESS METALLURGY DIVISION

Owing to the increased requirements of industry and defence, the research activities of the Division were further expanded and covered a large field.

Priority was given to research undertaken for the Defence Research Board on the development of an economical method of producing pure titanium dioxide and titanium metal, the production costs of which are at present very high. New techniques for extracting pure titanium dioxide directly from ilmenite, and for producing titanium metal from titanium dioxide were developed on a laboratory scale.

Research was carried out on iron and steel slags to assist industry in the problem of removing impurities such as sulphur from metal and to effect improvements in the processsing of metal in general.

The corrosion resistance of certain new materials was evaluated for the Department of National Defence, as were new methods of protecting the commonly used metals from corrosion.

Research was continued on uranium ores to determine methods to serve as aids in the search for possible ore emplacement in operating mines, and these methods were developed to a stage where they are being applied during a thorough study of one section of the Eldorado mine at Port Radium, Northwest Territories.

Thirty-one companies used the facilities of the Division to conduct their own investigations with the assistance of Mines Branch staff. Twenty of these investigations were on metallic ores and eighteen on industrial minerals.

The Division acted as adviser to the Department of Resources and Development and to the mine operators at Yellowknife, Northwest Territories, on the difficult problem of disposing of the arsenic trioxide produced there as a by-product of the gold extraction process. The policy recommended and now in effect appears to be satisfactory to all interested parties.

INVESTIGATIONS

The Division carried out sixty-nine ore dressing investigations compared with forty-six in the previous fiscal year. Nineteen of these investigations were on copper-lead-zinc-nickel ores, and suitable mill flowsheets were designed whenever requested by the companies. Most of these ores required separation of two or more intimately mixed economic minerals and the problems were generally complicated by the presence of gold and silver. Five investigations were on gold ores from new properties, and nine were carried out to improve recoveries of gold at operating mines. One investigation was carried out on an ilmenite ore, eight on iron ores, five on tungsten ores, four on cobalt-silver ores, and one on a tantalite ore, all of which were low-grade, the object of the work being to devise economic methods of treatment.

Fifteen investigations were made on industrial minerals and two on the effectiveness of new flotation reagents.

For several years gold mines have experienced trouble in the precipitation of gold from cyanide solutions in the presence of even very low amounts of nickel. Research was carried out that established that nickel affected the precipitation adversely when lime and high hydrogen ion concentration were also present. Further research defined the conditions under which this deleterious effect of nickel may be minimized or completely avoided.

A new compound that had hitherto not been found to occur in nature was detected in gold ores from such widely separated points as the Yellowknife area, Northwest Territories, and northeastern Ontario. The new mineral (aurostibnite) is a diantimonide of gold and is associated in the ore with native gold and various silver-bearing antimony minerals. Its economic significance lies chiefly

in its resistance to treatment by cyanidation and in its comparatively low melting point, both of which properties adversely affect recoveries of gold from antimonial gold ores. It is formed artificially with great ease and may be responsible for the tenacious coatings that have been observed on gold particles in ores subjected to roasting during treatment.

Lithium

Investigations done earlier by the Division indicated the commercial possibility of a 98 per cent recovery of lithium from its common ore, spodumene, low-grade undeveloped deposits of which occur in Manitoba and Quebec. The existing process gives a recovery of from 75 to 80 per cent. A paper was published describing the Division's process and two Canadian companies holding spodumene properties have since asked for an estimate of the costs of the process.

Lithium is extracted from spodumene as a sulphate salt, and then has to be reduced to metal and in some cases refined. Investigations were continued on the refinement of ordinary commercial lithium by distillation. The effect of different atmospheres, pressures, and retort designs, in particular, was studied.

Titanium

Because of its light weight, high strength, and high resistance to corrosion, titanium metal is urgently required for national defence and for industrial purposes. However, its present high price ($15 per pound of titanium sheet) makes its extensive use, especially in industry, prohibitive, and the Division has been endeavouring through research to bring down the cost of producing it.

Some of the Canadian ilmenite ores contain sulphur in the form of pyrite. The elimination of this sulphur is of prime importance before the smelting of ilmenite ores. At the request of a Canadian company, sintering investigations to eliminate sulphur were undertaken, completed successfully, and the conditions necessary for the maximum elimination of sulphur determined.

The present process for the production of titanium dioxide from ilmenite requires the use of excessive amounts of sulphuric acid, one of the causes of the high cost of titanium. A new pressure leaching technique was applied to Canadian ilmenite ores on a laboratory scale using an autoclave, and a process was developed that yields a very pure titanium dioxide with a much smaller consumption of sulphuric acid than has hitherto been possible. This project was undertaken for the Defence Research Board.

A process, for which a patent has been applied, was developed on a laboratory scale for the production of titanium metal from titanium dioxide. The latter may be obtained by processing titania-rich slags resulting from the smelting of ilmenite ores. In the present titanium industry, pure titanium metal can be produced only from titanium tetrachloride, which is a volatile, poisonous liquid. There has hitherto been no known economic method of producing a satisfactorily pure titanium from the oxide. The price of titanium tetrachloride per pound of contained titanium is $2.23, whereas the price of titanium oxide per pound of contained titanium is $0.32. Thus, if pure titanium can be produced from titanium oxide, the saving per pound of pure titanium will amount to at least $2.

Concurrently with this phase of the research, titania slags from a plant in the province of Quebec were investigated by X-ray diffraction and by high temperature phase equilibrium methods to assist the company in establishing the best operating conditions. The identity of the crystalline constituents was

learned and a study was made of the effect of variations in plant operating conditions on the properties of slag. The purpose of this work was to make the titania slag in a form readily utilized by pigment-producing companies.

As even traces of non-metallic impurities in titanium affect the properties of titanium metal and its alloys, research was undertaken to determine the precise chemical analysis for these impurities. Satisfactory measurement in one operation of the total non-metallic impurities was achieved. However, due to the chemical nature of titanium, determinations of such common impurities as carbon, sulphur, nitrogen, silica, and phosphorus in titanium and its alloys cannot be done by the ordinary methods used in iron and steel analysis. Special techniques for the determination of nitrogen, carbon, sulphur, calcium, and alkali metals were developed, which will be of great help to the metallurgist in evaluating properties of titanium metal and its alloys.

Uranium Ore

Mineralogical research on the uranium ores of the Eldorado mine at Great Bear Lake was continued. This deposit, with its wide variety of mineral species, provides, from a scientific point of view, one of the most interesting examples of mineralization known today. The present study was designed primarily to furnish data that might assist in the further discovery of ore in the deposit, and possibly provide further useful scientific knowledge as well. The project involves the microscopic study and X-ray diffraction and spectrochemical studies of a large number of samples taken from numerous points throughout the mine.

Another phase of this research is the study of inclusions to determine the temperatures at which the minerals crystallized.

Study of Quebec-Labrador Shales

For the use of the Geological Survey of Canada a study is being made of the shales of the Quebec-Labrador iron region, using specially designed laboratory equipment. In this equipment the thermal behaviour of each particular shale on heating determines its diagnostic features, which are of assistance in stratigraphic correlation of formation, and thus of considerable indirect aid in locating iron ore deposits. About one hundred samples provided by the Geological Survey were studied by this method, and the laboratory determinations of the shale types are showing good correlation with field observations.

Iron and Steel

Investigations were carried out on blast furnace and open hearth slags, with the co-operation and support of the iron and steel industries, which provided numerous samples of slag and operating furnace data. The laboratory studies have provided much needed data on the effect of slag composition on melting points and on the conditions of slags at iron- and steel-making temperatures. Studies of rapid methods of basic open hearth slag composition control based on the hydrogen ion concentration and conductivity of aqueous suspensions of slag were also made, which showed the significance of the various compounds present. The limitations of the methods in current use in steel plants were pointed out as well as certain features that might give erroneous results.

The Division did experimental work on the fusion of magnetite concentrates and prepared small casts to assist a Canadian steel manufacturer in investigations concerning blast furnace feed.

It collaborated with the British Iron and Steel Research Association in analysing selected steel samples by various methods in order to evaluate the procedures and apparatus available for making very low carbon determinations.

The substitution of boron for scarce alloying metals in steel led to research into methods for accurately determining this element. In working out methods for boron analysis in steel it is necessary to ensure that the methods recover all the boron. By an ingenious combination of decomposition, distillation, and use of ion exchange resins, the Division worked out a method whereby it is now possible to recover all the boron in steels, which is finally measured by a spectrophotometric procedure.

Antimony

An important trend in metallurgy is toward the production of purer metals in order to control more effectively the compositions and properties of the alloys for which these metals are produced. In experimental work on the refining of antimony by distillation the Division obtained a substantial reduction in the sulphur, iron, and copper contents of the antimony. The research is being continued.

Corrosion Prevention

Numerous investigations concerning the conservation of metals by preventing their corrosion were conducted for the Department of National Defence and Canadian industry. These included evaluations of the corrosion resistance of certain new materials, and of the efficiency of certain new methods of protecting the commonly used metals from corrosion. A number of cases in which metal equipment had been seriously damaged by corrosion were investigated and remedies were recommended. Simultaneously, laboratory corrosion test methods were developed for several materials.

Extensive experimental work was done for the Federal Department of Agriculture on the resistance of steel ship hulls to corrosion under marine atmospheric conditions, through the use of the fumigant methyl bromide. Work was also done on which of four types of steel piling would be most resistant to the corrosive conditions at the proposed South Saskatchewan River dam.

Although the corrosion of metals is of major importance, the methods of testing metals and protective coatings for corrosion resistance are far from satisfactory. The Division has been co-operating with the National Research Council Associate Committee on Corrosion Research and Prevention in efforts to develop more adequate testing methods.

"Tin Plague"

Chiefly for use of the Department of National Defence in connection with the deterioration of "tin" containers in the Arctic regions, the Division has been studying the factors affecting the transformation of ordinary white tin to the undesirable grey variety under Arctic and other fairly low temperature conditions. As the presence of some of the other metals as impurities in tin stimulates this transformation, research was carried out during the fiscal year at different low temperatures to determine the effect of the presence of these metals in different concentrations. As germanium is frequently present in tin ores, special emphasis was placed on the study of its effect on the transformation. Many determinations were completed and reports issued.

Reclamation of Metals

Process information was given to an industry that is planning to recover lead and antimony from scrap consisting of automobile batteries and lead cables. Advice and analytical assistance was given to another industry that desired to recover silver from waste material produced during manufacturing operations.

Refractory Oxides

The growing demand for special refractory oxide articles for the many and varied uses in industry and science and for military purposes has stimulated much research in Canada and elsewhere concerning their properties and fabrication techniques. Included among the special refractory oxides, are: zirconia, beryllia, thoria, and titania, as well as alumina and magnesia, which have been more widely used. The use of these materials in their highly purified condition is mainly for small high temperature furnace linings, crucibles for melting refractory metals, rocket linings, jet engine linings, etc. The Division during the fiscal year completed an investigation of the factors influencing the properties of zirconia slips (water suspensions of finely pulverized zirconia) for the casting of crucibles, tubes, etc., using plaster of Paris moulds, and published the results. It undertook work on the fabrication of crucibles of zirconia, alumina, and thoria, including the coating of one oxide on the other for use in the experimental melting of titanium metal.

Bone China

An investigation of the crystalline constitution of bone china compositions is providing much information on the high temperature reactions occurring between the raw ingredients used in the preparation of bone china bodies and on the ultimate compounds formed on firing. Using the high temperature phase equilibrium method, it was shown that the compound anorthite, which had not formerly been recognized in bone china, was an important constituent. The presence of this constituent was subsequently found in actual china specimens.

Spectrochemical Analysis of Powder Samples

For the past several years the Division has been engaged in research designed to meet the need for a reliable and rapid method for the semi-quantitative analysis of minerals and mineral powders. During the fiscal year further improvements were effected and the scope of the method developed was extended to include the analysis of such materials as coal ash, slags, and titanium dioxide. The method is now in routine use in the Division and the experience gained indicates that it can be used also for the analysis of certain experimental metals and alloys whose compositions differ radically from any obtainable standards and for samples on which, because they are far too small, the well-known methods of quantitative spectrochemical analysis cannot be used.

Analysis for Some of the Strategic Metals

Instrumental analysis for strategic metals is constantly under investigation in the Division. Spectrophotometric procedures for cobalt, tungsten, and molybdenum were developed during the fiscal year which compare favourably in accuracy with the long, tedious chemical methods. A rapid amperometric method for evaluating fluorspar by means of its fluorine content was developed.

INDUSTRIAL MINERALS DIVISION

Demand for the industrial minerals continued at a high level during the fiscal year, and to assist in the development of domestic deposits to help meet this demand, the Division's research work was again directed chiefly to the beneficiation of material from low-grade deposits and to the development, from domestic deposits, of new mineral products such as light-weight aggregates and electronic ceramic products that are being used to an increasing extent. Much attention was given also to minerals essential to the defence effort, such as quartz crystals, kyanite, and rare-element minerals.

Field work was carried on in the ten provinces and many hundreds of samples of all kinds, including industrial waters, were shipped to the laboratories for examination, analysis, and processing.

The service rendered in identifying and appraising samples of rocks and minerals submitted by the public was utilized to a greater extent than ever before. An outcome of this service during the fiscal year was the discovery of a large deposit of kyanite, a mineral used in making special refractories and not previously known to occur in commercial quantity in Canada. The kyanite was observed in a sample of graphitic gneiss submitted for an opinion as to its value as a source of graphite, and an examination of the source area disclosed a large deposit of rock containing the mineral, which is being core-drilled. Kyanite is in demand for making special refractories, and is in short supply, the principal sources being British East Africa, India, and the southern United States. An investigation into the practicability of recovering the kyanite is under way on a representative sample of several tons of the kyanite-bearing rock.

The investigation into sources of light-weight aggregates was continued in central and eastern Canada. The greater part of the country has now been covered in the preliminary survey and deposits of clay or shale suitable for making light-weight concrete aggregate have been found in the vicinities of most of the principal cities in Canada. More than six hundred samples of shales and clays have been processed in the laboratories. The preliminary reports dealing with raw materials available in Alberta, Saskatchewan, and Manitoba have been issued and those dealing with raw materials available in eastern Canada will be ready shortly. As a direct result of this work a plant is being built in Ottawa to manufacture light-weight concrete aggregate, and another is in prospect in western Canada. The trend in the construction industry is toward the use of light-weight materials and thus there is a large potential market for light-weight aggregates, especially as the supply of cinders and clinkers has decreased greatly owing to the increasing use of fuel oil and powdered coal in locomotive and industrial furnaces.

Studies are being made of the various types of chert occurring in Canadian limestones and of the feasibility of utilizing cherty limestones for concrete aggregate. The results to date show that there is a great difference in the reactivity of the several types. The dense, impervious variety, usually black in colour, is inert when subjected to cycles of freezing and thawing and when tested with various chemical solutions, and is, therefore, suitable for aggregate, but the porous variety may expand and disintegrate rapidly when subjected to the same tests and is thus not suitable for aggregate. Efforts are being made to ascertain the reaction of the several types of solutions of various salts.

Because of the shortage of clean sand in the neighbourhood of some of the cities of Canada, initial studies were made of the commercial practicability of making sand from gravel and from different kinds of rock. In view of the shortage of cement in relation to the increasing demand, the Division undertook to examine the effects of substituting powdered rock, in part, for Portland cement in concrete mixes. The preliminary work has shown that as much as 15 per cent of cement can be replaced by certain of these rock powders without seriously reducing the strength of the concrete. In many cases, however, the suitable rock powders cost almost as much as Portland cement and their extensive use in industry will depend largely upon the continuance or otherwise of the cement shortage, and the local prices of the powdered rocks.

Investigations of Canadian pozzolanic materials were undertaken and are being continued. These materials when added to concrete enter into combination with the lime compounds and tend to reduce volume changes and decrease permeability.

Much work was done on developing and perfecting processes for producing pure silica sand from relatively impure sandstones. One of these processes involves grinding the sandstone to particle size, followed by roasting, acid-leaching, and washing. About 20 tons of sand suitable for making artificial abrasives and glass was produced by this process in the Division's laboratories from sandstone obtained near Gananoque, Ontario. The other process, developed in the laboratories, involves grinding the sandstone to particle size, followed by air classification and elimination of the iron minerals by high-intensity magnetic separation. Using this latter process, 100 tons of glass sand was produced in the laboratories from a deposit of sandstone at Bell's Corners, near Ottawa, Ontario, for testing by the glass industry. This sand would meet the specifications imposed by the industry.

It is expected that commercial plants will be built to utilize both processes.

Late in 1951 the quartz crystal property near Lyndhurst, Ontario, was reopened by the Trustee in Bankruptcy under arrangement with the Department of Defence Production, and the production of piezo-electric quartz was begun under the direction of the Industrial Minerals Division. This is at present the only source of quartz crystal on the North American Continent.

The Division continued its special survey of the mineral resources of Newfoundland, and gave particular attention to the industrial minerals. In the course of its work in 1951 it found a deposit of shale in the vicinity of one of the brick-making plants in the Trinity Bay district that would be suitable for making structural clay products of better than average quality. Preparations are being made by the brick company to utilize this deposit.

An engineer was again loaned to the Department of Resources and Development to complete the survey of road-building materials along the proposed route of the Trans-Canada Highway across Newfoundland. As noted in the detailed report he prepared for that Department, there are ample supplies along the route.

A flowsheet that has since proved satisfactory on commercial scale operation was worked out for the utilization of low-grade vermiculite from deposits near Perth, Ontario. The existence of vermiculite in this area was brought to light by an engineer of the Division in the course of field investigations in 1950. Two additional deposits were discovered in the area late in 1951.

A study of active and potential sources of sulphur in Canada was completed and a report (Sulphur and Pyrites in Canada) was prepared for publication, a summary of which was given in a paper presented at the annual meeting of the Canadian Institute of Mining and Metallurgy at Ottawa in January 1952.

The survey of Canadian resources of rare-element minerals was continued, with particular attention to sources of beryllium, cerium, columbium, gallium, germanium, indium, lithium, tantalum, thallium, and zirconium.

The Division continued its search for types of rocks suitable for making roofing granules and tested hundreds of samples from various parts of Canada. To date few rocks having outstanding properties as raw materials for making these granules have been found in areas near the main markets.

Much work was done on ceramic materials required for defence purposes, in co-operation with the departments of National Defence and Defence Production. Special ceramic products for use in electronics research were developed and supplied to the Department of National Defence.

The scope of the investigation on refractories, which originally involved a complete series of tests on all brands of firebrick made in or imported into Canada, was enlarged at the request of the Royal Canadian Navy to include high-temperature cements, plastic refractories, and castable refractories. The

series of tests has been completed on thirty-five brands of firebrick, six high-temperature cements, three brands of plastic refractories, and two brands of castable refractories. The information obtained from this investigation is of value in the selection of refractories for use on warships, and to the Canadian Government Specifications Board in drawing up specifications. It has been of use also to manufacturers in improving their products.

At the request of a manufacturer of electrical porcelains, an investigation was begun into the possibilities of adding wetting agents, detergents, and dispersants to speed up the ageing process necessary to avoid cracking of the products during subsequent processing.

Research on developing super-duty and high-alumina firebrick, hitherto not made in Canada, was continued in co-operation with two Canadian manufacturers of refractory products. Utilizing information obtained in the Division's laboratories, experimental brick of various compositions were made up at the plants of the two companies and were then shipped to the laboratories for firing and subsequent testing.

An investigation into the possibilities of using anorthosite rock, so abundant in Quebec, as a flux in ceramic products was successfully completed. The research showed that anorthosite may be used as a ceramic flux in applications where colour is not of first importance. In general, the anorthosite bodies had a lower maturing temperature than those in which standard fluxes were used, and had adequate strength.

One hundred and eighty-five samples of clay, shale, and other ceramic raw materials were tested to evaluate them for industrial use.

In continuation of the survey of the industrial water resources of Canada the sampling in the North and South Saskatchewan River basins, in the Ottawa River basin, and in the upper St. Lawrence River and the Great Lakes was completed. Sampling of the Mackenzie River basin and in the Canadian part of the Mississippi River basin was started. The initial program of sampling the major rivers and lakes of British Columbia was completed during the previous fiscal year. Final reports on the results of the industrial water surveys of the Ottawa River, Columbia River, and Skeena River drainage basins are in press.

The Division's mobile water laboratory was in western Canada from early in August until late in October, during which time 157 water samples were taken and partly analysed on the spot as a check on samples sent to Ottawa.

A special water sampling program of the St. Lawrence River at Caughnawaga and at St. Regis was undertaken at the request of the Indian Affairs Branch, Department of Citizenship and Immigration, and a preliminary report on the quality of the water was prepared.

A study of the turbidimetric method of determining sulphate in water was undertaken at the request of the American Water Works Association. Studies of methods of determining silica in water were made at the request of the American Society for Testing Materials. Progress reports were submitted.

Reviews for 1950 on 42 minerals produced in Canada were prepared for publication.

During the fiscal year 594 rock and mineral samples were examined, identified, and appraised, and 1,386 technical inquiries regarding industrial minerals were answered.

RADIOACTIVITY DIVISION

This Division is concerned primarily with the investigation of radioactive ores. Major emphasis was placed during the fiscal year on development of new or improved processes for recovery of uranium from such ores in the form of marketable products. Much of this work was on ore from the Ace property of the Crown-owned Eldorado Mining and Refining (1944) Limited in the Beaver-

lodge area of northern Saskatchewan. This property is expected to enter production early in 1953. Many field trips were made to the Ace property and to the company mine at Port Radium in Northwest Territories. In the course of these trips recommendations were made for flowsheets and equipment, and estimates of operating costs were prepared, based on laboratory test work. The leaching plant for extraction of uranium from mill tailing at Port Radium will commence operation in May 1952 and will use a process previously developed by the Division.

Routine extraction tests were carried out on samples submitted by Eldorado and by private companies and individuals, many of these samples being from the Beaverlodge area.

DEVELOPMENT OF NEW LEACHING PROCESSES

A few Canadian ores of uranium can be concentrated by standard methods of mineral dressing to marketable concentrates, but most of them must be treated by leaching methods. Previously known leaching methods were efficient but relatively expensive as regards capital and operating costs.

Two new leaching methods were developed during the fiscal year. One, a simplified basic leach particularly suitable for ores containing considerable carbonate minerals, has proved successful on a laboratory scale and is ready for setting on a pilot-plant scale. The other is particularly suitable for granite ores such as those in the Charlebois Lake area in northern Saskatchewan. The process costs of this method that can be estimated from small-scale tests are considerably lower than the corresponding costs for uranium leaching by other acid processes, and the method seems to offer wide possibilities for the economical treatment of lower grade ores. Pilot-plant tests will be made in the next fiscal year.

SERVICES TO ELDORADO

Assistance to this company included extraction testing of ores and recommendations for methods and equipment at Port Radium and Beaverlodge. Other services comprised check analysis of samples from operating plants, mineralogical examinations, development of electronic equipment for ore treatment plants, and help in the installation of control equipment for the Port Radium leaching plant. Assistance was also given in revising the flowsheet of the rebuilt gravity concentration plant at Port Radium, the original plant having been destroyed by fire in November 1951. The rebuilt plant will be ready for operation in May 1952.

TESTING OF ORES FROM PRIVATE COMPANIES AND INDIVIDUALS

Forty-four samples from fifteen sources were submitted for concentration and extraction tests. For purposes of laboratory investigation certain groups of these samples were combined for test work so that extraction tests were carried out on twenty-seven samples or composite samples and the results given in thirteen special reports and fourteen internal reports. Eight samples submitted during the previous fiscal year were also tested. Test work was being continued on five of the samples submitted during 1951-52.

Three hundred and twenty-one samples from sixty-five sources were submitted to the Division for mineralogical examination or special assay services. The samples received for mineralogical examination came from twenty-three different occurrences and included those submitted for concentration tests, exclusive of Eldorado samples, and two carried over from the previous fiscal year.

MINERALOGY

Mineralogical investigations were completed on twenty lots of samples in connection with uranium extraction tests, and four similar examinations are in progress. Research was started on the solubility of uranium minerals as related to mineralogical composition.

ANALYTICAL CHEMISTRY

A total of 16,753 chemical determinations were made on 8,488 samples, compared with 14,911 determinations on 5,302 samples in the previous year. Chemical uranium determinations totalled 10,064.

Considerable time was given to the development of improved analytical methods for uranium ores. These included cerium separation in the fluorimetric determination of uranium, an improved method for thorium determination, and methods for determining columbium, tantalum, and vanadium in ores in which uranium occurs with these elements. Flame photometer techniques were adapted for the determination of sodium, potassium, and strontium in uranium ores.

A split field visual comparator was developed for rapid determination of uranium in barren leach solutions.

PHYSICS AND ELECTRONICS

The Division continued its work on the development of improved techniques and equipment for radiometric analysis by Geiger or scintillation counters, and for utilization of the radioactivity of uranium in the operation of extraction plants.

Much effort was devoted to the development of liquid and plastic phosphor materials for use in scintillation counters. The properties of various suitable solutions were investigated and a new type of plastic phosphor was developed that offers many advantages over previously available commercial materials.

A simple and reliable method that appears to have wide applications was developed to determine the tantalum content of ores by irradiation with a neutron source. A similar method for the assaying of tungsten in ores is being investigated.

A new unit was developed that permits the continuous recording over long periods of time of the total activity of waste ore carried on a conveyer belt.

Apparatus for the routine assay of uranium and thorium in ores by the equilibrium method was redesigned and greatly improved in sensitivity and reliability. Uranium assays down to 0·002 per cent can be obtained in 3 to 4 minutes with an accuracy of $\pm$ 2 per cent. Details of Geiger equilibrium methods and equipment for general assay purposes are covered in a manual issued during the fiscal year.

CONTACTS WITH OTHER RESEARCH GROUPS

Close contact was maintained with groups in the United Kingdom and United States through exchange of reports and through travel.

The Division co-operated with the Universities of Alberta and British Columbia, which are engaged in research on uranium extraction.

REPORTS ISSUED

Twelve confidential reports on ore treatment were issued to private firms and individuals from whom bulk ore samples were received for investigation. Twenty-seven reports dealing with technical projects, information on which is restricted by security regulations, were prepared for the Atomic Energy Control Board.

Unclassified Topical Reports

No.	Title	Author	Date
TR-84/51	The Determination of Na_2CO_3 in the Presence of Na_3PO_4 and Na_3AsO_4. Using a Beckman Electrotitrimeter	Herbst, H. J.	11 June/51
TR-85/51	Coincident Circuit for Scintillation Counters	Wilson, J. E.	25 June/51
TR-86/51	Use of High Vacuum Tube as a Grid Controlled Rectifier in Stabilized High Voltage Power Supplied	Wilson, J. E.	16 July/51
TR-89/51	A Dekatron Scale of 400	Baker, J. C. Eichholz, G. G.	23 Aug./51
TR-91/51	The Determination of NaOH in the Presence of Large Quantities of Na_2CO_3 using pH to Determine the End Point	Herbst, H. J.	4 Oct./51
TR-92/51	Equilibrium Assaying of Uranium Ore	Hilborn, J. W.	1 Dec./51
TR-93/51	Activation Assaying for Tantalum in Ores	Eichholz, G. G.	10 Nov./51
TR-95/52	Electronic Concentration of Radioactive Ores with the Lapointe Picker Belt	Lapointe, C. M. Wilmot, R. D.	10 Mar./52
TR-96/52	The Determination of Uranium in Ores; Fluorophotometric Method—A Procedure for the Removal of Interfering Cerium	Zimmerman, J. B. Guest, R. J.	21 Feb./52

FUELS DIVISION

The efforts of the Division were concentrated chiefly on technical problems of the coal industry, in the belief that well-planned and co-operative research can do much toward enabling the industry to maintain its markets in competition with oil and natural gas.

DEEP MINING OF COAL

In co-operation with the Geological Survey of Canada the Division continued the study of rock pressures in several coal mines in western Canada, particularly in the Crowsnest Pass area of Alberta. This fundamental research is concerned with the economic mining of coal at depth, with special attention to the avoidance of violent pressure "bumps" and "gas outbursts", which make the mining of the coals hazardous and interfere greatly with production. An indirect aim of the work is to enable the mining, at greater depth, of bituminous coking coals needed for the production of coke for the metallurgical industry. Including those giving part-time attention, eleven men are engaged on the project, three of whom are stationed at the mines. Closely associated with this work is the study of the methane gas contained in the coal in place, and its effect on the gas outbursts hazard.

TESTING MINE AIRS

The Division co-operates with the mining inspectors of the different provinces in periodically testing mine air. During the fiscal year samples were received and analysed from Nova Scotia, Quebec, Alberta, and British Columbia. The use of diesel engines in mine locomotives is recognized as a possible source of contamination of the mine air and some inspectors insist on a regular analysis of a sample by the Division.

COAL PREPARATION

The Division has been investigating problems of cleaning and utilizing the low-grade (high ash), finer sizes of bituminous coal, which predominate in Canadian mining operations and are difficult to market. In this work an engineer of the Division stationed in Calgary is investigating the efficiency of the coal preparation machines in use in western Canada. Similar investigations are in progress in New Brunswick and Nova Scotia.

COKING AND DOMESTIC STOKER COAL INVESTIGATIONS

To aid in promoting the increased and more efficient use of Canadian coals in making coke for foundry and other metallurgical uses, experiments were conducted on the blending of western bituminous coals, particularly from the Crowsnest area. A main purpose of the experiments is to ascertain the feasibility of blending weakly caking coals with coking coals, and in the work to date some satisfactory blends have been determined. The feasibility of blending Nova Scotia coals, varying considerably in volatile matter content, was also investigated, the aim being to improve the physical properties of metallurgical coke materially for use in steel plant blast furnaces.

The increased use of Canadian coal in domestic stokers was further studied. Installation of an experimental stoker testing unit was completed for use in comparing the results of burning various types of stoker coal. A series of tests was started to compare the value of Canadian coals with imported coals. The results are expected to be of assistance to manufacturers of equipment, in improving stoker design.

For use of the Dominion Coal Board the Division completed a survey of the industrial market in Ontario for Canadian coals. It was concluded there is a market for approximately 1,000,000 tons of these coals a year, provided the coals meet minimum requirements in regard to cost and delivery. At present much the greater part of the coal for this market is imported from the United States.

PEAT

Field work was carried out in Ontario, Quebec, and New Brunswick, to note developments in the peat moss industry and to supply information and advice to correspondents who had requested assistance in developing new properties. During a trip to Europe by the engineer in charge, large-scale peat fuel operations by three different methods and a peat-fired electric generating station were visited in Ireland, to obtain first-hand information for assessing the possible utilization of these methods in Canada.

COAL-FIRED GAS-TURBINE PROJECT

The Division has been taking an active part in efforts to develop a satisfactory coal-fired gas-turbine engine. Beginning in 1946 it assisted in the work of the Locomotive Development Committee of Bituminous Coal Research, Incorporated, and since 1950 has taken part in a co-operative project with McGill University in the design and construction of a prototype engine. Under the latter arrangement both parties contribute technical personnel and equipment to the project. The Mines Branch supplies the finances and McGill University the laboratory space. During the fiscal year a 500 h.p. gas-turbine engine was installed in the gas dynamics laboratory of McGill University at Ste. Anne de Bellevue, Quebec, and much progress was made on the design and installation of the equipment to enable the use of coal as fuel, in accordance with the conception of Professor Mordell of McGill for a heat-exchanger operated

engine. By the end of 1951 the compressor and turbine units had undergone mechanical tests with oil as fuel. The special heat exchanger and ducting essential to the use of coal are being fabricated. A coal combustor unit was constructed by the Mines Branch and tested at Ottawa prior to the design of the unit to be installed in the Ste. Anne laboratory.

A series of tests on a model heat exchanger under conditions similar to those of the prototype were made by the Division with satisfactory results and no fouling of the heat exchanger tubes by coal ash was observed. It is expected that trials of the complete engine with coal as fuel will commence by the spring of 1953. If a coal-burning engine of high efficiency can be produced and brought to a satisfactory state of development for incorporation into a locomotive, major benefits would result to the coal mining industry, the railways, and the general public. It should be emphasized, however, that the coal-fired gas turbine is at present only in the development stage. There is no sound basis for predicting the time when it will be in extensive commercial use. It is not certain that it will ever reach that status. Some reassurance can be drawn, however, from the fact that no technically insurmountable difficulty has yet been recognized. Moreover, the interests of coal producers, railway companies, and turbine manufacturers, as well as general considerations of economy and security, combine to create a strong incentive to pursue the development. It is probable, therefore, that developments will continue until a satisfactory coal-fired gas turbine is achieved, or, for some definite reason, is known to be unattainable.

BASIC RESEARCH ON HYDROGENATION

The investigation of hydrogenation as a means of producing gasoline and light oils from Canada's bitumen and other heavy oils was continued. On theoretical grounds, and on the basis of past experience, there is reason to expect that the chemical reactions involved in the hydrogenation process will proceed much more favourably at pressures in the range between 10,000 and 20,000 pounds per square inch than at the lower pressures previously used. Accordingly, the Division has undertaken an experimental investigation of the influence of high pressure on the hydrogenation reactions. An apparatus involving new and ingenious mechanical features has been designed and is under construction. Part of it has been installed in the Division's laboratories and the remaining equipment is nearing completion in the manufacturer's shops. Construction will be completed during 1952, unless there are unexpected delays in delivery.

Increased interest has been shown in the utilization of the large oil reserves in the bituminous sands of Alberta. A necessary step in the production of a marketable product from the bitumen is the removal of sulphur from it, and hydrogenation appears to be the only feasible method at present. During the fiscal year the Division operated a small experimental hydrogenation unit in an effort to find the best operating conditions to remove sulphur from distillate produced from bitumen, and the results have been encouraging. It has been found possible, by a simple procedure, to reduce the sulphur from about 4 per cent in the raw oil to 0·2 per cent in the product, with a yield of 102 per cent by volume, and at the same time to lower the amount of hydrogen required and to increase the rate of throughput by several times. The product is a high-grade gas oil that would be a feed stock of premium value to petroleum refineries. The work is being continued in an endeavour to further reduce the cost of operation.

ATHABASCA BITUMINOUS SANDS

The Division devoted considerable effort towards solving technological problems involved in the recovery and refining of bitumen. An investigation of the chemical constitution of bitumen gave an indication of the geological period of its origin, a factor that will have a bearing on future exploration. This investigation also provided data of use in the development of refining procedures.

Engineers of the Division along with other officers of the Department took an active part in a conference on the bituminous sands, sponsored by the Alberta Government. The conference enabled presentation of the known facts concerning the bituminous sands to a large number of representatives of oil companies and of other interested commercial organizations. Since then, several companies have been issued prospecting permits to explore parts of the deposits.

EVALUATION OF CRUDE PETROLEUM

A still of 5 gallons capacity to evaluate the quality of crude petroleum was constructed to yield products comparable to those obtained in a modern refinery and in sufficient amount to permit of the various products being analysed separately. Preliminary trials indicated that excellent separation of the fractions will be obtained. The project is of interest both to producers of crude petroleum and to refinery operators.

SULPHUR RECOVERY FROM FLUE GASES AT PULP AND PAPER PLANTS

At the request of the Dominion Coal Board preliminary studies were made of the feasibility of recovering sulphur from flue gases at power plants of pulp and paper companies in eastern Canada that burn coals having a high sulphur content. The initial results indicate that an appreciable part of the sulphur requirements of pulp and paper plants in New Brunswick is available as sulphur oxides in their power plant flue gases. However, the economic feasibility of recovering the sulphur has still to be proved.

ANALYSIS SURVEYS AND LABORATORY INVESTIGATIONS

The physical and chemical survey was continued as part of the basic study of the properties and beneficiation of Canadian coals. The results of this comprehensive study afford data on the characteristics of Canadian coals as mined as a basis for fundamental research, as well as for the valuation and improvement of the quality of the coals being prepared for marketing.

PHYSICAL METALLURGY DIVISION

The fundamental phases of research were curtailed so that the necessary attention could be given to the metallurgical problems of the Department of National Defence and of the Atomic Energy project at Chalk River, Ontario. The Division's research on titanium, noted below, and seven of the other defence projects were partly financed by the Department of National Defence, mainly by the Defence Research Board.

A start was made on developing metallurgical methods to process titanium metal. The cost of extracting the metal must be greatly reduced, and the difficult problems of processing it into usable forms solved before titanium can be used in large tonnages in the structural, industrial, and defence fields for which it is adapted. Because of its high physical strength and corrosion resistance titanium has many potential uses, but its high melting point, refractory nature,

and other peculiar characteristics have posed difficult problems for metallurgists in their efforts to develop satisfactory commercial titanium products at reasonable cost.

Following the designing and building of special furnaces, Canadian-produced titanium powder was melted by arc and induction methods under protective atmospheres, and was successfully worked into sheet, rod, and forgings. However, this metal was found to have low ductility and research is proceeding on titanium and titanium alloys, using both purer imported metal and Canadian-produced titanium. Fifteen research and industrial laboratories in the United States were visited in connection with this project.

The seven aforementioned defence projects consisted of: continuation of research dealing with welding under Arctic conditions; technical assistance concerning the welding of high-temperature, high-pressure steam lines to be installed on naval vessels; the developing of metallurgical practices to enable production in Canada of large turbine rotors for naval escort vessels; the developing of magnesium anodes for naval use; participation in a guided missiles project; the design and development of a depth charge thrower; and radiographic services to direct control of quality in castings used in R.C.A.F. aircraft.

The Division continued a program of research on development of high-temperature metal for jet engine applications, and continued to assist the Defence Services in developing special metals for equipment and weapons.

The effects of radiation from nuclear reactions on the performance and life of metals gave rise to a continuous inflow of problems from the Atomic Energy project. These concerned both current operations and the essential materials for the new atomic energy reactor. The Division has a metallurgical staff at Chalk River and additional staff at Ottawa, where the services have included experimental production of special alloys and their fabrication into various shapes by rolling, extruding, hot forging, and cold drawing. The recent installation of new special laboratories at Ottawa, equipped to handle radioactive materials, will expedite the solving of various atomic energy problems, and will permit the use of tracer techniques in solving other problems.

Following field investigations at Churchill, and the design and installation of special control equipment, research welding was begun by the Division during the fiscal year in a National Research Council cold room at temperatures ranging down to —80°F. The study must be continued over a lengthy period to obtain the performance data required by industry and the military authorities. A main purpose of the work is to acquire basic scientific data for predicting the behaviour of welds under severe temperature changes and for defining the methods, conditions, and limitations for field welding at low temperatures. The life of welded joints under great temperature variations is of increasing importance in Canada in view of the widespread use of welding in the construction of buildings, bridges, industrial plants, and ships, and in assembling components of construction equipment, vehicles, and mobile military equipment. Studies of welding under Arctic conditions are included in the program at the request of the Defence Research Board.

The program of naval shipbuilding in Canada has brought various requests for metallurgical assistance. The Division recommended the procedures used in producing the first naval steam turbine rotor forged in Canada, and supervised inspection and testing, and is continuing the development work necessary to keep Canada to the forefront in this field. At the request of the Royal Canadian Navy, technical assistance in regard to pipe-welding of high pressure steam lines was undertaken.

The Division accepted an assignment from the R.C.A.F. to direct the control of quality of castings used in its aircraft. This involves training of R.C.A.F. inspectors and industrial producers in the most modern techniques of

inspection by X-rays; examination of industrial X-ray laboratories to ensure that the equipment and techniques used are up to standard; and certification of such laboratories as being qualified to do this work. The governing specifications have been modernized and the development of new techniques is being pressed.

The effects of tin and copper on the forging properties of mild steel were investigated. Small quantities of these elements cause serious cracking of steel when processed at high temperatures. Certain types of heat treatments have been found to alleviate this condition. This project is of interest to the locomotive industry in particular and to the steel industry in general.

Jointly with the Steel Castings Institute of Canada, a project was carried out to ascertain the maximum tolerances for stray elements in cast steel. The results of the work now serve as a guide to the casting industry when inferior scrap has to be used in making steel.

A casting developed by the Division has been adopted by the American Foundrymen's Society as the standard for determining the quality of sand to resist metal penetration. Any foundry can now evaluate a sand with regard to its ability to part from the metal, thus leaving a clean surface on the casting. This is important, as cleaning costs in the foundry are one of the major expenses in producing castings.

Among the major continuing activities is the study of the metallurgical factors contributing to brittle fracture in structural steels. The abrupt failure of normally tough plates or girders in ships and bridges is still a serious problem, and the limiting conditions remain largely undefined. Special tests have been developed by the Division to investigate these conditions, and have been applied specifically to ship plates, dock piling, and bridge girders.

Modern experimental stress analysis techniques have been employed extensively by the Division in the development of prototype weapons and vehicles in co-operation with the Department of National Defence. This work has involved the perfection of internal pressure testing methods with strain gauge instrumentation, the application of strain-indicating lacquers to complicated structures under static or dynamic loading, and improvements in the dynamic recording of strain measurements in firing trials. By these means tentative designs are rapidly modified to provide equipment of maximum efficiency, with consequent savings in time, materials, and manpower.

The Division has been investigating the use of various substitute metals such as boron for nickel, molybdenum, cobalt, and other metals used in the manufacture of steel, which are in short supply. A small amount of boron has the same effect in giving certain properties to steel as much larger amounts of nickel, molybdenum, and chromium.

Kinsalloy, the new high-temperature alloy for jet engines developed by the Division, has successfully met the engine designers' requirements in engine tests. However, actual engine temperatures proved to be considerably higher than those anticipated by the designers, and it was, therefore, necessary to modify the alloy so that it could withstand these higher temperatures with an adequate margin of safety. A modification developed during the fiscal year is awaiting further engine trials.

In the field of light metals, new alloys have been developed, and two Canadian patents have been granted. These concern the development and heat treatment of magnesium-zinc-zirconium casting alloy ZK61, which has higher strength-to-weight ratio than any other commercial casting alloy, ferrous or non-ferrous. A considerable number of ZK61 alloy castings have been produced in Canada and are being used successfully in various modern aircraft applications and in some prototype combat equipment for airborne operations.

Extensive research was carried out on magnesium alloys for service applications at high temperatures in jet engines and guided missiles, in co-operation with the magnesium founding and aircraft industries. Satisfactory improvements in alloying and refining techniques were achieved, and considerable improvement of high-temperature properties was obtained by changing the composition of the mixture of rare-earth elements used in these alloys. All magnesium casting alloys used in the present jet engine program of the Canadian aircraft industry are based on this development work.

In co-operation with the Department of National Defence and with the Atomic Energy project, much work was done on the design and production of prototype castings and wrought products for experimental defence equipment and special purposes.

By its pilot and demonstration work, the Division has interested a Canadian firm in the commercial rolling of magnesium sheet to the extent that the company has made full-scale trial rollings. No magnesium alloy sheet has hitherto been produced in Canada, although the design and efficiency of many pieces of military equipment could be improved by its use. The same applies to domestic and industrial uses, but the use of magnesium sheet requires familiarity with its special working properties, and this cannot be acquired until sheet becomes available.

The Division continued its pioneering work in the development of nodular cast iron. This material is already in production. It combines the strength of steel with the good machinability of cast iron. As the ductility of nodular iron is relatively low, the Division has conducted a number of investigations to improve this property by heat treatment, and has obtained an increase in ductility by certain of these treatments. Further work is being done to obtain a detailed knowledge of the reactions involved in the heat treatment.

In co-operation with the mining and steel industries, the Division has been engaged in extensive research and field work on the development of an efficient drill set—drill rod, bit, attachment, and shank end—for use in Canadian mines. Four different types of laboratory drilling machines and testing methods have been developed for use under simulated service conditions. Data obtained were used in studying the best manufacturing procedure for the set. The mining industry was provided with graphs and tables for evaluating the field performance of typical Canadian drill rods for the impact resistance of various rocks representing different mining operations.

The Pulp and Paper Research Association received further assistance in its efforts to determine the cause of the short service life of modern pulp digesters. This is a matter of serious concern to the industry and no early solution of the problem can be expected.

The Division, mainly at the request of the defence manufacturers, conducted many metallurgical investigations on unsatisfactory metal products and parts to determine causes and to suggest remedies for overcoming poor performance.

It issued 10 research reports, 46 reports of investigations, and 223 test reports, chiefly for restricted distribution to the Defence Services and to the Canadian metal industry. Senior members of its staff contributed 22 papers to the metallurgical literature and delivered 45 lectures before technical societies.

A list of the papers appears at the end of this report.

DOMINION OBSERVATORIES

C. S. Beals, Dominion Astronomer

The services of the Dominion Observatories include: the practical functions of providing an astronomical basis for Canadian time and arranging for time distribution by radio and other means; carrying out magnetic surveys and preparing maps indicating the deviation of the compass needle from true north; the study of earthquakes in their relation to industrial business hazards; the study of geophysical prospecting methods; and the application of the techniques of meteoric astronomy to various upper atmospheric problems of interest to National Defence.

In addition to these tasks, which are in the nature of direct services to the public or to departments of Government, much fundamental and applied research in the related fields of astronomy and geophysics is carried on. The fields covered include: the study of latitude variation; investigation of the origin of the earth's magnetic field and its variations; studies of the sun and its relation to earthly phenomena; investigations of the thickness and density of the earth's crust; studies of the nature of the forces producing earthquakes; and such observational and mathematical investigations of the stars and other heavenly bodies as comprise the science of astrophysics.

The geophysical work and the more practical aspects of astronomy are centred at the Dominion Observatory in Ottawa, and the major programs in astrophysical research are carried on at the Dominion Astrophysical Observatory in Victoria, B.C. Magnetic observatories for the observation of local magnetic variations are maintained at Agincourt, Ontario, Meanook, Alberta, and Resolute Bay and Baker Lake, Northwest Territories. Seismograph stations are operated at: Halifax, Nova Scotia; Seven Falls and Shawinigan Falls, Quebec; Ottawa and Kirkland Lake, Ontario; Saskatoon, Saskatchewan; Victoria, Alberni, and West Vancouver, British Columbia; and at Resolute Bay, Northwest Territories. Observatories for meteoric observations are located at Meanook and Newbrook in Alberta.

Through his retirement on superannuation on December 15, 1951, the Observatories lost the services of E. A. Hodgson, a distinguished seismologist whose work in that field gained for him international recognition. Dr. Hodgson joined the Department in 1914, was appointed seismologist in 1920, and Assistant Dominion Astronomer in 1948, the position he held at the time of his retirement, along with that of Chief of the Seismological Division.

DOMINION OBSERVATORY

ASTRONOMY

Positional Astronomy

Time Service. Of first importance is the newly installed photographic zenith tube for determining time by photographic methods. With this installation Canada now has one of the most modern and powerful instruments in the world for time determination and for related observations of the variation of latitude. The new instrument is mounted on piers in the transit room, but will be moved to a more suitable location after the automatic controls have been tested. Changes can then be made to ensure reliable operation at Ottawa winter temperatures.

The main optical component of the instrument is a 10-inch objective of 167·47 inches focal length so figured that one Gaussian point of the lens lies approximately ½ inch below the lower surface. A photographic plate mounted

horizontally at this point, in a carriage driven by a crystal-controlled synchronous motor, records the image of a star as it crosses the zenith. The instrument was designed to be operated by remote control and an observation, initiated at the proper time by an electrical contact and involving four exposures on each star, is automatically completed. The first observations were made in September 1951, and they have been continued since that time, along with observations for time taken visually with the older broken-type transit.

The new instrument depends for its accuracy in the measurement of star images upon a photographic plate rather than on their estimation in the field of a visual telescope, and its greater precision in the determination of time was apparent from the start. It is expected that the results will be improved further as required corrections to the measurements are worked out in more detail.

Observations with the photographic zenith tube were taken on 86 nights on 1,008 stars, providing 80 clock corrections. With the broken-type transit 1,893 star transits were observed on 157 nights. From March 1, 1952, the clocks have been corrected from the photographic zenith tube results.

The primary clocks now consist of a Western Electric Frequency Standard, two General Radio crystal clocks, and the Shortt Free Pendulum. Seconds' beats from two other crystal clocks, one at the National Research Laboratories and one at the monitoring station of the Department of Transport, were monitored daily. The Shortt clock was used for observing and control of one time-signal machine; the second machine was changed to a crystal-controlled 60-cycle synchronous motor. This latter type of drive is now used on all the chronographs.

To increase the precision of the Observatory's time signals two time-signal machines of the most modern type were installed in November 1951, and these now control the continuous time signals broadcast over CHU, and over the Canadian Broadcasting Corporation's chain of stations at 1:00 p.m. Eastern Standard Time. Time signals are sent continuously by wire to the Canadian Broadcasting Corporation, National Research Laboratories, the monitoring station of the Department of Transport, and the Naval Headquarters, Ottawa, the last for relay to Halifax twice daily for broadcast over CFH to ships in the Atlantic. The Canadian National Railways and the Canadian Pacific Railways receive time signals by wire for a period of 2 minutes daily direct from the Observatory. These are sent across their systems from coast to coast, serving as local standards of time in many communities. The Bell Telephone Company of Canada receives time signals at 11:00 a.m. Eastern Standard Time daily and these are used as official time throughout the company.

The 1:00 p.m. signals over the CBC network make time of the highest accuracy available to all Canadians with standard receiving sets. A broadcast service available to short-wave receivers is 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 a major effort of the Observatory in the distribution of time, seconds time signals, coded for identification of minutes and half minutes, are broadcast on the frequencies 3,330 kc., 7,335 kc., and 14,670 kc. The broadcasts are intended primarily for surveyors, aerial or marine navigators, and persons travelling or living in remote parts of Canada. A new transmitter for increasing the power of the 7,335 kc. signal to 5,000 watts will be placed in operation as soon as alterations have been made to the present building.

Nearly 700 electrically operated clocks in Government buildings in Ottawa, synchronized from the Observatory, are maintained. Observatory clocks, watches, and other timing devices are kept in repair, and during the fiscal year 318 watches were overhauled for other Government offices. Circuits for the photographic zenith tube were designed.

Determination of Accurate Star Positions. The group of meridian circle observers, who are primarily concerned with the accurate measurement of star positions, devoted their main efforts to improving the positions of stars needed for the determination of time. The national observatories of England, Canada, and the United States are setting up new photographic zenith tubes, and each of these observatories requires a list of approximately 500 stars, the positions of which have not been well determined. An agreement was reached by the services in the three countries to make intensive observations of all 1,500 stars needed for these time programs. Over 5,000 observations were made at Ottawa on this list of stars during the fiscal year. Observations were made on 118 nights and 365 readings for the vertical and 226 instrumental constants were taken.

In its study of precise stellar positions the Observatory has enlised the aid of the newly established Computing Centre of the University of Toronto to carry through some of the more laborious calculations on a contract basis. The automatic machines maintained by the Centre with their printing attachments make possible very great savings of time and labour in certain types of calculations. Some help was obtained from the Centre in the previous fiscal year and if the present experiments work out successfully it is expected the arrangement will become permanent. The 1950 observations for mean places of stars have been completed at Toronto and are being checked and tabulated. The computations for the calendar year 1951 were completed to the point where they can be finished by the Computing Centre.

Meridian circle observations obtained during the period 1923 to 1935 are in press, and work is proceeding on the preparation of the 1935 to 1950 observations.

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

Stellar Physics

Research in Meteoric Astronomy. Much of the effort was devoted to upper atmospheric research using the techniques of meteoric astronomy. Preparations were made for a major program of photographic triangulation of meteors at Meanook and Newbrook in northern Alberta. The two new observatories were staffed and a systematic program of the visual and photographic observation of meteors was commenced in January 1952. Detailed preparations were made for mounting the two Super-Schmidt meteor cameras of 8 inches focus and focal ratio 0·8 that have been on order for several years. The sky test of the first Canadian camera is scheduled for April 1952, and both the Canadian instruments should be in operation before the end of that year. Work is proceeding on the design and construction of the film moulding unit and other auxiliary equipment required for the operation of the Super-Schmidt cameras.

At a meeting with representatives of the United States Defence Forces and Harvard Observatory in Norwalk, Conn., tentative plans were consolidated for international co-operation in the program of upper atmospheric research through meteor observations. General agreement was reached on the division of labour in the reduction of the data obtained.

At Ottawa the program of observation of major meteor showers was continued, in co-operation with the National Research Council. The Delta Aquarids, Perseids, and Quadrantids were observed. Summarizing all programs, meteor observations were carried out on 27 nights, the average number of observers working each night being five. A total of 1,850 meteors were observed visually and 1,250 exposures were made with meteor cameras.

The information available on meteor spectra was consolidated and a study of the line intensities was continued preparatory to a theoretical treatment of meteor luminosity. Detailed measurement and reduction of the 1950 meteor observations were carried out.

Field trips were made to investigate a possible meteor crater near Brent, Ontario, and a possible meteorite fall near Windsor, Ontario. The results were inconclusive for the first investigation and negative for the second. A second stone of the Benton meteorite fall of 1949 was located and obtained for the Observatory.

Solar Physics. Equipment for study of the sun and the atmosphere of the earth was placed in full operation. The new grating solar spectrograph performs highly satisfactorily both in the photographic region and in the far infra-red. The maximum resolving power of 300,000 in the red region is far in advance of equipment previously available and compares favourably with that of the best foreign research institutes. Preliminary analysis of molecular spectra in the infra-red by photo-conductive methods was begun and it is expected that during 1952-53 the emphasis will be placed on full-time solar research, as compared with instrumental development.

Equipment for the systematic study of solar eruptions is nearing completion. A time-lapse camera to be used with the Lyot monochromatic filter was built and will be mounted on the 15-inch equatorial telescope. This will produce a continuous record of the appearance and growth of solar flares for correlation with geophysical phenomena.

Theoretical Astrophysics. The investigations of the preceding year, which centred on stars with expanding atmospheres, evolved during 1951-52 into a similar study of stars with rotating atmospheres. The relation between the diameter of the star relative to that of the emitting or absorbing envelope was investigated and theoretical profiles were derived both for the case of pure scattering and for that of a monochromatic emitting region within the scattering envelope. It was shown that the rotational model resulted in profiles closely resembling those shown by the well-known class of Be stars. An interesting and unexpected result was the conclusion that the scattering shell that produces the Be type profile must be larger relative to the star than in the comparable case of a P Cygni-type line. In an investigation of the relationship between theoretical and observed line profiles an officer of the Division spent 2 months at the Dominion Astrophysical Observatory to obtain spectra of a number of typical emission line stars of type Be.

General. The Division was represented at the 85th meeting of the American Astronomical Society in Washington in June and at an International Conference on Auroral Physics in London, Ontario, in July. Fifteen lectures were given to technical and non-technical groups in various parts of Canada.

TERRESTRIAL MAGNETISM

Magnetic Mapping. Studies were made of the earth's magnetic field for use in constructing and revising magnetic maps and charts and in investigating short- and long-term changes in the various components of the magnetic field in Canada. Magnetic survey operations were confined mainly to the sections of Canada extending from the southern coasts of Newfoundland and Nova Scotia to the southern coasts of Ellesmere Island in the eastern Arctic. Measurements of declination, inclination, and force were made at 112 field stations comprising 43 repeat and 69 new stations, 24 of the field stations being in Newfoundland, 4 in Prince Edward Island, 10 in Nova Scotia, 3 in New Brunswick, 49 in Quebec, 7 in Ontario, 2 in Manitoba, and 13 in the Northwest Territories. Particular mention might be made of the magnetic survey operating

by chartered aircraft based at Knob Lake, whereby 54 field stations were established in and around the Labrador Trough (iron ore) area. This survey was in co-operation with the Geological Survey of Canada.

Magnetic data necessary for new and revised topographical map-sheets and marine and air navigation charts were supplied for 1,271 items. These comprised 757 for the Surveys and Mapping Branch, 492 for the Department of National Defence, and 22 for other agencies. Much information of a similar character was supplied to private investigators and prospecting companies.

Mathematical analyses of the earth's magnetic field in Canada were continued with special emphasis on the accurate forecasting of magnetic values. As an example of the practical use of such research it may be noted that at the end of the fiscal year a request was received from the Surveyor General of Canada for isogenic lines applying to the year 1955 to be drawn on twenty-one air navigation sheets for use by the R.C.A.F.

Instrumental Development. Good headway was made in the construction of the Division's own design of electrical universal magnetometers for field and observatory use. These magnetometers have superseded the old standard types for field observations and observatory types are in use at the Arctic magnetic observatories and will be installed at Agincourt and Meanook during the next fiscal year.

Work was continued on the design and construction of a universal airborne magnetometer including a gyro-stabilized platform on which it is to be mounted. The first experimental model with its auxiliary equipment was tested on long range flights in northern Canada in the vicinity of the North Magnetic Pole through the co-operation of the R.C.A.F., and the results have been used to further the design of the final instrument.

The preliminary mechanical design of a new gyro-stabilized platform was completed. Experimental models of the electrical components were built and tested and quick-response servomechanisms and an accelerometer were designed. An investigation of the stability of some of the more complicated servo loops was carried out with the aid of a Phillbrick analogue computer, and the result checked with a mechanical model.

Magnetic Observatories. The four magnetic observatories at Agincourt, Meanook, Baker Lake, and Resolute Bay were in continuous operation.

A new non-magnetic observatory building was built at Meanook and certain absolute magnetic instruments were installed. The building is being prepared for the transfer of all recording variometers from the old observatory built in 1916. At Agincourt the wiring for clock and instrumental circuits from the new office building to the Observatory was completed. Additional land was purchased to prevent the construction of private dwellings too close to the station.

Three-hour range indices, which provide measures of the frequency and intensity of magnetic disturbances, were measured from Agincourt and Meanook magnetograms and supplied monthly to research centres in Holland, Germany, United States, and Canada.

SEISMOLOGY

Operation of Seismograph Stations. The ten seismograph stations maintained by the Seismological Division serve a twofold purpose. They provide data on seismic activity local to the particular station, information that is of great value to engineers, and form part of the world-wide network of seismic observatories. The latter makes possible the rapid location of all earthquake epicentres and the study of problems of earth structure and the mechanisms of the earth's failure.

Instruments particularly suited for the study of local seismicity are concentrated in those areas believed to be most seismic. Stations at Victoria, Alberni, and North Vancouver make possible a detailed study of local earthquakes in British Columbia, whereas those at Ottawa, Shawinigan Falls, and Seven Falls provide information on shocks of the St. Lawrence Valley. Stations with instruments better adapted to the study of distant earthquakes are located at Victoria, Saskatoon, Resolute Bay, Kirkland Lake, Ottawa, Seven Falls, and Halifax. Data on all earthquakes recorded at these stations are supplied in the form of mimeographed bulletins to other seismic observatories and to those international organizations that determine epicentres. In addition, preliminary data from Ottawa and Resolute Bay are sent by radio to the United States Coast and Geodetic Survey in Washington, which makes a rapid preliminary determination of all epicentres.

A new station being installed in Halifax will be equipped to record distant and nearby earthquakes.

Research Programs. Particular attention is being paid to the seismicity of the Pacific Coast, and owing to the importance of the work, a full-time seismologist was transferred to the Victoria Observatory. Similar studies of the St. Lawrence Valley have been in progress for many years. In a study concerned with the microseisms recorded at Resolute Bay, it has been shown fairly conclusively that these are largely due to storms over the North Atlantic.

The large network of Canadian stations makes it possible to provide valuable information to seismologists of other countries, who in turn reciprocate. For example, records from stations all over the world have been received for the British Columbia earthquakes of 1946 and 1949. Several worthwhile studies have been made from these records and others are in progress. Another example of the value of such international co-operation is in a study known as the Fault Plane project. In this project, information on the direction of initial motion caused at each of the seismograph stations of the world by a particular earthquake, allows the Division to determine the direction of the fault on which the earthquake occurred. To date, the analysis has been applied to 20 earthquakes, and the results suggest that in circum-Pacific earthquakes transverse faulting is the predominant type. These preliminary results have proved to be of such geophysical interest that it is proposed to carry on the project indefinitely.

General. The meeting of the Eastern Section of the Seismological Society of America was held in Ottawa, under Dominion Observatory auspices, on June 15 and 16, 1951.

GRAVITY

Field Observations. Using automobile and aircraft transportation, Dominion Observatory observes 2,064 gravity stations. All of the observations were made with the three gravity meter instruments and no pendulum observations were obtained.

Four hundred and thirty-four stations were observed in the Prairie Provinces to cover areas not previously surveyed and to connect the Observatory gravity network to several detailed gravity surveys previously conducted by commercial prospecting companies. In the Sudbury area, 108 observations were made at points along railroads inaccessible by motor transport. In southeastern Ontario 418 observations were taken over the area covered by the geological map (Map 852A, G.S.C.) of the district on a scale of 4 miles to 1 inch. Analysis of this dense network will comprise part of the report covering all gravity work of the Dominion Observatory in southern Ontario.

A study of the gravity field throughout the mining areas of northern Ontario and Quebec was started. Approximately 600 regional stations were established at intervals of 1 mile or 2 miles along all passable roads extending from Timmins, Ontario, to Senneterre, Quebec. In addition to the gravity measurements, density determinations were made for rock specimens collected in the vicinity of the gravity stations wherever rock outcrops occurred.

Using aircraft for transportation, 398 gravity points were established, chiefly in the province of Quebec between Ottawa River and Eastmain River, extending as far as Lake Mistassini. An attempt was made to carry this project into the James Bay area of northern Ontario, but because of the shallowness of the lakes and rivers only 48 observations were made in the large area between Winisk and Moose Rivers and extending 160 miles inland from the coast of James Bay. To obtain more complete gravity data over this area it will be necessary to use an aircraft equipped with skis and to conduct the survey in the early spring before break-up.

A detailed gravity survey was carried out in the vicinity of a sulphide metal deposit in the Timmins area to provide regional data to facilitate analysis of previous gravity measurements over this property.

Analysis of the results of gravity meter observations have revealed their dependence on the older network of gravity stations for the determination of instrumental scale constants, and to avoid systematic errors when observations are made over large ranges of latitude. The existence of such a network of 190 stations covering a range of latitude from 43 to 75 degrees has been of the greatest assistance in accurately reducing the gravimeter observations, but it is now clear that not only are more Canadian pendulum stations needed but a network of stations extending over a larger latitude range than is available in Canada, is highly desirable. This matter was discussed at the International Union of Geodesy and Geophysics at Brussels in 1951 and negotiations are in progress with United States scientists for the setting up of such a network, by Canadian observers, extending from Mexico through the United States and Canada to Alaska.

Studies of the Earth's Crust. A study of gravity observations made in the Canadian Shield areas of northern Ontario and Manitoba has indicated the presence of large belt-like areas of alternating high and low gravity of the order of several hundred miles long and 50 miles broad, and these might possibly be interpreted as indicating the presence of remnants of ancient mountain systems. In connection with the same studies, a method has been developed in an attempt to determine from gravity measurements the thickness of greenstone belts in Canadian Shield areas, and layers studied suggest depths of from 4 to 6 km. It is hoped eventually to check some of these values by other geophysical methods.

A study of isostatic anomalies in areas close to centres of Pleistocene glaciation has indicated that compensation is practically complete and that there is little evidence to support the idea that the land is still rising following the removal of glacial loads.

DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.

Effective July 1, 1951, Dr. J. A. Pearce resigned his position of Dominion Astrophysicist in order to devote his time to purely scientific matters. Dr. R. M. Petrie was appointed Dominion Astrophysicist and assumed the duties of that position on August 1, 1951.

RESEARCH

The research work embraced investigations into the physical and chemical processes occurring in stellar atmospheres, the motions of the stars, and the mechanics of double star systems. The telescope was employed exclusively upon stellar spectroscopy during a year that was about 10 per cent above average in number of clear hours. However, the winter months were again very poor, thus retarding progress on certain of the programs. The telescope was used on 223 nights for a total of slightly more than 1,300 hours' observing time, and 1,385 spectrograms were obtained.

Seismological research work was commenced during the year.

Stellar Spectroscopy

Studies in this field are carried on for the purpose of interpreting the observed radiations from the stars in order to understand and explain the physical nature and the sources of energy of these bodies. During the year special efforts were made to observe two interesting eclipsing stars that during eclipses offer favourable opportunities for studying the stellar atmospheres. In the results to date new information has been gained on the structure and the turbulent nature of the outer layers of the hotter stars.

Another project completed during the year has shown how to find the true brightness of the high-temperature stars. This work will be applied in studies of the distances and motions of certain stars in order to give a closer to complete understanding of the dimensions and the dynamical nature of the galaxy. As a result of this work it is now possible to assign, with some assurance, distances to every hot star under observation.

Studies included an analysis of the light from three comets that appeared in 1939, 1940, and 1942. This work has shown that the radiations from the comets are induced largely by the action of sunlight, and has given information on the densities and general nature of these strange bodies. The cometary work at Victoria will be reported by invitation at a colloquium at the University of Liége in the summer of 1952.

The observations and measurements made upon the analysed light of stars have been supported by calculations and theoretical studies of the way in which the gases composing the stars may be expected to behave under the enormous flood of radiation and the high gravitational forces prevailing. The general outcome of the work on stellar spectroscopy provides a better understanding of the nature of atoms, and supplements to some extent the knowledge that is obtained by physicists and chemists in terrestrial laboratories.

Stellar Motions

The stellar motion programs are devoted to the determination of the line-of-sight speeds of large numbers of stars and to the investigation of close double stars that can never be seen separately but which are revealed by spectroscopy. In the former, programs are chosen so as to shed light upon the movements of groups of stars, which in turn gives knowledge regarding the structure of the universe and how the laws of mechanics apply in the stellar field. Double stars are observed as they pursue their orbital motions, and from these observations it is possible to deduce the sizes, densities, and other interesting information regarding the individual stars. This information dovetails with other physical studies bearing on stellar structure and the origin of stellar energy. During the year more than 1,100 photographs were measured for the determination of stellar speeds, and seven double-star systems were studied in

detail and their orbital motions thoroughly determined. One of these systems turned out to be triple rather than double, providing an opportunity to study the operation of gravitational forces in a more complicated system.

SEISMOLOGY

Two new seismograph stations were established at Horseshoe Bay and Port Alberni, B.C., and began recording on August 11, 1951. These stations, together with the older station at Victoria, constitute a triangular network that makes possible the precise location of numerous local earthquakes that occur in the Coast region. One hundred and twenty-nine local tremors have been recorded and the positions of the disturbances located; of these, six were strong enough to be felt by residents of southern British Columbia.

Many inquiries in the field of seismology were answered during the year. Earthquake data were supplied to the Water Rights Branch of the Provincial Department of Lands and Forests and to the B.C. Underwriters' Association.

INSTRUMENTATION

The main project undertaken by the Observatory is the new stellar spectograph, which is designed to make available new techniques and optical equipment so as to increase the efficiency in the fundamental spectroscopic observations. The new spectrograph will be put into operation shortly. As part of the modernizing of the equipment, additional optical parts were designed and acquired in order to increase the spectroscopic dispersion in the ordinary region and to extend the observations to the ultra-violet region of the spectrum. Experiments were carried on with a view to replacing the photographic plate by photoelectric cells for special observations. The recording of starlight by this new method promises to open new fields in the study of stellar physics.

An electronic device designed to improve the recording of earthquakes is now ready for field tests.

GENERAL

The Observatory was represented at four scientific conferences during the year. At these conferences members of the staff presented papers dealing with new scientific contributions to astronomy and stellar physics.

Forty-four seminars were conducted by staff members and by scientists visiting the Observatory.

The Department of Public Works completed plans and specifications for a much-needed new wing to the existing office building.

An estimated 24,906 persons visited the Observatory. Public observation periods were held each Saturday night from April to November inclusive, and 4,559 visitors took advantage of this opportunity to view the heavens. Many educational and cultural groups were received and shown the Observatory.

Staff members delivered 24 addresses before scientific and educational groups and service clubs. A booklet "The Dominion Astrophysical Observatory, Victoria, B.C." was published describing the Observatory and its work, and has been very popular with schools and the public generally.

GEOGRAPHICAL BRANCH

J. W. Watson, Director

The work of the Branch in the main comprised field surveys of the physical geography of northern regions and of the economic and social geography of areas in southern Canada, as well as studies of the general geography of selected overseas areas of interest to Canada.

The principal project of the Branch has been the preparation of a new Atlas of Canada to replace the last Atlas, published in 1915. In addition, much work was undertaken for use of the Department of National Defence. This consisted mainly of field studies of northern Manitoba, northern Ontario, northern Quebec, and the Northwest Territories, and included the compilation of basic data on ice conditions and on terrain, and an evaluation of map coverage of Canada.

In its work on foreign geography the Branch completed a series of single-country surveys.

Canadian Geography Studies

FIELD SURVEYS

Continuing the systematic geographical surveys commenced in the Maritimes in 1948, the Branch carried out investigations in the New Glasgow and Halifax areas of Nova Scotia in co-operation with the Nova Scotia Research Foundation and the Community Planning Association of Canada. These surveys are designed to provide guidance in the economic and social development of areas, and consist in examining the relationships between topography, climate, drainage, soils, and vegetation in any region, and in showing the combined effect of these factors on the distribution of farming, fishing, lumbering, transportation, industry, commerce, settlement, and population. During the fiscal year full information on the use of the land in rural areas was plotted on aerial photographs. In the urban centres, the location, function, and other characteristics of each building were mapped, classified, and correlated with the physical and economic geography of the area, and their interrelationships were described and interpreted so as to give a better understanding of the way in which the region functions and to provide the basis for future development. The port of Halifax was studied to determine the relationship of certain physical features, the growth of the port, and its division into functional zones. The importance of the port on a provincial, national, and international basis was also investigated through its connection with adjacent coastal areas and its location in relation to certain resources and to major producing and consuming areas.

The surface characteristics, including land forms, drainage, kinds of soil, and types of vegetation cover, of selected areas in northern Manitoba, northern Ontario, and northern Quebec were examined and mapped for the Department of National Defence.

In Northwest Territories a sketch survey was made of Paulatuk Harbour on Darnley Bay where an automatic tide gauge was installed for the Canadian Hydrographic Service. The party also made traverses inland 60 miles to study the interrelationships between land-soil conditions, drainage, and vegetation. This work led to the disclosure of regions affording greater subsistence potentialities for coastal inhabitants. Information collected on the plants and animals in the area for the appropriate government departments has already assisted in extending the ranges of some species.

In co-operation with the Department of Resources and Development, a survey was made of the physical geography of the Slidre Fiord area of Ellesmere Island, the results of which will be correlated with those of the Canadian Wildlife Service, which made biological investigations at the same time. Permafrost studies were carried out for the Department of Transport.

Field investigations were also made for the Civil Defence Division of the Department of National Health and Welfare and the results incorporated in a report for the Cabinet. In this work settlement studies were made of fifty-two centres in the Ottawa Valley and maps were compiled on each showing such data as the residential, commercial, and industrial areas, their geographical growth and density of population. General maps were also compiled of the Ottawa Valley showing the different industries, occupations, French and English speaking communities, etc. Similar information was compiled on the city of Saint John, New Brunswick, in collaboration with civic authorities.

Two geographers accompanied the Joint Canada-United States Weather Station Supply Mission to the eastern Arctic, and collected geographical data en route, particularly on ice conditions in northern waters and on the adaptation of building types to topography, soil, and climate.

OTHER CANADIAN PROJECTS

The Branch acts as the co-ordinating agency empowered by the Interdepartmental Atlas Committee to facilitate the production of a new Atlas of Canada, which is being planned to show the nature and extent of Canada's human and physical resources and their development. During the fiscal year preliminary considerations of the amount of space to be allotted to each topic were completed as well as details of the basic layout for 109 plates, including 435 maps. In addition, an investigation was made of the methods of mapping demographic, economic, and social statistics, and over 800 publications containing maps of Canada were indexed.

The Branch continued its survey inventory of ice conditions in Canadian waters and indexed more than 1,500 items of ice information, 1,300 of which were printed and distributed to those organizations collaborating in the project. In co-operation with the Department of Transport and the National Research Council, the survey was extended to include the waters of the St. Lawrence River and Gulf.

A systematic office survey of physical conditions in northern Canada was continued on a sheet by sheet basis, on a scale of 8 miles to 1 inch, for the Department of National Defence. Data on land form, drainage, texture of soil, and vegetation cover are abstracted from all available published sources, assembled, and plotted on each sheet.

About 200 requests were received for information on topics relating to the physical, economic, and social geography of Canada. These were mainly from other government departments and necessitated the preparation of reports on the Strait of Canso in connection with the building of a causeway across the Strait and on the geography of the Saskatchewan River drainage basin for the Royal Commission on the South Saskatchewan River Development.

Foreign Geography

The Branch completed and published a report on Korea in its Foreign Geography Series. Reports in this series are aimed at providing factual accounts of the geographical background of the outstanding problems and characteristics of countries currently of interest to Canada.

An annotated bibliography was prepared on the geography of Colonization and Settlement in Latin America and Anglo-America for presentation to the Third Pan-American Consultation on Geography in Washington, D.C., July 1952, with the twofold objective of ascertaining what areas in the Americas have been studied geographically and of comparing and contrasting different techniques of making geographical studies of colonization and settlement.

During the fiscal year 147 requests for reports or memoranda on foreign geography were answered on behalf of the Departments of External Affairs, Trade and Commerce, Citizenship and Immigration, and National Health and Welfare, and for universities and national societies.

Draughting

Nine maps and 6 charts and diagrams were drawn for field reports, 126 maps and 3 diagrams for other Branch publications, 133 maps and 193 diagrams for reports in preparation, 51 maps and 515 diagrams for the Ottawa Valley Civil Defence project, 2 maps and 14 charts for the Atlas of Canada, and 41 maps and 15 diagrams for other government departments.

Map Library

The map library collects all types of maps published by federal, provincial, and municipal agencies relative to the geography of Canada, as well as geographical and topographic maps of the principal foreign countries. During the fiscal year 50,000 maps were added to the collection. New exchange agreements were initiated for complete sets of Spanish and Portugese maps, bringing up to 20 the number of such exchanges.

Library

The library maintains a loan service to all government departments and national institutions. During the fiscal year it received by purchase, gift, and exchange 1,641 books and pamphlets, bringing the total number of volumes in the library to approximately 9,650.

Compilation of bibliographies on Canadian geography was continued, three of which were issued during the fiscal year. These bibliographies are widely distributed to other government departments, to the public, to university libraries, and to other educational institutions. Compilation was commenced of an annotated bibliographical index of articles on Canadian geography in geographical periodicals covering the period 1940-50.

PUBLICATIONS

Department of Mines And Technical Surveys

English Publications

Report No.

Annual Report for the Fiscal Year Ended March 31, 1951.
Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31,1951.
**Summary of Activities in 1951.*

French Translations

Annual Report for the Fiscal Year Ended March 31, 1951.
Emergency Gold Mining Assistance Act for the Fiscal Year ended March 31, 1951.
**Summary of Activities in 1951.*

Surveys And Mapping Branch

HYDROGRAPHIC SURVEY

English Publications

1 *Tide Tables for Atlantic Coast, etc., 1952.*
2 *Tide Tables for Quebec, Chicoutimi, and Father Point for 1952.*
3 *Tide Tables for Charlottetown and Rustico, P.E.I., and Pictou, N.S., for 1952.*
4 *Tide Tables for Halifax and Sydney, N.S., for 1952.*
5 *Tide Tables for Saint John, N.B., Yarmouth, N.S., and Windsor, N.S., for 1952.*
6 *Tide Tables for St. John's and Argentia, Newfoundland, for 1952.*
10 *Tide Tables for Pacific Coast for 1952.*
11 *Tide Tables for Vancouver and Point Atkinson, B.C., for 1952.*
12 *Tide Tables for Prince Rupert, B.C., for 1592.*
13 *Tide Tables for Port Alberni and Clayoquot, B.C., for 1952.*
30 *Tide Levels and Tidal Bench Marks,* by C. M. Cross.

GEODETIC SURVEY

English Publications

24 *Precise Levelling in British Columbia and Yukon Territory,* by L. O. R. Dozois.
Geodetic Operations in Canada, January 1, 1948, to December 31, 1950, by J. E. R. Ross.

LEGAL SURVEYS

English Publications

Canada Air Pilot:
Vol. I. Amendment Nos. 92 to 116.
Vol. II. Amendment Nos. 101 to 126.

Geological Survey of Canada

English Publications

2496 Memoir 257. *Geology of a Southwestern Part of the Eastern Townships of Quebec,* by H. C. Cooke.
2497 Memoir 258. *Pierre Greys Lakes Map-area, Alberta,* by E. J. W. Irish.
2498 Memoir 259. *Geology of Northeastern British Columbia,* by F. H. McLearn and E. D. Kindle.
2499 Memoir 260. *Geology and Coal Deposits of the Minto and Chipman Map-areas, New Brunswick,* by J. E. Muller.
2500 Memoir 261. *Mineral Industry of District of Mackenzie, Northwest Territories,* by C. S. Lord.

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*Mimeographed.

Bulletin 17. *Gastropoda and Conularida of the Ottawa Formation of the Ottawa-St. Lawrence Lowland,* by Alice E. Wilson.

Bulletin 18. *Contributions to the Palæontology and Stratigraphy of the Jurassic System in Canada,* by Hans Frebold.

Bulletin 19. *The Correlation by Petrographic Analyses, of No. 5 Seam in the St. Rose and Chimney Corner Coalfields, Inverness County, Cape Breton Island, Nova Scotia,* by P. A. Hacquebard.

Bulletin 20. *Precambrian Correlation and Nomenclature, and Problems of the Kisseynew Gneisses, in Manitoba,* by J. M. Harrison.

Handbook. *Prospecting for Uranium in Canada,* by officers of the Radioactivity Division.

Geophysics Paper 36. *Fourniere, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 37. *Amos, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 38. *Kanasuta River, Abitibi and Témiscamingue Counties, Quebec.* (Aeromagnetic map.)

Geophysics Paper 39. *Yellowknife Bay, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 40. *Prosperous Lake, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 41. *Quyta Lake, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 42. *Opasitica, Témiscamingue County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 43. *Desmeloizes, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 44. *Palmarolle, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 45. *Lightning River, District of Cochrane, Ontario.* (Aeromagnetic map.)

Geophysics Paper 46. *Magusi River, Districts of Timiskaming and Cochrane, Ontario.* (Aeromagnetic map.)

Geophysics Paper 47. *Larder Lake, District of Timiskaming, Ontario.* (Aeromagnetic map.)

Geophysics Paper 48. *Aylen River, District of Cochrane, Ontario.* (Aeromagnetic map.)

Geophysics Paper 49. *Preble Island, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 50. *Petitot Islands, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 51. *Wilson Island, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 52. *Hornby Channel, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 55. *Slave Delta, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Gepohysics Paper 56. *Jean River, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 57. *Bathurst, Gloucester and Restigouche Counties, New Brunswick.* (Aeromagnetic map.)

Geophysics Paper 58. *Nepisiguit Falls, Gloucester and Northumberland Counties, New Brunswick.* (Aeromagnetic map.)

Geophysics Paper 59. *Tetagouche Lakes, Restigouche, Gloucester, and Northumberland Counties, New Brunswick.* (Aeromagnetic map.)

Geophysics Paper 60. *Rat River, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 61. *Taltson Bay, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 62. *Thubun Lakes, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 64. *Nepisiguit Lake, Restigouche, Northumberland, and Victoria Counties, New Brunswick.* (Aeromagnetic map.)

Geophysics Paper 65. *Sevogle, Northumberland and Gloucester Counties, New Brunswick.* (Aeromagnetic map.)

Geophysics Paper 66. *California Lake, Northumberland, Gloucester, and Restigouche Counties, New Brunswick.* (Aeromagnetic map.)

Geophysics Paper 67. *Renfrew, Renfrew and Lanark Counties, Ontario.* (Aeromagnetic map.)

Geophysics Paper 68. *Clyde, Renfrew, Frontenac, and Lanark Counties, Ontario.* (Aeromagnetic map.)

Geophysics Paper 69. *Sharbot Lake, Frontenac and Lanark Counties, Ontario.* (Aeromagnetic map.)

Geophysics Paper 71. *Lamorandiere, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 72. *Barraute, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 73. *Val D'Or, Abitibi County, Quebec.* (Aeromagnetic map.)

Paper 50-26. *Vancouver North (East Half), British Columbia,* by J. E. Armstrong. (Map.)
Paper 50-29. *Perth map-area, Lanark and Leeds Counties, Ontario,* by J. Dugas.
Paper 50-34. *Yellowknife, Northwest Territories,* by J. F. Henderson and I. C. Brown. (Map.)
Paper 50-36. *Pleistocene Geology of Fenelon Township, Victoria County, Ontario,* by H. A. Lee.
Paper 51-1. *Gull Pond, Newfoundland,* by J. Kalliokoski. (Map.)
Paper 51-3. *Sipiwesk, Manitoba,* by J. M. Harrison. (Map.)
Paper 51-4. *Ymir Map-area, British Columbia,* by A. L. McAllister.
Paper 51-5. *Hodges Hill, Newfoundland,* by J. J. Hayes. (Map.)
Paper 51-6. *Snowdrift Map-area, Northwest Territories,* by F. Q. Barnes.
Paper 51-7. *Forget Lake Map-area, Saskatchewan,* by D. A. W. Blake.
Paper 51-8. *Carp Lakes, Northwest Territories,* by J. C. G. Moore, M. L. Miller, and F. Q. Barnes. (Map.)
Paper 51-9. *Harbour Grace, Newfoundland,* by R. D. Hutchinson. (Map.)
Paper 51-10. *Canadian Deposits of Uranium and Thorium,* by A. H. Lang.
Paper 51-11. *Springhill, Cumberland and Colchester Counties, Nova Scotia,* by W. S. Shaw. (Map and structure-sections.)
Paper 51-12. *Pleistocene and Recent Deposits of the Cornwall-Cardinal Area, Stormont, Dundas, and Grenville Counties, Ontario,* by E. B. Owen.
Paper 51-13. *Geology of the Southern Coast of Labrador from Forteau Bay to Cape Porcupine, Newfoundland,* by A. M. Christie.
Paper 51-14. *Courageous Lake, Northwest Territories,* by J. C. G. Moore. (Map and notes.)
Paper 51-15. *Westfield, Kings, Queens, Saint John, and Charlotte Counties, New Brunswick,* by G. S. MacKenzie. (Map.)
Paper 51-16. *Some Lower Cretaceous Sections on Peace River below the mouth of Smoky River, Alberta,* by R. T. D. Wickenden.
Paper 51-17. *Cranberry Portage (East Half), Manitoba,* by T. Podolsky. (Map.)
Paper 51-18. *Giauque Lake (Southwest Sheet), Northwest Territories,* by L. P. Tremblay. (Map.)
Paper 51-19. *Hampstead, Queens, Kings, and Sunbury Counties, New Brunswick,* by G. S. MacKenzie. (Map.)
Paper 51-20. *Marks Lake, Newfoundland,* by John Jesse Hayes. (Map.)
Paper 51-21. *The Geology of Burlington Peninsula, Newfoundland,* by D. M. Baird.
Paper 51-22. *Pincher Creek, Alberta,* by R. J. W. Douglas. (Map.)
Paper 51-23. *Griffis Lake (West Half), Quebec,* by W. F. Fahrig. (Map.)
Paper 51-24. *A Petrographic Description of the Wall-rocks and Alteration Products Associated with Pitchblende-bearing veins in the Goldfields Region, Saskatchewan,* by K. R. Dawson.
Paper 51-25. *Christie Bay, District of Mackenzie, Northwest Territories.* (Map and notes.)
Paper 52-3. *The St. Mary River-Willow Creek Contact on Oldman River, Alberta,* by E. T. Tozer.

Mines Branch

English Publications

Report No.

830 *The Canadian Mineral Industry in 1949.*
832 *Analyses of Canadian Crude Oils,* by H. McD. Chantler, P. B. Seely, and F. E. Goodspeed.

Memorandum Series

*113 *Survey of the Copper Resources of Canada,* by W. R. McClelland.
*114 *The Determination of Uranium in Ores by Fluorophotometric Method,* by J. B. Zimmerman.
*115 *Radioassay of Uranium Ore with the Geiger Type Equilibrium Counter,* by R. D. Wilmot and C. McMahon.
*116 *The Utilization of Low Grade Domestic Chromite,* by K. W. Downes and D. W. Morgan.

* Reprints available.

Papers

*1. *Magnesium Alloys and Method of Treatment,* by J. W. Meier; Canadian Patent No. 472,670 (April 3, 1951).

*2. *The Structural Lattice of Hessite,* by J. F. Rowland and L. G. Berry; The American Mineralogist, vol. 36 (1951), pp. 471-479.

*3. *Empressite and Stuetzite,* by R. M. Thompson, N. A. Peacock, J. F. Rowland, and L. G. Berry; The American Mineralogist, vol. 36 (1951), pp. 458-470.

*4. *Precise Determination of Lattice Constants by Electron Diffraction, and Variation in the Lattice Constants of Very Small Crystallites,* by F. W. C. Boswell; Proceedings of the Physical Society, vol. 64, Pt. V (May 1951).

*5. *Discussion by T. V. Simpkinson of paper entitled "Identification and Mode of Formation and Resolution of Sigma Phase in Austenitic Chromium-Nickel Steels,* by Dulis and Smith; A.S.T.M. Special Technical Publication No. 110 (1951), pp. 30-34.

*6. *Stress Raisers in Fatigue,* by R. C. A. Thurston; Canadian Mining and Metallurgical Bulletin, vol. 44, No. 469 (May 1951), pp. 347-355.

*7. *The Fatigue Strength of Threaded Connections,* by R. C. A. Thurston; Paper No. 51-SA-11, A.S.M.E., Semi-Annual Meeting, Toronto, June 1951; Transactions A.S.M.E., vol. 73, No. 8 (November 1951), pp. 1085-92.

*8. *Effect of Phosphorus Content on the Mechanical Properties of a Nodular Cast Iron,* by J. E. Rehder—American Foundrymen's Society Preprint No. 51-43, 8 pp.

*9. *The Relative Effects of Chromium and Silicon Contents on the Rate of Anneal of Black-Heart Malleable Iron—Part I—First Stage Annealing,* by J. E. Rehder; American Foundrymen's Society Preprint No. 51-51, 6 pp.

10. *A Note on the Dephosphorization Effect of Magnesium Additives to Cast Irons,* by J. E. Rehder; American Foundryman, vol. 19, No. 5 (May 1951), p. 95.

*11. *Metal Penetration,* by S. L. Gertsman and A. E. Murton; American Foundrymen's Society Preprint No. 51-16, 8 pp.

*12. *Evaluation of Metal Penetration Variables,* by S. L. Gertsman; Foundry, vol. 75, No. 5 (May 1951), pp. 84-89; American Foundryman, vol. 19, No. 4 (April 1951), pp. 94-99.

*13. *Magnesium Alloys and Desulphurization,* by S. L. Gertsman and B. F. Richardson; Canadian Metals, vol. No. 5 (May 1951), pp. 20-33.

*14. *The Annealing and Heat-Treatment of Nodular and Other Cast Irons,* by J. E. Rehder; Congrès International de Fonderie, Bruxelles, 1951, Memoire No. 4, pp. 313-324.

*15. *Nodular Iron Hot-Forged and Rolled Experimentally,* by J. A. Perry and J. E. Rehder; The Iron Age, vol. 168, No. 40 (October 4, 1951), pp. 229-233.

*16. *Magnesium Alloys,* by J. W. Meier; Canadian Patent No. 478,060 (October 23, 1951).

17. *Testing Low Hydrogen Electrodes,* by S. Agnew, L. H. Stirling, and W. P. Campbell; Canadian Metals, vol. 14, No. 12 (December 1951), pp. 40, 42, 44, 46.

*18. *Quench-Temper Treatment Improves Nodular Iron,* by J. E. Rehder; The Iron Age, vol. 169, No. 3 (January 17, 1952), pp. 89-93.

19. *Nodules and Nuclei in Nodular Iron,* by J. E. Rehder; American Foundryman, vol. 21, No. 2 (February 1952), pp. 44-48.

*20. *Tin and Copper in Steel: Both are Bad, Together They're Worse,* by S. L. Gertsman and H. P. Tardif; The Iron Age, vol. 169, No. 7 (February 14, 1952), pp. 136-140.

21. *Substitution for Strategic Metals in Steel Production,* by S. L. Gertsman; Canadian Metals, vol. 15, No. 3 (March 1952), pp. 20, 22-23.

*22. *Analysis of the Excitation Characteristics of Spectra Emitted by Ferrous Alloys,* by J. K. Hurwitz and J. Convey; Journal of Optical Society of America, vol. 42, No. 1 (1952), pp. 24-30.

Lists of Mines and Mine Operators

4-1. Coal Mines in Canada, 1951.

* Reprints available.

Reprints

A Study of Cold-water Separation of Bitumen from Alberta Bituminous Sand on a Pilot Plant Scale (fundamentals of the process), by L. E. Djingheuzian and T. E. Warren; Can. Jour. Tech., vol. 29: 170-189, April 1951.

Cold-water Method of Separation of Bitumen from Alberta Bituminous Sand (economic aspects of the process), by L. E. Djingheuzian; Proc. Athabasca Oil Sands Conference, Sept. 1951, pp. 185-199, Board of Trustees, Oil Sands Project, Government of Alberta, Edmonton, Alta.

Pilot Plant Investigations on Cold-water Separation of Bitumen from Alberta Bituminous Sands (ore dressing aspects of the process), by L. E. Djingheuzian; Can. Inst. Min. Met., Trans., vol. LV: 1-14, 1952.

Beneficiation of a Canadian Spodumene Ore from Cat Lake District, Manitoba, by H. L. Beer; the Precambrian, June 1951.

Laboratory Flotation Concentration of Some Canadian Non-metallic Ores, by H. L. Beer; Canadian Mining Manual, 1951 Ed., Gardenvale Press.

Coal Preparation and Its Relationship to Mineral Dressing, by E. Swartzman and L. E. Djingheuzian; Can. Min. Jour., vol. 73, Nos. 1 and 3, 1952.

French Translations

The Canadian Mineral Industry in 1949.

The Canadian Mineral Industry in 1950.

Dominion Observatories

Dominion Observatory

English Publications

Report No.

Vol. XIV, No. 8. *Bibliography of Seismology, July to December 1950.*

Vol. XIV, No. 9. *Bibliography of Seismology, January to June 1951.*

Reprints

Vol. 1, No. 6. *Direction of Faulting in Certain Earthquakes of North Pacific,* by J. H. Hodgson and W. G. Milne.

Vol. 2, No. 9. *Atmospheres of the Early Type Stars,* by C. S. Beals.

Astrophysical Observatory

English Publications

Descriptive booklet: *The Dominion Astrophysical Observatory, Victoria, B.C.*

Vol. VIII. Title page, contents.

Vol. VIII, No. 12. *Model Atmosphere for an Early O-Type Star,* by Anne B. Underhill.

Vol. VIII, No. 13. *On the Luminosity Effects of the Hydrogen Lines on O-Type Spectra,* by Anne B. Underhill.

Vol. VIII, No. 14 *Spectroscopic Observations of Epsilon Ursae Minoris,* by J. L. Climenhaga, A. M. McKellar, and R. M. Petrie.

Vol. VIII, No. 15. *Revised Radial Velocities of Seventy-nine B-Type Stars,* by J. A. Pearce and R. M. Petrie.

Vol. IX, No. 1. *Spectra of P. Cygni Stars,* by C. S. Beals.

Reprints

Contribution No. 23. *Estimate of Relative Helium Content of Early-Type Stars,* by Anne B. Underhill.

Geographical Branch

Information Series No. 2. *Canadian Arctic.*