CANADA

Annual Report

Department of Mines and Technical Surveys

Fiscal Year Ended
March 31, 1950

Price, 50 cents

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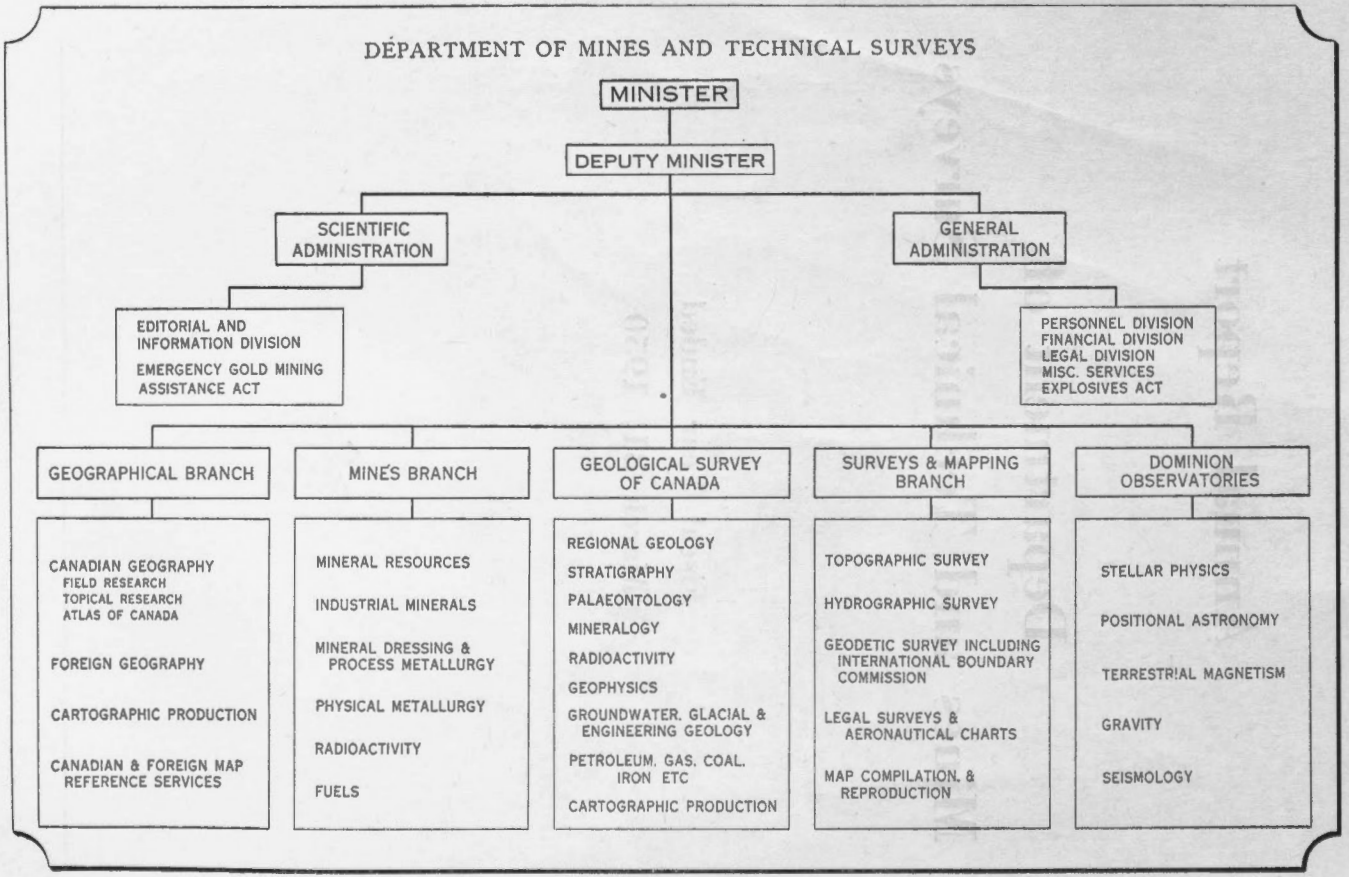

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MAY IT PLEASE YOUR EXCELLENCY:

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, 1950.

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, 1950.

Your obedient servant,
MARC BOYER,
Deputy Minister.

REPORT OF THE DEPARTMENT OF MINES AND TECHNICAL SURVEYS FOR THE FISCAL YEAR 1949-50

THE NEW DEPARTMENT

The Department of Mines and Technical Surveys was created by an Act of Parliament (13 George VI Chapter 17), which received Royal Assent on December 10, 1949, and came into force by Order in Council P.C. 2/330 of January 20, 1950. Its establishment resulted from the organization of certain former government departments into three new departments, one of these being the Department of Mines and Technical Surveys. It is actually the old Department of Mines and Resources, minus Indian Affairs, Immigration, Forestry, Water Power Resources, and the National Museum of Canada.

The Department was established in view of the growing feeling, particularly among those interested in mining, that the importance of the mineral industry and of the Government's relations with the industry was such that there might well be a Minister of the Crown who would devote his full attention to the fields of mines and mining.

In setting up the Department the Government met the wishes of industry by transferring to other departments the administration of such branches of the former Department of Mines and Resources as Indian Affairs, Forestry, and Immigration, and as now constituted the Department of Mines and Technical Surveys is an integrated organization whose primary function is to provide technological assistance in the development of Canada's mineral resources through studies, investigations, and research in the fields of geology, mineral dressing, and metallurgy, and of topographic, geodetic, and other surveys. Although the Department had been functioning only a few months by the end of the fiscal year, editorial and other comment in the technical and mining press was mainly to the effect that its establishment received a favourable reception in Canadian mining circles.

The Department has five branches, namely, the Surveys and Mapping Branch, the Geological Survey of Canada, the Mines Branch, the Dominion Observatories, and the Geographical Branch.

The Surveys and Mapping Branch provides the base maps required for use in the development of Canada's natural resources, produces and distributes all Canadian aids to navigation, is responsible for all legal surveys of federal lands, and provides a national system of levelling and precision surveys for use as geodetic control by federal, provincial, and private agencies. As an added service, the branch makes the results of surveys quickly available to federal and provincial organizations and to the public through the distribution of advance information prints. It maintains the National Air Photographic Library, which is responsible for the indexing, preservation, and distribution of prints from all air photography carried out by, or for, the federal government. It provides the staff of the Canadian Board on Geographical Names and its vote includes funds for the expenses of the board. The branch issues the official Canadian navigation charts, volumes of sailing directions, and the standard tide prediction tables for Canadian seaports. It prepares and maintains aeronautical charts and flight manuals and prepares electoral maps. The Chief of its Geodetic Survey is the Canadian representative on the International Boundary Commission.

The functions of the Geological Survey of Canada comprise: Geological studies in the field and office to promote the discovery and development of mineral resources and underground water resources; to contribute geological

information as an aid in the construction of such public works as dams, bridges, tunnels, foundations, etc.; to make mineralogical and palæontological studies in the field and office that assist in promoting the study and development of mineral resources; to collect minerals and material for study, exhibition, and distribution; to make geophysical surveys; and generally, to add to the knowledge of the geology of Canada and to disseminate such knowledge through the publication of reports and maps. The types of reports issued by the Geological Survey comprise memoirs, bulletins, papers, and reports of the Economic Geology Series. Memoirs are fairly complete descriptive accounts of the geology of particular areas, and are accompanied, as a rule, by geological maps. Bulletins deal with problems rather than areas. Papers, which are issued as soon as possible after the close of the field season, treat separately of each area and summarize the information acquired. Economic Geology Series reports deal in a comprehensive way with mineral deposits of a particular type. Coloured geological maps are issued on various scales from 1 inch to a few hundred feet to 1 inch to 8 or more miles, the common standard scales being 1 inch to 1 mile and 1 inch to 4 miles. Preliminary blue line prints, on which the geology is shown in pattern, are issued shortly after the field season ends of those areas where the search for metals or minerals is active.

The Mines Branch is primarily concerned with the technological problems of the mineral industry and maintains well-equipped ore testing, mineral dressing, fuel research, ceramic, radioactivity, industrial waters, and physical metallurgy laboratories to handle these problems. The scope of its activities is as wide as the technical needs of the industry it serves. It ranges from relatively minor tests on the lowly sands to fundamental research on the rare metals; from routine inquiries on various phases of Canadian mineral development to such highly important and specialized assignments as handling all the metallurgical problems of the Atomic Energy Project at Chalk River. Within this broad range comes the test work on ores designed primarily to work out and to improve treatment methods and thus aid in reducing milling costs; the investigations on industrial minerals aimed largely toward the greater utilization of Canadian sources of these minerals; the work in the ceramic laboratories; the intricate studies in the spectrographic and mineralographic laboratories; researches on Canadian fuels; the tests and other work on radioactive minerals; the varied investigations in physical metallurgy; and the special studies on various economic phases of Canadian mineral development.

The Dominion Observatory at Ottawa and the Dominion Astrophysical Observatory at Victoria, B.C., are responsible for all research in astronomy carried out by the federal government. In addition to studies of purely scientific interest, data and services of practical application are regularly maintained, notably in the Time Service of Canada, which is an activity of the Ottawa Observatory.

The Dominion Observatory is also charged with geophysical research in seismology, terrestrial magnetism, and gravity, and field studies of all earthquakes occurring in Canada and seismic studies of the earth's crust. The magnetic map of Canada, extending from the United States border to the North Pole and definitely locating the north magnetic pole, is under continuous construction and modification, with the co-operation of other government services. A gravity survey of Canada has been under way for many years to provide a gravity map of Canada, thus contributing largely to the research on crustal structure in this part of North America.

The primary function of the Geographical Branch is to organize and make available to all branches of the federal government all the geographical data on Canada and on foreign countries that might be of use in promoting the economic, commercial, and social welfare of Canada. Work undertaken by

the Branch is of two kinds, namely, the compilation of geographical material of national significance, and geographical surveys in the field. One of the main projects on hand is the compilation of an Atlas of Canada. It will replace the present official atlas published in 1915.

The Department administers the Explosives Act, which regulates the manufacture, testing, sale, storage, and importation of explosives. It also administers the Emergency Gold Mining Assistance Act, which provides cost-aid assistance to the Canadian gold industry.

The Act creating the Department is cited below:

His Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:

Short title.

1. This Act may be cited as The Department of Mines and Technical Surveys Act.

Definitions. "Department". "Minister". "Technical surveys".

2. In this Act

(a) "Department" means the Department of Mines and Technical Surveys;

(b) "Minister" means the Minister of Mines and Technical Surveys; and

(c) "technical surveys" means geographical, geological, geodetic, topographical and hydrographic surveys.

Department established.

3. (1) There shall be a department of the Government of Canada which shall be called the Department of Mines and Technical Surveys over which the Minister of Mines and Technical Surveys for the time being appointed by commission under the Great Seal of Canada shall preside.

Management.

(2) The Minister shall have the management and direction of the Department and shall hold office during pleasure.

Deputy Minister.

4. (1) The Governor in Council may appoint an officer who shall be called the Deputy Minister of Mines and Technical Surveys who shall be the deputy head of the Department and who shall hold office during pleasure.

Other officers, clerks and employees.

(2) Such other officers, clerks and employees as are necessary for the proper conduct of the business of the Department shall be appointed or employed in the manner authorized by law.

Transfer of members of staff.

(3) Notwithstanding subsection two, the Governor in Council may, by order, designate persons who, prior to the commencement of this Act, were members of the staff of the Department of Mines and Resources or the Department of Reconstruction and Supply, to be members of the staff of the Department, and, upon such designation, such members shall be deemed to have been transferred to the Department on the date of the commencement of this Act, but no person shall by reason only of such transfer be eligible to be certified as permanent by the Civil Service Commission.

Duties, powers and functions of Minister.

5. The duties, powers and functions of the Minister shall extend to and include all matters over which the Parliament of Canada has jurisdiction relating to mines, minerals, explosives and technical surveys.

Further duties.

6. The Minister shall

(a) collect and publish full statistics of the mineral production and of the mining and metallurgical industries of Canada, and such data regarding the economic minerals of Canada as relate to the processes and activities connected with their utilization, and collect and preserve all available records of mines and mining works in Canada;

(b) make detailed investigations of mining camps and areas containing economic minerals or deposits of other economic substances, for the purpose of determining the mode of occurrence, and the extent and character of the ore-bodies and deposits of the economic minerals or other economic substances;

(c) make a full and scientific examination and survey of the geological structure and mineralogy of Canada;

(d) make such chemical, mechanical, metallurgical and other researches and investigations as are necessary or desirable to carry out the purposes and provisions of this Act and particularly to aid the mining and metallurgical industry of Canada;

(e) have the control, management and administration of any astronomical observatories maintained by the Government of Canada;

(f) collect and prepare for exhibition such specimens of the different ores and associated rocks and minerals of Canada and other materials as are necessary to afford a knowledge of the geology and mineralogy and the mining and metallurgical resources and industries of Canada; and

(g) prepare and publish such maps, plans, sections, diagrams and drawings as are necessary to illustrate and elucidate any reports of investigations and surveys made pursuant to this Act.

Surveys.

7. The Minister may, for the purpose of obtaining a basis for the representation of the mineral and mining resources and of the geographical and geological features of any part of Canada, cause such measurements, observations, investigations and physiographic, exploratory and reconnaissance surveys to be made as are necessary for or in connection with the preparation of maps, sketches, plans, sections or diagrams.

Distribution of specimens and publications.

8. The Minister may cause distribution to be made of duplicate specimens to scientific, literary and educational institutions in Canada and other countries, and also authorize the distribution or sale of the publications, maps and other documents issued by the Department.

Department, Minister and Deputy Minister substituted.

9. (1) Wherever in any Act of the Parliament of Canada or in any order, rule or regulation thereunder the Department of Mines, the Minister of Mines or the Deputy Minister of Mines is mentioned or referred to there shall in each and every such case be substituted the Department of Mines and Technical Surveys, the Minister of Mines and Technical Surveys, and the Deputy Minister of Mines and Technical Surveys, respectively.

Idem.

(2) Wherever the Department of Interior, the Minister of Interior or the Deputy Minister of Interior or the Department of Mines, the Minister of Mines and Resources or the Deputy Minister of Mines and Resources is mentioned or referred to in the Dominion Land Surveys Act, there shall in each and every such case be substituted the Department of Mines and Technical Surveys, the Minister of Mines and Technical Surveys, and the Deputy Minister of Mines and Technical Surveys, respectively.

R.S., c.117.

Idem.

(3) Wherever the Department of Mines and Resources, the Minister of Mines and Resources or the Deputy Minister of Mines and Resources is mentioned or referred to in The Explosives Act, 1946, or The Emergency Gold Mining Assistance Act, there shall in each and every such case be

1946, c.7.
1947-48, c.15.

substituted the Department of Mines and Technical Surveys, the Minister of Mines and Technical Surveys and the Deputy Minister of Mines and Technical Surveys, respectively.

Powers under contracts.

(4) Whenever in any contract, lease or other document any power, authority or function in relation to mines, minerals, explosives or technical surveys is vested in or exercisable by the Minister of Mines and Resources or the Deputy Minister of Mines and Resources, the Minister of Mines or the Deputy Minister of Mines, the Minister of Interior or the Deputy Minister of Interior, the power, authority or function shall be vested in and shall or may be exercised by the Minister of Mines and Technical Surveys and the Deputy Minister of Mines and Technical Surveys, respectively, or by such other Minister or Deputy Minister as the Governor in Council may designate.

Appropriations based on 1949-50 Estimates.

10. The provisions made by any Appropriation Act for the financial year ending the thirty-first day of March, one thousand nine hundred and fifty, based on Estimates 1949-50 to defray expenses of the public service of Canada within the Department of Mines and Resources, and the Department of Reconstruction and Supply, shall apply to such similar or other as well as like classifications of the public service within the Department of Mines and Technical Surveys as the Governor in Council may determine.

Annual report.

11. The Minister shall submit to Parliament within thirty days after the commencement of the first session of Parliament in each year a report showing the operations of the Department during the year then last preceding.

Coming into force.

12. This Act shall come into force on a day to be fixed by proclamation of the Governor in Council.

REVIEW OF MINERAL DEVELOPMENTS

The period under review proved to be a banner year for the Canadian mineral industry, and for the fifth successive year a new record was established in the value of output. The production of metals, fuels, and the industrial minerals combined reached a value of $901,100,000, an increase of nearly $81,000,000 over 1948, the previous peak year. The physical volume of production was also at a record level, being slightly above the previous peak established in 1942 and 37 per cent above the 1935-39 average. Quantity records were attained in the production of iron ore, coal, natural gas, petroleum, cement, fluorspar, nepheline syenite, salt, and stone. The entry of Newfoundland into Confederation added to the Canadian supply a substantial production of iron ore, zinc, lead, copper, silver, and fluorspar, valued at $27,600,000 in 1949. Capital expenditures by the industry in 1949 for new construction, machinery, and equipment, exclusive of smelters and refineries, reached an estimated total of $135,000,000, a 29 per cent increase over 1948.

Developments in the oil fields of Alberta were again prominently to the forefront and brought further significant changes to Canada's oil picture. Crude oil output in that province was 84 per cent higher than in 1948, and by the end of the fiscal year was at a daily rate of 76,000 barrels. Discoveries of new fields—Golden Spike, Normandville, Joseph Lake, Stettler, and others—brought nearer to realization the hope that Canada will eventually attain a self-sufficiency, in balance, in its oil requirements. The continued success of drilling raised the proved reserves of petroleum in Alberta to more than a billion barrels, valued at close to $3,000,000 at the well head. Preliminary work on construction of the 1,150-mile pipeline from Edmonton to Superior, Wisconsin, was commenced, with expectations that oil would be moving through the line to Superior by the end of 1950 or by the spring of 1951.

The active and potential importance of these developments and their timeliness require little stressing, for petroleum has long been a principal item on the list of Canada's imports. Moreover, Canadian consumption has been rising steadily. It rose from a daily rate of 138,000 barrels in 1939 to 320,000 barrels in 1949, with an increase in the annual per capita consumption from 4·5 barrels in 1939 to 8·6 barrels in 1949. Although it is likely to continue to rise—and perhaps at an accelerated rate—the proportion of the requirements imported, in excess of 90 per cent in 1947, had declined appreciably by the end of the fiscal year as a result of these developments, and seems likely to continue to do so. In fact, a saving in dollar exchange of $100,000,000 or more is anticipated in 1951.

Developments in natural gas in Alberta closely paralleled those in oil, and estimates made by the Department of Mines and Technical Surveys placed reserves at about seven trillion cubic feet at the end of the fiscal year. An outstanding completion in 1949 was the Walter Marr well southeast of Pincher Creek, the largest gas well ever drilled in Canada. In addition, many gas wells were discovered during oil-drilling operations. However, the discoveries have been either abandoned or capped until such time as a market is available, the market in the immediate vicinity of the gas fields being fully supplied. In any event, the number of discoveries made incidental to the search for oil is indicative of the large reserves that can be expected when exploration is directed toward the discovery of gas.

Sharing the limelight with oil and contributing greatly to the expansion of the mineral industry were the developments in connection with iron ore in Ontario and in the Quebec-Labrador region, titanium at Allard Lake in Quebec, and asbestos in northern Ontario. Operations in the Steeprock and Michipicoten areas in Ontario point to substantial increases in the production of iron ore from each of these areas. Production from the Steeprock operations to date has come from the open pit of the "B" orebody, which can be worked economically for several more years, and preparations were being made to open an underground mine in this orebody. Financial arrangements for developing the "A" orebody were completed late in 1949, production from which is expected to commence in 1953, with full production of 2,000,000 tons a year anticipated by 1955. The grade is about the same as that of the "B" pit, but the proportion of open-hearth lump ore is possibly greater. Drilling of the "C" orebody was commenced early in January 1950 by Inland Steel Company of Chicago. Preliminary drilling in this locality several years ago indicated the possibility of a large deposit of ore.

Operations in the Michipicoten area are expanding, though on a smaller scale, and are expected to provide about 1,000,000 tons of ore in 1950, compared with 600,000 tons in 1949. The Siderite Hill deposit, discovered in 1948, is being prepared for production as a separate operation, with indications that the output will be about the same as that of the Helen mine, the sole source of iron ore production in the area in recent years.

Continued exploration of the iron ore deposits in the Quebec-Labrador region increased the total reserves of ore to about 360,000,000 tons by the end of the fiscal year. A major development was the announcement late in 1949 that an agreement had been made with Iron Ore Company of Canada to finance the project to the point of production. This company represents six steel companies in the United States, including M. A. Hanna Company, which will market the 10,000,000 tons a year considered to be the minimum payable tonnage. It was expected that preliminary work on construction of the 360-mile railway from the Port of Seven Islands to the deposits would be underway before the close of 1950.

Significant headway was made toward bringing the large deposits of titanium ore at Allard Lake into production. A 27-mile railway to connect

the deposits with Havre St. Pierre on the Gulf of St. Lawrence was under construction, as was an electric furnace smelting plant at Sorel, Quebec, to treat the ore. Designed to treat 1,500 tons of ore a day, the plant will have a daily yield of 500 tons of iron and 700 tons of titanium dioxide concentrate. The latter will be used to produce refined titanium for pigments and other purposes.

The opening up of a new and important asbestos-bearing area by Canadian Johns-Manville Company, Limited, in Munro township, Ontario, brings that province into prominence as a major potential source of supply of this mineral. Several deposits had been delimited by the end of the fiscal year and a 50-ton per hour capacity unit of a 100-ton per hour milling plant was brought into operation. The asbestos is a harsh variety of chrysotile of the cross-fibre type and occurs in veins up to 1 inch wide. It is well suited for making asbestos-cement products.

Despite the declines in the average prices of copper, lead, and zinc, the total output of these metals in 1949, at 711,494 short tons, was 11 per cent higher than in 1948. Output of nickel was lower, but the value was higher because of the increase in the price of the metal. Just a few weeks prior to the commencement of the fiscal year the prices of copper, lead, and zinc began to recede from the peaks for recent years reached late in 1948. This recession was largely attributable to a recession in business in the United States and gained momentum until late in the summer of 1949, following which there was a moderate recovery. By the end of the fiscal year, however, the price levels were well below the 1948 peaks.

Exports of the five metals showed an overall increase in 1949, when 700,000 tons of unmanufactured copper, nickel, lead, and zinc valued at $257,400,000 was exported. Sixty per cent of the total tonnage was marketed in the United States and about 30 per cent in Great Britain. Compared with 1948, exports of copper to the United States showed close to a twofold increase, zinc a 24 per cent increase, and lead a 21 per cent increase, whereas nickel exports were about 10 per cent lower. Exports of lead, zinc, and nickel to Great Britain increased, but there was a slight decrease in exports of copper to that country. The tariff concessions obtained at Geneva in 1947 on the principal base metals entering the United States remained in effect throughout the fiscal year.

The status of the base metal industry was strengthened by the entry into production of the Quemont copper-gold-zinc mine in the Noranda area, Quebec, and of the Reeves-MacDonald lead-zinc mine 20 miles east of Trail in British Columbia. Both mines show great promise of becoming leading contributors to the output of these metals. Exploration and development work on a number of properties that can now be classed as potential producers proceeded apace. Drilling during 1949 by Gaspe Copper Mines, Limited, on its copper property in Gaspe North county, Quebec, disclosed an additional 7,000,000 tons of ore, bringing the total indicated by drilling to 48,000,000 tons. The company is a subsidiary of Noranda Mines, Limited. Development of the property is indicative of the increasing interest being shown in the opening up of large low-grade deposits. Another case in point is in the Sudbury area where the International Nickel Company of Canada, Limited, is preparing a new mine for production near its present Creighton mine. The expected output of 9,000 tons a day of low-grade copper-nickel ore will be concentrated in a new mill to be erected at the mine. Underground development work on Sherritt Gordon's copper-nickel deposits in the Lynn Lake area, Manitoba, also resulted in proving up substantial tonnages of additional ore.

Gold production rose to 4,123,518 ounces in 1949, a gain of 593,910 ounces over 1948. This is the largest gain the industry has recorded in recent years, but the output was still well over a million ounces below the peak reached in

1941. The increase came mainly from Ontario, Quebec, and the Northwest Territories, among the important contributing factors being the cost-aid assistance provided under the Emergency Gold Mining Assistance Act, and the devaluation of the Canadian dollar. Cost-aid payments to the gold mines totalled $12,674,604.91 in the fiscal year.

Three new gold mines entered production, the chief addition to the list being the Nor-Acme mine in the Snow Lake area in Manitoba. The mine is equipped with a 2,000-ton milling plant. Campbell Red Lake mine in Ontario has a 500-ton mill, and Discovery Yellowknife in the Northwest Territories, a 100-ton mill.

Activities in connection with uranium ore consisted for the most part of the development of properties and further exploration of discoveries made in 1948. Chief interest was centred in the Goldfields area of Saskatchewan, where shaft sinking was done by the Crown-owned Eldorado Mining and Refining (1944), Limited, and by Nicholson Mines, Limited. In the Black Lake area, 120 miles east of Goldfields, Nisto Mines, Limited, did extensive drilling and made preparations for full development as soon as adequate equipment could be brought on the property over a road from Stony Rapids, construction of which will be financed under a three-way arrangement between the company and the provincial and federal governments. Several properties in the Montreal River area on the northeast shore of Lake Superior were under investigation.

The record of $178,488,295 set in the value of output of the industrial minerals in 1949 mainly reflects the continued expansion in the construction industry. This expansion has been gaining momentum steadily since the war and has outpaced the rising production of the clay products and other structural materials. Though the output of cement reached a peak of 15,916,564 barrels in 1949, it was necessary to import close to 3,000,000 barrels to meet the requirements. Several major engineering developments absorbed large quantities of the material, and supplies for other constructional purposes were much short of the demand. The heavy demand for clay products resulted in an expansion of production facilities and the establishment of some new plants. The demands for light-weight aggregate greatly exceeded the amount available for making light-weight structural units. Likewise, capacity operation of lime and rock wool plants failed to meet the domestic requirements, necessitating large imports.

The aforementioned developments in Munro township highlighted activities in the asbestos industry. In the Thetford and Asbestos areas in Quebec new deposits were also proved by drilling, among these being the new orebody at the Vimy Ridge property of Asbestos Corporation, the new property of Bell Asbestos Mines in Thetford township, and the extension of Johnson's Company orebody at Black Lake. Modernization of established mills and haulage systems in these areas was continued and further progress was made in the changeover from open-pit mining to underground mining by the block-caving method. The labour strike in the asbestos industry that started in February and lasted for 117 days resulted in a total time loss of 494,000 man-working days. But for the strike, production of asbestos would doubtless have reached a record in 1949. It was the only major labour dispute in the mineral industry during the fiscal year. The entry of Newfoundland into Canada was reflected in a marked increase in the production of fluorspar in 1949. In the past Canada depended chiefly upon imports to meet its requirements, as is shown by the fact that 82 per cent of the average consumption of 21,800 tons during the 30-year period ended 1948 was imported. Canada now has sufficient fluorspar for years to come and is the second largest producer of the mineral in the British Empire.

The Canadian salt industry was considerably expanded. The new plant of Prairie Salt Company, Limited, at Unity, Saskatchewan, entered production, and construction of the new caustic-soda-chlorine plant of Dominion Alkali and Chemical Company, Limited, at Beauharnois was completed. Imports of salt in the coarse grades increased, the chief reason being the entry into Confederation of Newfoundland, which uses large quantities of coarse salt in the fishing industry, most of which is imported from the West Indies.

OUTLINE OF ACTIVITIES OF THE DEPARTMENT

The heightened pace of developments in the mineral industry found reflection in the activities of the Department during the fiscal year, as did the increased public interest in mining resulting from the impact of these developments on the Canadian economy. All branches of the Department and units of branches primarily concerned with mineral development experienced a particularly busy year in endeavouring to meet the many and varied demands on their services. In this the addition to the facilities provided since the war proved especially helpful, not only in expediting much of the work of the units concerned, but in making it possible to widen the scope of activities and to enhance their usefulness to industry.

The mining and metallurgical industries and the Defence Services will benefit from the many-sided program of tests, research, and investigative work conducted by the Mines Branch. Faced with rising operational costs, industry made increasing use of the benefits of science to reduce these costs. This, coupled with the pressure of demand for most products of the mines and with the rapid expansion of mining, gave added importance to the services of the Branch. In tests and research on the efficient and economic processing of Canadian ores, Branch engineers made considerable progress in effecting higher recoveries through improvements in milling practices and the development of new methods of treatment. In their studies of low-grade and complex gold ores they developed an improved method for testing the leaching power of mill cyanide solutions, which it is believed will prove helpful in maintaining leaching solutions at maximum efficiency. Working on low-grade or complex uranium ores, they developed a leaching process that shows promise of providing an economic means of treating such ores. The process is to be tried on a larger scale by the Crown-owned Eldorado Company.

Looking to the active development of the large deposits of spodumene in Manitoba and Quebec the Branch continued its efforts to develop a cheap and direct process for recovery of lithium from the ore, and devised a refining process on a laboratory scale by which lithium was produced containing as low as 0·001 per cent sodium compared with a sodium content of 0·5 per cent in the original crude material.

Research in the field of ceramics was stepped-up, particularly in reference to the adaptation to industrial uses of ceramics raw materials found in Canada. Likewise, research on the application of spectrographic methods to the analyses of metals and minerals was extended.

The industrial minerals received major attention in the Branch's program, and work was done on deposits of these minerals in every province. This included the examination and sampling of numerous deposits in Newfoundland favourably located for development.

The rising demand for light-weight aggregates for construction use caused the Branch to undertake research into the possibilities of producing these aggregates from any clay or shale. Some excellent products were obtained from test work on one hundred samples, mainly from Ontario and Quebec.

Research was also commenced on the possibilities of producing artificially coloured roofing granules from Canadian rocks. Imports of these granules amount to about $2,000,000 a year.

Sufficient headway was made in work on the processing of low-grade silica sands to indicate that a silica sand of the necessary purity for use in the glass and sodium silicate industries will shortly be available from Canadian sources.

A study was undertaken of the possibilities of making fertilizer materials from the deposits of apatite and associated pyroxenite in Ontario and Quebec.

To aid the coal industry in maintaining its markets against the rising competition from fuel oil the Branch undertook an extended program of research and investigation work on Canadian coals, as it is considered that well-planned and co-operative research can do much to lessen the adverse effects of this competition. As the railways provide one of the principal markets for coal the Branch devoted much attention to its part of a co-operative project on the development of a coal-fired gas turbine engine. The investigation centres largely around the combustion problems involved.

Continuing their studies of Canadian coal mining methods, Branch engineers found that many underground operations suffer from excessive strata pressures. Accordingly, a study of these pressure phenomena was initiated.

Further research on means of overcoming the high losses suffered by industry through metal corrosion indicated that the use of chemical resistant paints may be one of the answers to the curbing of these losses.

Worthy of particular note was the development of "Kinsalloy", a new alloy of nickel, aluminium, and molybdenum, which is particularly well suited for very high temperature uses such as in the rapidly moving parts of jet aircraft engines, and is produced from materials readily available on the American continent. So, too, was the development of a high-strength magnesium casting alloy that has one of the highest strength to weight ratios of all commercial alloys and has proved successful in various industrial products and for uses in aircraft and airborne equipment. Still another accomplishment was the development of a process, yet to be commercially tested, for the desulphurization of steel whereby the sulphur is removed from the molten steel in the ladle rather than in the furnace, the action being instantaneous, whereas removal of sulphur while the steel is in the furnace requires about an hour to complete. Should the process prove successful in practice a saving of approximately $3,000,000 to the Canadian steel industry is visualized.

It is encouraging to report in connection with the administration of the Explosives Act that although the output of commercial blasting explosives reached the highest level in the history of the industry, not a single accident involving high explosives occurred to mar this achievement. The work of safety committees in the various explosives factories proved an invaluable aid in administration of the Act.

Reviews for 1949 on each of the metals and minerals produced in Canada in commercial quantities were issued by the Branch. Wide use in Canada and abroad is made of these informative accounts of developments in the mineral industry.

The unit responsible for producing and repairing secret anti-submarine equipment continued its operations, its work during the year being largely of a repair and service nature. It also continued the refinishing of quartz for radio-frequency control units for the Armed Services.

Geological and topographical mapping were both carried out on a greater scale than in any past year. Seventy-two geological and sixty-eight topographical parties were assigned to field work compared with sixty-one and forty-one respectively in the previous fiscal year.

The geological work took the parties to areas in every province, including, for the first time, Newfoundland, to which seven parties were assigned, and to the two territories. Standard geological mapping on scales of either 1 or 4 miles to the inch was conducted in thirty-seven areas across Canada, and several productive areas were mapped in greater detail to acquire information useful to operators on the sources and nature of ore deposits. Some wholly or largely unexplored areas were mapped, three cases in point being the work in the Aylmer area 250 miles northeast of Yellowknife in the Northwest Territories, the western part of the Bennett area in British Columbia, and a reconnaissance survey in southern Baffin Island.

Nine of the forty-four geological parties assigned to geological work in the West gave their whole attention to areas of oil and gas developments, mainly in Alberta.

As a service to the coal industry, the Geological Survey published 68 geological maps pertaining to Canada's coal resources. These included a set of 52 maps of coal areas in Alberta showing all coal mines and other occurrences of coal, and a set of 13 maps relating to the twelve commercial seams of the Sydney submarine coalfield. This service was in addition to the field work on coal measures in British Columbia and Nova Scotia, included in which was detailed mapping in the Springfield Colliery area where coal is being mined at a depth of 4,000 feet, the deepest coal mining operations in North America.

The Survey made a start on the geological mapping of the Quebec-Labrador iron belt in work that will provide information on the character, distribution, structure, origin, and age of the rock formations, and on their relationship to the iron deposits.

An area of iron-bearing Grenville rocks extending roughly from Maniwaki, in Quebec, westward to Parry Sound, in Ontario, was covered by aeromagnetic surveys in the largest and most important geophysical project yet undertaken by the Geological Survey. Carried out in co-operation with the Ontario government, the project is of special interest in view of the possibilities for the discovery of commercial deposits of iron in the region. The results will be of guidance in the search for such deposits and in geological mapping. Approximately 13,150 square miles of territory were covered in the survey. In another aeromagnetic survey an 8,300-square mile section of New Brunswick was covered, this being at the request of the provincial government.

The rapid pace of resources and industrial development in Canada during the year is perhaps best reflected in the many demands that were made on the Surveys and Mapping Branch for surveys, maps, and charts. As a part of its efforts to meet these demands the Branch, in a stepped-up program of topographical mapping, covered areas across Canada totalling approximately 116,000 square miles. It undertook a large program of geodetic work that will provide positional and height control as a basis for new mapping and charting, and for major construction projects such as power developments; carried out legal surveys of Dominion lands in various parts of Canada; had in hand the preparation of landing and approach charts, to be printed in three colours, for all Canadian airports where radio range facilities are available; distributed more than 210,000 topographical maps, 122,000 aeronautical and plotting charts, more than 1,000 forestry maps, 14,162 Electoral District maps, 52,626 Canada Air Pilot sheets; and to the collection of its National Air Photography Library it added one print each of 236,294 new aerial negatives covering areas in Canada totalling 872,446 square miles.

To meet the demands for more and better charts of Canada's waterways and coasts the Branch placed two additional 230-foot ships into service with its Hydrographic fleet. Including these two vessels, it had thirteen ships in operation, engaged chiefly in charting on the Newfoundland coasts, Bay of

Fundy, Grand Manan, Hudson Bay, the Great Lakes, Great Slave Lake, and the British Columbia coast. The season's work of the fleet included roughly 9,600 linear nautical miles of ship and boatsounding, over 900 linear nautical miles of coastlining, and the examination of close to 1,300 shoals. Chart sales of the Hydrographic Service rose to the highest level in several years, the increase being chiefly attributable to defence requirements, development of northern transportation to serve mining interests, and growth of the water-borne tourist trade.

Speed, and efficiency of operation are factors of the greatest importance to the Branch in handling such a large volume of work, much of it of an urgent nature, and here it may be noted that although the staff of the Branch has increased about fivefold since the war, there has been close to a tenfold increase in its actual output. This has been made possible largely by the use of multiplex and other modern map-plotting equipment, which not only improves the quality of the work but in many cases reduces the cost of the finished product. In its field activities, too, the Branch is turning to the use of the latest scientific tools in an effort to speed up its mapping and other work. The experimental use it has been making of the helicopter in its topographical mapping and of Shoran in its geodetic work are two examples. Though the results of the use of the helicopter have not been fully up to expectations, they do indicate that this type of transportation has great possibilities both in speed and economy. Likewise, the experimental use of Shoran encourages the view that this method of obtaining horizontal control will enable a rapid expansion of such work in several of Canada's northern regions.

Astronomical observation and research and a series of geophysical investigations formed the core of the program of the Dominion Observatories. A major project at Ottawa was the observation of accurate positions of stars in conjunction with other observations throughout the world to provide accurate star catalogues for use by navigators and surveyors. At Victoria, British Columbia, fundamental astrophysical research programs were actively advanced and reports on a large number of completed researches were published. The research was concerned chiefly with the motions and physical characteristics of the stars and of interstellar material.

Observatory buildings at Meanook and Newbrook in Alberta were under construction for use in the program of photographic triangulation of meteors.

The practical value of the geophysical work of the Dominion Observatories to prospectors and commercial companies became increasingly apparent. The search for mineral wealth is facilitated by the magnetic maps, which, when supplemented by Observatory magnetograms and studied in conjunction with geological maps, indicate areas where the magnetic field is distorted by mineralized belts. Through its gravity survey of Canada the Observatory at Ottawa contributes to the research on crustal structure, particularly on the location of geological structures, including faults, dykes, buried ridges or inclinations, and mineral deposits. The thousands of gravity stations established across Canada are proving of valuable assistance to the mineral industry, particularly in the search for oil.

Using a gravimeter mounted on an automobile the Observatory at Ottawa made 718 observations in Ontario, Manitoba, Saskatchewan, and Alberta in the summer of 1949, a primary aim being to correlate a number of local gravimetric surveys made by commercial geophysical companies in the western provinces. The results of the field work over the Sudbury basin should prove helpful to geologists in their studies of the sub-surface structure of this important mineralized region. The summer's work included extension of the airborne gravity survey of Canadian Shield areas into northern and eastern Ontario.

Studies made of several thousand gravity observations east of the Rocky Mountains indicated numerous interesting correlations with the geology and topography of the region.

Work on the compilation of a new Atlas of Canada that will replace the existing edition, which was published in 1915, formed the principal activity of the Geographical Branch. Many changes have taken place in all phases of Canadian development in the intervening years, and these changes will be incorporated in the new atlas. Important discoveries such as new mineral resources will be depicted and new islands found in Canada's northland will be shown. Weather maps and related information will appear in the new publication.

Mention should be made of various other services that were rendered to industry, the public, other government departments and agencies, and to different international organizations, particularly as these services, considered as a whole, form a major part of the work of the Department. They comprise such varied activities as the papers, articles, and talks prepared by senior officers of the Department for presentation before scientific, trade, and other associations in Canada and abroad; the production of prototype equipment for the Defence Services; the preparation of briefs and other material for the use of UNESCO and other United Nations' organizations; the many short-term but often complicated projects undertaken to assist industry to overcome operational difficulties; the routine testing of ores, minerals, and their products for some immediate use of industry; the identification of thousands of rock and mineral specimens for prospectors and other interested parties; the participation of the Department in or its representation on interdepartmental, government-industry, international, and other committees; the systematic collection of basic information largely for use in building up an inventory of the country's mineral resources; and advising the Department on matters pertaining to the taxation of mines.

The large number of papers and talks that were presented served the main purposes of keeping members of the associations concerned posted on the aims and results of several of the Department's principal research and investigative activities, and made possible a valuable interchange of ideas on the subjects in question.

Much of the routine testing of samples of ores and minerals is for use of small mining and metallurgical enterprises that are unable to maintain facilities of their own for such work. It is a service that often results in a considerable saving of expenditures to the parties concerned because of the expert and timely information that is provided.

In the fiscal year under review more than 8,000 specimens of rocks and minerals were identified, mainly for prospectors.

Of great assistance to industry also are the many small projects carried out by the Department relating chiefly to problems encountered in plant practice. This service, too, is of particular value to the smaller enterprises. Equally important are the services rendered through the answering of many hundreds of inquiries, ranging from requests for information on Canadian sources of raw materials and on possible markets for new products to requests for data on new mineral developments. Although most of these requests are of Canadian origin, an increasing number are from the United States and other countries.

Space permits mention of only a few illustrative examples of the many services that were rendered to other government departments and agencies. These are listed below.

(1) For the Naval Service work was done on refractories for use in marine boilers. This involved actual tests on one of the destroyers during a run, taking temperature measurements and studying the conditions the refractories had to meet.

(2) For use of the Department of Citizenship and Immigration a comprehensive program was undertaken of sampling the St. Lawrence River water just above Caughnawaga in order to provide information on the water supply for the Indian Reservation.

(3) An engineer was loaned to the Resources and Development Department to conduct a study of raw materials available in Newfoundland for the construction of the Trans-Canada Highway in that province.

(4) At the request of the Dominion Coal Board the Department conducted a comprehensive investigation into the quality of coal being supplied to the railways in western Canada and as actually supplied to the locomotives whether from fresh deliveries or from stockpiles. The purpose of the investigation was to encourage the use of Canadian coals in locomotives on western runs.

(5) Complete subdivision of ten Indian Reserves in Manitoba, Saskatchewan, and Alberta into farm lots for Department of Citizenship and Immigration.

Illustrative of the services to the United Nations was the work of a senior official of the Department in connection with the United Nations Scientific Conference on the Conservation and Utilization of Resources, held at Lake Success in August 1949. This work related in particular to the preparation of material on critical world mineral shortages. Another service was the preparation of a brief on the geography of Bolivia for use of the United Nations Mission on Technical Assistance to Underdeveloped Countries.

Much of the work of the Department is centred around the activities of interdepartmental and other committees. It is through these interdepartmental committees that many of the co-operative projects are planned, and that requirements of other departments for the services of the Department of Mines and Technical Surveys are co-ordinated. For instance, the Interdepartmental Committee on Air Surveys co-ordinates the requirements of all Dominion Government services for air surveys and arranges an annual program of air photography. Government-industry committees come into play chiefly in the work of the Mines Branch, a good illustration being the Physical Metallurgy Research Laboratories where many of the projects are carried out in co-operation with committees of such organizations as The Steel Castings Institute of Canada, The American Foundrymens' Association, and the Canadian Welding Bureau, on all of which the Department is represented.

In other committees, use is made of the special skills of the Department's professional staff, an example being The Combined Tin Committee on which a senior officer of the Department served as consultant. This Committee, which ceased to function near the close of the fiscal year, was responsible for the international allocation of tin. The same officer is also a member of the International Tin Study Group, which considers possible solutions to the problems of tin supply and demand. In this capacity he attended a meeting of the Group in London, England, in June 1949, and another in Paris in March 1950.

The Department was represented at the Fourth Empire Mining and Metallurgical Congress held in London, England, in the summer of 1949 by the Director of the former Mines, Forests and Scientific Services Branch, the Director of the present Mines Branch, and by its senior coal geologist.

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

SUMMARY OF REVENUE AND EXPENDITURES FOR THE FISCAL YEAR 1949-50

—	Revenue	Expenditures		
		Ordinary	Demobilization and reconversion	Total expenditures
Mines and Technical Surveys—				
Departmental Administration	8,039.32	(1)14,295,726.24	.....	14,295,726.24
Mines Branch	19,436.77	1,891,758.75	14,816.17	1,906,574.92
Geological Survey	6,727.43	1,196,404.58	.....	1,196,404.58
Surveys and Mapping Branch	65,250.17	4,661,447.15	(2) 1,340,000.00	6,001,447.15
Dominion Observatories	72.68	352,943.72	.....	352,943.72
Geographical Branch	30.64	141,323.27	.....	141,323.27
	99,557.01	22,539,603.71	1,354,816.17	23,894,419.88

(1) Includes payments totalling $14,055,554.17 made under the provisions of the Emergency Gold Mining Assistance Act.

(2) This amount was paid to the Royal Canadian Air Force and commercial companies for air photography and includes the expenses of the Interdepartmental Committee on Air Surveys.

SPECIAL MINERAL PROJECTS

AGREEMENT WITH YUKON COAL COMPANY LIMITED

This agreement, dated July 10, 1947, provides for loan advances not exceeding $300,000 for the development and operation of the Tantalus Butte coal mine near Carmacks, Yukon. The loan is repayable on the basis of $2 royalty on each ton of coal sold. At the close of the fiscal year advances had reached a total of $294,124.60 and repayments totalled $16,516.24. The mine was in operation throughout the 1949 navigation season, though underground work was restricted to mining sufficient coal to satisfy somewhat limited market requirements. Coal sales during the season amounted to 2,554 tons, the principal markets being the silver-lead mining industry at Mayo and domestic consumers in Dawson. Coal burning tests in the S.S. *Whitehorse* were unsuccessful with the vessel's present equipment.

Administration of the Yukon Coal Company project was passed to the Department of Resources and Development March 31, 1950.

AGREEMENT WITH ABASAND OILS LIMITED

Funds from War Appropriation were used during the war to remodel and enlarge the Abasand Oils Limited bituminous sands plant near Fort McMurray, Alberta, and to operate it as a test plant for extracting and refining bitumen from the tar sands of that area. The separation plant was destroyed by fire in June 1945. Under an agreement of sale dated November 1, 1946, the remaining facilities were handed over to the company, who later disposed of them. Proceeds from the sales to the amount of $254,717.90 were paid to the Federal Government in accordance with the terms of the 1946 agreement. In maintaining the plant and equipment as saleable assets in the Government's interest, however, the company expended $76,379.13 of its own funds. Reimbursement of this expenditure was authorized by Order in Council P.C. 39/6191 dated December 7, 1949. The company is retaining its lease of an extensive area underlain by high-grade bituminous sands in the Mildred-Ruth Lakes area north of Fort McMurray.

AGREEMENT WITH FLUOROC MINES LIMITED

This company's fluorspar property in Madoc area, Huntingdon township, was reopened in 1949 by W. J. Symon, who acquired the property under lease in 1948. Considerable surface improvements were installed by Mr. Symon, but no underground work was reported. A small amount of past-due royalty on fluorspar sold by Fluoroc Mines Limited is still outstanding.

FORMER WARTIME OILS, LIMITED

During the war the Government advanced funds through Wartime Oils, Limited, a Crown company, for the drilling of twenty-two wells in the Turner Valley area, Alberta, twenty-one of which became producers. Under the terms of agreements with owners of the wells the funds advanced are repayable out of production. Six of the producing wells have repaid the cost of drilling, and the remaining producers have repaid a large part of the drilling advances. Revenue to the Government continues from the six paid-up wells in the form of royalty in varying amounts proportionate to the amounts advanced for drilling each well. The amount of advances outstanding at March 31, 1950, was $386,796.88.

ROADS INTO MINING AREAS

Administration of these projects now rests with the Department of Resources and Development, which consults with the Department of Mines and Technical Surveys on various matters relating to the projects.

MINES BRANCH

C. S. Parsons, Director

In this review of the work carried out in the Mines Branch during the past fiscal year it should be emphasized that the Branch (formerly Bureau of Mines) is a technical organization covering the technology of the mining and metallurgical industry in Canada.

As mining has continued to expand—and it has expanded at a rapid rate in recent years—its requirements for research and test work have become more urgent. Oil developments in the West and the impact of oil on the coal industry have given rise to a greater need for an extended program of studies on coal. New treatment methods for low-grade and refractory ores must be worked out if industry is to realize the much-needed support of production from the extensive Canadian deposits of these ores. Research in ceramics must keep pace with the stepped-up demand for these products. The challenge proffered by atomic energy must be matched with increased test work and research on radioactive minerals. And it is only through research that new alloys are developed, new methods of fabrication are devised, and metallurgical and mineral dressing problems are solved. These are only a few of a wide range of problems on which the Branch has patterned its program of test work and research activities.

The necessity of preserving the coal industry against the inroads being made upon it by oil led the Branch to step-up research aimed broadly at the more economic production of better quality coals. In co-operation with the Dominion Coal Board it continued its studies of coal mining methods with emphasis on the major problem of excessive strata pressures encountered by coal mine operators. As this problem is particularly acute in western Canada where the seams dip into the Rocky Mountains, the long-range program of study was launched with the setting up of pressure measurement stations underground in various western coal mines. Further research was done on the beneficiation of Canadian coals to assist industry in the upgrading of these coals to improve their qualities for marketing.

In another project designed to assist the coal industry, the Branch continued its research on the development of a coal-fired gas locomotive by carrying out experimental tests on coals typical of Canadian railway use. This is a co-operative project aimed at maintaining the important railway market for coal, the Branch's phase of the work being the study of combustion problems.

By working out a process on a pilot plant scale for the separation of bitumen from the bituminous sands of northern Alberta, Branch engineers succeeded in overcoming a major technological problem affecting the development of these huge deposits. Much better results than were formerly anticipated were obtained when the resultant flow sheet gave recoveries of over 95 per cent of bitumen content.

Recent developments in iron ore have posed many problems bearing on the economics of operations. As more and more attention is being given to the suitable preparation of furnace burden, the Branch has launched a long-range program of research into the preparation of certain of these ores for market and the improvement of the marginal ores associated with the deposits.

At the request of the Industrial Research Board a further intensive study was made of methods of producing a marketable grade of chromite from the large low-grade deposits of this mineral in the Bird River area, Manitoba.

Meanwhile research was continued on gold ores aimed at increasing the extraction of the metal and devising more economic methods of recovery, particularly from marginal and refractory ores, with a view to easing the increased operational costs being encountered by gold mines.

Research in the field of ceramics was broadened to better service this rapidly expanding branch of the mineral industry.

The ever-increasing demand for industrial minerals for use in the chemical, construction, and manufacturing industries, and the growing rigidity in the specifications governing the minerals, led the Branch to intensify its research activities aimed at the greater utilization of Canada's industrial mineral resources. These included field studies of deposits, industrial processes, and methods of beneficiating minerals from marginal and sub-marginal deposits. These investigations were extended to include the new province of Newfoundland, where technical assistance was given to operators on methods of improving and expanding operations and on marketing problems. The successful development of a method of producing coarse salt of a high degree of purity from fine salt will prove of material benefit to the fishing industry, which annually imports coarse salt to the value of $2,000,000. Seeking new uses for industrial minerals, Branch engineers made magnesium oxychloride and magnesium oxysulphate cements from domestic sources of magnesia. A new industry was establsihed in Ontario as a result of this work.

The "stocktaking" of the country's mineral resources that was commenced by the Branch shortly after the last war has now reached a stage where all the significant metallic occurrences have been systematically catalogued and where it is now possible to make a practical appraisal of the country's mineral resources and mineral production potential. The need for an inventory of this kind was made crystal clear during World War II when the lack of such information in readily available form proved an expensive lesson in wasted time, effort, and money.

The heightened interest of prospectors and the mining industry in general in the search for and development of uranium deposits in Canada was evident in the 100 per cent increase in demands for concentration and extraction tests on ores, mineralogical examinations, and the assay of samples. In its research on the treatment of radioactive ores, the Branch developed an improved method for the economic recovery of uranium from low-grade or complex ores unsuited to conventional methods of treatment. Another accomplishment was the development of the Geiger probe, which facilitates underground exploration by assaying a particular vein to the exclusion of interference on the counter of surrounding radioactive vein material.

Through the adoption of improved methods for the chemical and physical analyses of uranium ores, the Branch achieved the twin goals of speedier and more accurate analysis and a ready means of analysing low-grade material, thus greatly facilitating the handling of the marked increase in the demands for tests on radioactive minerals. The work on radioactive minerals is done under the authority of the Atomic Energy Control Board and the information that is made available on this work is subject to the approval of the Board.

A possible saving to the Canadian steel industry of approximately $3,000,000 a year and a 10 to 15 per cent increase in Canada's steel melting capacity without addition to present furnace facilities are visualized by the Branch as a result of its research on the desulphurization of steel. The chief feature of the improved process is the almost instantaneous elimination of sulphur in the ladle containing the molten steel by means of the addition of a magnesium-aluminium alloy rather than the time-consuming present commercial practice of removal while the steel is in the furnace. Economies in the use of manganese, which is in short supply in Canada, would also be realized from the use of this method of desulphurization.

Following several years of effort directed to the development of new, superior, high-temperature alloys, the Branch developed "Kinsalloy", an alloy composed entirely of nickel, aluminium, and molybdenum, materials readily

available on this Continent. Proved capable of withstanding stresses at high temperature in service, Kinsalloy has successfully passed engine tests and is being tested in an actual engine. A new high strength magnesium casting alloy containing zinc and zirconium (ZK61) was also developed that possesses one of the highest strength to weight ratios of all commercial alloys, a valuable contribution to the manufacture of light airborne and combat equipment.

To assist the paper-making industry the Branch launched investigations into the critical problem posed by the present high rate of wear of welded pulp digesters. The successful completion of these investigations would greatly reduce the present high replacement costs being met by the mills.

The handling of the metallurgical problems of the Atomic Energy Project at Chalk River continued to be a major activity of the Branch, and mainly involved various studies in metal physics and nuclear metallurgy.

The administration of the Explosives Act was extended to the province of Newfoundland, where Branch officers licensed explosives magazines and made preliminary surveys and inspections. It is encouraging to report that, despite a peak production of commercial blasting explosives in Canada, no accidents occurred during their manufacture. Further headway was made in the investigation into the hazards attending the storage and shipment of ammonium nitrate fertilizer, an investigation that has aroused much interest as extensive quantities of this material are manufactured in Canada.

A divisional reorganization was effected in the Branch early in the year in which the physical metallurgical laboratories, which formed a section of the former Mineral Dressing and Metallurgical Division, were separated and established as the Division of Physical Metallurgy. The former Mineral Dressing and Metallurgical Division was renamed the Mineral Dressing and Process Metallurgy Division. The handling of the ever-increasing demand for test work and research on Canadian ores was thus greatly facilitated.

MINERAL RESOURCES DIVISION

The Division is a clearing house for many types of information, economic, technical, and non-technical, on mineral resources and the metallic and industrial mineral products derived from them. It also assists the Canadian mining industry by means of specific economic studies and allied activities that usually necessitate examination of minerals in the field followed by analytical and research work in the laboratory to determine how best to process and apply them commercially. The quantity and variety of the work of the Division increase with the growth of the mineral industry and depend upon the nature of that growth and the economic policies and trade associated with or arising from it.

The Chief of the Division served at the request of the Department of Trade and Commerce as technical adviser to the Canadian representation on the Combined Tin Committee at Washington and also to the Canadian delegates at the International Tin Study Group meetings at London and Paris. He attended the United Nations Scientific Conference on the Conservation and Utilization of Resources at Lake Success, New York, and the meeting of the Sub-Committee on Non-Ferrous Metals and Minerals of the Joint United States-Canada Industrial Mobilization Planning Committee at Washington.

Officers of the Division served on various committees formed to consider and advise on matters bearing upon minerals and mineral products.

The Division's Mineral Resources Inventory continued to keep abreast of the active mineral development in Canada. The increasing demand for metals and minerals has resulted in renewed activity in many of the old base metal mining areas, along with new exploration and discovery. The mineral occurrence index has readily provided the condensed information and references for

the numerous inquiries regarding properties and mineral occurrences. This information is utilized extensively by the Department and by other Government departments and the cards are frequently consulted by representatives of the mining industry.

The strategic importance of minerals in national defence is well recognized, and sources of supply, both domestic and foreign, are vitally important. A function of the Mineral Inventory is to survey available Canadian mineral resources, with particular attention to ore reserves and mining potential. Information on the more important foreign mineral resources are compiled, especially those in which Canadian sources are lacking or small.

Based largely on information in the Mineral Inventory, an economic survey was prepared on thirty strategic and critical minerals and metals for the Crown-owned Canadian Arsenals, Limited. The inventory was also utilized by the Non-Ferrous Metals and Advisory Committee of the Industrial Defence Board in the preparation of some preliminary reports on low-grade and marginal deposits.

In line with the policy of a co-operative exchange of information on mineral resources, a number of provincial Departments of Mines were visited and arrangements were made to receive reports and information on new mineral discoveries and current development.

ECONOMIC SECTION

The Section is concerned primarily with the study of economic aspects of the development, use, and conservation of Canada's mineral resources, particularly the metals, and provides investigatory and information services on these matters.

Preliminary studies were made of iron-bearing formations in eastern Ontario and in the adjacent part of Quebec. These formations are geologically similar to those in the Adirondacks area of New York State that now produces 3,000,000 tons of high-grade concentrated ore a year. Iron-ore deposits in eastern British Columbia were also under study. These deposits could conceivably provide a suitable supply of iron ore for the production or iron and steel in the Prairie Provinces that would speed and consolidate the industrial developments arising from the discoveries of oil in that section of Canada.

A study was in progress concerning domestic sources of manganese ore that might be suitable for use in the event of an emergency, and for supplies of which ore Canada is dependent entirely upon imports from overseas. Chief attention was given to iron-manganese deposits and manganese-bearing shale beds in New Brunswick and to the manganese-iron ore in Labrador.

Mimeographed reviews for 1948 prepared by the Section and other officers of the Branch were issued on each of the metals and minerals produced in Canada in commercial quantities during that year.

Senior officers of the Division assisted in the administration of the Emergency Gold Mining Assistance Act. Two of its engineers served full time as a small administrative unit under the direct supervision of the Director General of Scientific Services, one of whom spent approximately 20 weeks on field work examining mine operations.

Much time was given to consideration of special problems arising in the course of administration of the Act, and to the preparation of basic material for amending the regulations as authorized under the 1950 amendments to the Act.

Comments and opinions were prepared on 43 applications the Department of National Revenue received from mining companies for special concessions granted under Dominion tax legislation. Forty-one of these applications were in reference to the 3 years' exemption from income tax accorded corporations operating new mines, and the remainder to depletion allowances.

Submissions were prepared from the Minister's information in considering eight applications for approval by the Cabinet for the special benefits made available under income tax legislation to oil companies drilling approved deep-test oil wells.

Revision of the "Summary Review of Dominion Tax and Other Legislation Affecting Canadian Mining Enterprises" was nearing completion.

INDUSTRIAL MINERALS SECTION

This Section is concerned with matters relating to the development and processing of Canada's industrial minerals, including water used for industrial purposes, and also makes studies of ores of such alloying metals as cobalt, manganese, molybdenum, tungsten, and chromium.

To encourage and assist in the development of domestic resources and thereby lessen the dependence of industry on outside sources of essential raw materials, the Section makes field studies of deposits of industrial minerals throughout Canada, examines industrial processes utilizing them, and initiates research into methods of beneficiating minerals from deposits of marginal and sub-marginal quality to bring them up to the standards demanded by modern industry.

It is of interest to note in this connection that the steadily increasing requirements of the chemical, agricultural, construction, and general manufacturing industries of Canada have resulted in establishment of a new production record for these minerals each year since 1944. However, imports of the minerals and their products have also set new records annually, and at present are increasing at a faster rate than is domestic production. Already these imports exceed in value the domestic production of only a few years ago.

Work was done on deposits of industrial minerals in every province during the fiscal year. In the new province, Newfoundland, all the operating mineral properties were visited and numerous deposits favourably located for development but not being operated at present were examined and sampled. This work is to be continued in greater detail until as much knowledge is obtained of the resources of Newfoundland as is now available of the rest of Canada.

An investigation of clays and shales for uses other than for ceramic purposes was begun. One hundred samples, mainly from Ontario and Quebec, were tested to determine their suitability for making light-weight aggregate, and some excellent products were obtained. Selected samples representing a wide variety of materials were being subjected to numerous physical and chemical tests in the hope of finding the basic reasons for the difference in behaviour during processing, and also as an integral part of the research into the possibilities of producing light-weight aggregate from any clay or shale. As a result of this investigation the Section hopes shortly to be in a position to indicate deposits across Canada where raw materials suitable for making light-weight aggregate can be obtained. At present the demand for this type of construction material far exceeds the supply from the one known source of suitable material in the country. Some work was done in evaluating the commercial possibilities of making light-weight aggregate from deposits of perlite and obsidian in western Canada.

Research was undertaken into the possibilities of producing from Canadian rocks natural and artificially coloured roofing granules that will pass the exacting specifications of the construction industry. Imports of roofing granules cost Canadians approximately $2,000,000 annually. A variety of rocks, including slate, rhyolite, trap, andesite, and peridotite, were examined to ascertain the yields and general physical properties of the products. A testing machine was designed and built to determine the opacity of these various rocks. The results have been encouraging and the work is being followed with interest by Canadian producers and users of roofing granules.

Within the past 2 years a new approach has been made by the Section to the problem of supplying a high-grade silica product from domestic resources for use in the manufacture of glass, sodium silicate, and other products derived from silica. These manufacturers are required to import silica and silica sand valued at over $4,000,000 annually because no domestic deposits of sand, sandstone, and quartzite are known that will yield a product having less than the 0·03 per cent of Fe_2O_3 generally specified. This work has entailed a re-examination of many deposits and the application of new techniques. Sufficient progress was made during the fiscal year to indicate that a silica sand of sufficient purity for use in the glass and sodium silicate industries will soon be available from Canadian sources.

To explore the possibilities of making fertilizer materials from the deposits of apatite and associated pyroxenite in Ontario and Quebec, research was begun into the making of citrate-soluble tricalcium phosphate and citrate-soluble calcium-magnesium phosphate from these minerals by fusing various mixtures and quenching them in water. The results of the fifty fusions that were made by the end of the year were encouraging and the investigation is being continued. Endeavours were being made to develop a method of evaluating the results without having to make a detailed chemical analysis of the products.

The Section continued its general survey of the chemical characteristics of industrial water supplies of Canada, the immediate object of which is to obtain information on the quality of industrial water available in all parts of Canada, a matter of great importance to industry in general. Subsequently studies are to be made of the treatment of water and of its suitability for various uses.

The special survey of the waters of the Columbia River basin in British Columbia that was undertaken in the previous fiscal year, at the request of the International Joint Commission, was completed. A similar survey of waters of Fraser River and its tributaries was begun in February 1950 at the request of the Dominion Provincial Board-Fraser River Basin. This survey, like that of Columbia River, is to last for a period of 1 year. The data obtained will be incorporated into the general report on the industrial waters of Canada. A survey is also being made of the waters of Skeena River and tributaries.

Good progress was made in research into a method of producing from fine salt a coarse salt of a high degree of purity, suitable for use in the food industries. No highly pure, coarse salt is available at present from Canadian sources and it is imported to the value of about $2,000,000 yearly.

Work that was continued on the purification of gypsum gave favourable results in small-scale tests, and larger scale tests are to be undertaken. The object of this research is to remove by dry separation methods the impurities, principally dolomite, that occur in some of the Canadian deposits of gypsum. Hitherto, no economic method of removing these impurities had been found and the quality of the products made from the gypsum containing them has suffered in consequence.

Investigatory work was continued into the making of magnesium oxychloride and magnesium oxysulphate cements from domestic sources of magnesia, and into the production of pure magnesia and magnesium chemicals from brucite. Directly as an outcome of this work, an industry in Ontario was established to make floor tiles having a magnesium oxychloride cement bond.

Work was started on the recovery of pure glauberite from deposits of impure glauberite in New Brunswick, the object being to obtain a product suitable for use in the sulphate-pulp industry.

An investigation was started into the possibilities of making a light-weight insulation brick from diatomite with or without a bonding of clay.

A field survey was made of deposits of rock, sand, and gravel in the area adjacent to the proposed power and seaway development on the St. Lawrence River, and numerous samples were collected for study and testing in the laboratory.

In addition to the above, the Section did tests and other work on a variety of industrial minerals and their products, including quartz, bentonite, lime, cement, rock wool, pyrophyllite, potash, magnesite, limestone, talc, mica, fluorspar, rare minerals, sodium sulphate, corundum, garnet, granite, slag, barite, feldspar, graphite, and nepheline syenite.

Companies, prospectors, and others made extensive use of the information service on the identification of minerals, their possible utilization, and where they can be marketed.

Officers of the Section served on technical committees such as those of the Canadian Standards Association, the committee of the Canadian Government Specification Board, American Society for Testing Materials, Joint United States-Canadian Industrial Mobilization Planning Committee, and others.

LIBRARY

The Library is administered by the Division, but serves all divisions of the Mines Branch.

Chiefly as a result of the expansion of the Branch's activities the work of the Library has greatly increased. Compared with the previous fiscal year, acquisitions increased from 8,047 to 12,114; periodical and annual subscriptions from 243 to 326; recorded loans from 5,198 to 6,857.

Further efforts were made to renew exchanges, which were discontinued during the war, with the libraries of other countries.

Reference cards covering thirty-eight general subjects were distributed to a number of officials and added to the reference catalogue. Information in other fields was obtained from various periodicals and documents and was similarly distributed and filed.

The following acquisitions were recorded:

Publications received	
Canadian Government	1,368
British and Foreign Governments	3,408
Scientific societies	965
Periodicals	5,923
Books and pamphlets ordered	450
Total	12,114
Recorded loans	6,857
(Inter-library loans—lent 496, borrowed 612)	
Cards added to reference catalogue	9,503
Cards added to the general catalogue	2,020
Periodicals and annuals subscribed for	326
Volumes bound	546
Items accessioned	1,242

MINERAL DRESSING AND PROCESS METALLURGY DIVISION

The Division can report much solid accomplishment in its services to industry during the fiscal year. Reflecting the heightened activity in mining, there was a constant demand for these services, especially for test work on ores and minerals designed to assist companies entering production in working out mill flow sheets and established producers in overcoming difficult treatment problems. The unprecedented demand for the products of the mines emphasized the need for efficiency of operation in the treatment of ores and the assistance rendered by the Division aided greatly in maintaining this efficiency.

Meantime, Division engineers and specialists recruited and trained for such work since the war were busily engaged on various research projects ranging from the development of new techniques in chemical analyses to intensive studies of metal corrosion. Underlying most of this work is the recognition, based upon extensive experience, that research is vital to industry in developing and utilizing Canada's resources of metals and minerals to full advantage. Metal corrosion in Canada alone results in an annual waste estimated to be upwards of $200,000,000, but is possibly much higher. The Division's research on this problem is directed toward greatly reducing this waste, and the results to date give promise of success. Again, many low grade and complex ore deposits in Canada remain undeveloped, or their development is handicapped, largely for lack of economic methods of treating the ores. Accordingly, the need for research on the determination of suitable methods is readily apparent, and much of the Division's efforts are aimed toward this goal. A few cases in point are its work on lithium ores, on low-grade chromite ores, and on refractory gold ores, all of which is well advanced toward a solution.

Laboratory equipment installed since the war and additions to the staff of scientists have enabled the Division to step up its research in the field of ceramics, and this now forms a major part of its activities. Much of it relates to the development of special ceramic electrical insulators, to phase equilibrium studies applicable to basic refractories, and to the adaptation to industrial uses of ceramics raw materials found in Canada. Likewise, research on the application of spectrographic methods to the analysis of metals and minerals and in closely related fields of activity has been greatly extended. There appears to be considerable scope for research of this general nature, a view that finds support in the initial results of work under way in the Division on the determination of temperatures of formation of minerals in ore deposits. There is reason to believe that these studies, which are proceeding concurrently with similar studies by outside scientists, will prove to be of considerable aid in the discovery of ore deposits.

In all its research work the Division has received every co-operation from industry and in turn, to the extent that is practicable, has kept industry abreast of the progress being made in the various projects.

More detailed accounts of the Division's activities follow.

MINERAL DRESSING SECTION

Thirty-eight reports on major investigations carried out during the fiscal year were sent to mining companies who had forwarded samples ranging from 100 pounds to carload lots. Some of these were from new properties being developed, and others were for test work to improve current milling practice. Fourteen of these investigations were on gold ores or gold mill products; thirteen were on base metal ores; five related to iron ores; and the remainder to industrial minerals. The results of twenty-nine investigations were reported by letter. These covered examinations to determine where metal losses were being experienced in mill tailings and how they may be prevented; the possibility of changes in milling practice to increase recovery or produce cleaner products; the feasibility of adopting new methods; and the adaptability of new reagents. Use by industry of the services rendered resulted in improved recoveries, with consequent higher monetary returns to the companies concerned.

Using a pilot plant set up by the Mines Branch and embracing standard mineral dressing equipment, the Section, jointly with the Fuels Division, worked out a cold water process for separating bitumen from the bituminous sand deposits of northern Alberta, which constitute one of the world's greatest potential sources of petroleum. By this achievement a major technological problem affecting the development of these deposits has been solved. The

resultant flow sheet gives recoveries of over 95 per cent of the bitumen content as a crude oil suitable for subsequent refining. The refining phase of the investigation is being handled by the Fuels Division.

Beneficiation investigations carried out on disseminated magnetite-hematite ores occurring with the higher grade ores in the Steeprock and Labrador-Quebec iron deposits gave results that indicate that these ores, though low in grade, constitute potential reserves for future development. Sintering of the concentrates would be required to make them suitable for blast furnace feed. Similar work was done on samples of this type of ore from various smaller deposits in Ontario and Quebec.

Sixteen companies made use of the facilities of the Section to conduct their own investigations. Seven of these concerned metallic ores and the remainder industrial minerals.

EXTRACTIVE METALLURGY SECTION

Devoting most of its attention to research on economic methods of treating low-grade and complex ores, the Section, in one of its major projects, continued its work on the baffling problem of beneficiation of the low-grade chromite ore of the Bird River area, Manitoba. Though large, these deposits have remained undeveloped, mainly because of the high iron content of the ore and the difficulty in bringing the iron to chromium ratio to a marketable grade. Submarine action reduced overseas shipments of chromite ore to Canada to a dangerously low level during the war, and it was largely to facilitate the use of Canadian ores in the event of an emergency that the work was undertaken by the Section. It has investigated in detail several methods for beneficiating Canadian chromite to make an acceptable metallurgical product, only two of which appear to have promise of success. One has a long history, but was perfected only recently by private research in Canada, and the other was developed entirely by the Mines Branch. Both methods can produce high-grade chromite from low-grade Canadian ores at a reasonable cost. A final choice between the two methods will depend upon economic factors.

Continuing its studies of low-grade and complex gold ores, which are being encountered more frequently and have posed a difficult problem for the practising metallurgist, the Section developed an improved method for testing the leaching power of mill cyanide solutions, expected to be of aid in maintaining leaching solutions at maximum efficiency. The process is to be tested shortly in an operating plant.

It did further research on the applicability of electrostatic separation to Canadian mineral deposits such as silica sand, fluorspar, and apatite. Although it has been known for several years that certain minerals can be separated from each other by passing a granular mixture of the minerals through a high-intensity electric field, the method has found little application in Canada and Canadian metallurgists are largely unfamiliar with the process. However, Canada's increasing industrialization may be expected to create a domestic demand for mineral products hitherto mainly neglected. The research program will include all domestic minerals that can be obtained readily in a dry, granular form. In its research on this project to date the Section has made fluorite concentrates of acceptable grade, has separated apatite from gangue for fertilizer use, and gold-bearing pyrite from gangue.

Geographical and economic circumstances surrounding a nickel-copper deposit in Manitoba have led to a re-examination of possible treatment methods for these metals. So successful has been the time-honoured smelting method that alternative processes have scarcely been considered. The Section is collaborating with private Canadian interests in testing, in a pilot plant at the Mines Branch, a novel leaching method for the ore, which is entirely a Canadian development. Although the process appears to be successful, some problems are still under investigation.

A special roasting and leaching procedure originally proposed in Canada about 10 years ago for use in recovering copper, gold, and cobalt from a deposit in British Columbia was investigated and the conditions suitable for obtaining good recoveries of the three metals were accurately defined. The company concerned has not been recovering the cobalt, considering it to be too low in grade to warrant doing so. The results would apply to similar ores that occur in Canada having a cobalt content too low to warrant recovery by other methods.

CHEMICAL METALLURGY SECTION

Good progress was made by the Section in its program of research on the smelting, refining, and production of metals and on the prevention of metal corrosion. Government departments and industry were aided in solving problems in these fields.

In work that it is hoped will eventually lead to the active development of the large deposits of the lithium mineral in Manitoba and Quebec, the Section continued its efforts to develop a cheap and direct process for recovery of the metal from the ore. The lightest of the metals, lithium has a variety of potential uses but its high price of $12 to $15 a pound has precluded its extensive use. Concentration of the spodumene is not particularly difficult. However, extraction of the lithium from this concentrate, which may contain from 4 to 6 per cent lithium oxide, is an expensive operation. Endeavours are being made also to work out a cheaper method of producing the metal from its salts, and in this the Section has produced a lithium-bearing alloy that has been subjected to low pressure distillation to recover the lithium. There is increasing demand for lithium with an extremely low sodium content. Working on this problem the Section developed a refining process on a laboratory scale by which lithium was produced containing as low as 0·001 per cent sodium, compared with a sodium content of 0·5 per cent in the original crude material.

An extremely low pressure method of refining magnesium alloy scrap, which is being produced in increasing quantities owing to the expanding use of magnesium, was investigated and a useful secondary magnesium was obtained.

Emphasis was given to the development of methods of reducing the aforementioned waste resulting from metal corrosion. About half of the corrosion problems investigated were submitted by the Department of National Defence. The equipment used emulates as closely as possible such effects as sunlight, high humidity, wetting and drying, marine atmosphere, and immersion in corrosion solutions typical of those found in service. These methods are in the nature of accelerated tests and provide useful data on the behaviour of materials being investigated.

Corrosion losses are particularly heavy in the chemical, metallurgical, and mining industries, and in those industries that operate under marine conditions. Use of chemical-resistant paints appears to be one of the answers to this industrial problem, and the results of research by the Section on these paints prove beyond doubt that they can be used by industry to good advantage in curbing corrosion losses. Seven paints available on the market and selected by reason of special claims to resistance to corrosion made by their manufacturers or distributors were investigated in the course of this research. However, because of their costs, the paints are limited to special uses at present.

Research was continued on a problem of particular interest to the Armed Services in reference to the storage of canned foods supplies and arising from the tendency of ordinary white tin used for coating the containers to change to grey tin at temperatures below 56° F. In arctic and subarctic regions this frequently necessitates destruction of some of the supplies because of con-

tamination. Efforts were being made with considerable success to determine the factors that accelerate and inhibit this grey tin formation and to develop methods of prevention.

An investigation of difficulties that were being experienced with the corrosion of power line cables, particularly those near the seacoast, led to the development, in co-operation with industry, of cables that are more resistant to corrosion.

A method of preventing corrosion of certain aluminium alloy parts under marine conditions was developed.

Members of the staff took a prominent part in the activities of the Royal Canadian Navy Committee on Corrosion and Fouling.

Close co-operation was maintained with the National Research Council, particularly in connection with the Atomic Energy Project; the Associate Committee on Corrosion Research and Prevention; and with the Canadian Government Specifications Board.

CERAMIC SECTION

The activities of the Section reflected the rising demand for their products experienced by most branches of the ceramic industry. As most Canadian producers of clay products operate on a relatively small scale, few of them have adequate testing and research facilities. Thus the Section serves as a central research and investigative organization to these industries. As the types of clay found in Canada are usually of marginal value for use in making clay products it is only through the skilful operation of many of the plants and through close co-operation with the Section's laboratories, that it has been possible to manufacture high quality products.

An X-ray diffraction laboratory was established for use in the identification and detailed study of a wide variety of materials, including non-metallic minerals, slags, metals, and quenched silicate samples from phase equilibrium runs. The laboratory established on John Street, Ottawa, during the previous fiscal year, for studies of refractory oxides in conjunction with the National Research Council Atomic Energy Project was transferred to the Mines Branch. Similar work was resumed, but with the purpose of applying the findings to industry in general rather than to Atomic Energy.

The heavy demand for structural clay products led to a number of investigations in this field. Manufacturers in the Maritimes and in Ontario submitted samples of their products for freezing and thawing tests in order to evaluate their resistance to weathering in service under Canada's extreme climatic conditions. Where necessary, advice was given on methods of improving the products. Assistance was also rendered through laboratory work on a means of producing buff-coloured brick from a normally red-firing clay, and on the physical testing of sewer-pipe from a plant in western Canada.

Ninety-five samples of clay from all parts of the country were tested for possible use in the manufacture of brick and tile. A number of the samples tested showed promising characteristics. A large reserve of suitable raw materials is essential for the economic well being of this industry.

Much of the assistance rendered to the whiteware industry dealt with production problems and manufacturing techniques, but also included investigations of the extended and more efficient use of the fluxing constituents. This industry produces a wide variety of essential products such as dinnerware, hotelware, electrical insulators, stove plates, sanitary ware, floor tile, and wall tile, most of the raw materials for the manufacture of which are imported. However, most of the fluxes used in these products are obtained from domestic sources.

At the request of a manufacturer in Ontario, the Section did research to develop a method of accelerating the ageing of a ceramic body to avoid storage prior to fabrication. The results obtained led to plant trials using the method.

A project was undertaken to find ceramic uses for rejects from the production of nepheline syenite in Ontario. The use of these rejects in a number of ceramic products was investigated and some encouraging results were obtained. Other work on whitewares included the development and fabrication of special electronic ceramic shapes for communications equipment, in co-operation with the Department of National Defence, and examination of ten samples of kaolin type clays, which are of potential value to the whiteware industry. These included samples from Pine River, Manitoba, and Brebeuf, Quebec.

A major activity was the investigation, testing, and development of refractory materials. In a continuation of work on the evaluation of fire-clay refractories produced in Canada, samples from production were being tested and assistance was given to manufacturers on methods of improving the products.

Numerous refractory samples submitted by industrial consumers, government agencies, and producers were tested.

The development and improvement of porous refractory materials for the gas flushing of molten metals to remove certain impurities was continued jointly with the Physical Metallurgy Division. Commercial uses of the process are indicated, and application was made for a Canadian patent on one of the refractory materials.

Temperatures and other factors affecting refractories in marine boilers were investigated, in which work trials were carried out in H.M.C.S. *Haida* at Halifax. Based on this investigation recommendations for improved refractory practice were made to Naval Service, Department of National Defence.

Two officers of the Section visited ceramic plants in Quebec and the Maritime Provinces, to consult with the operators on operating problems and to obtain data on equipment and production. Laboratory work was subsequently undertaken on the problems encountered.

The Section was actively engaged in fundamental research on various ceramic problems. Special equipment was installed for high temperature phase equilibrium and sintering studies and for X-ray diffraction, petrographic, and crystallographic investigations. The research staff completed a phase equilibrium investigation of part of the system magnesia-alumina-dicalcium silicate. The results of this work are applicable to basic refractory clinkers made from Canadian dolomitic magnesites, to high-lime blast furnace slags, and to compositions approaching certain rock and mineral wools. Much time was spent on a study of the solubility of uranium oxide in silicate melts and on obtaining X-ray diffraction data for the different oxides of uranium encountered in the investigation. Grain growth studies were being made of aluminium oxide as a pure material and in combination with other oxides. This work was undertaken because of the application of these materials to special refractories such as those used in jet engines and for use as cutting-tools and for other special purposes. Problems relating to the casting and fabrication of refractory shapes made of thorium and zirconium oxides were investigated.

CHEMICAL SECTION

The Section functions as a service laboratory to the various divisions of the Mines Branch and to certain other government departments. To ensure speedier and more accurate work the Section has installed and is using a variety of instruments such as flame photometers whereby determinations of alkalis now take less than a day instead of the former minimum of 4 to 5 days; colourmeters by which values as low as five parts per million of iron in the lighter metal alloys can be determined; a Spekker photometer that is used in ferrous alloys work for rapid determination of silicon, manganese, molybdenum, phosphorus, and nickel; and a Beckman flame photometer by which many determinations of alloys can be made.

The Section developed new techniques for determining several metallic elements such as lithium, fluorine, titanium, and tungsten.

It developed a technique for the determination of magnesium during the course of a special study concerning the manufacture of nodular cast iron. Many requests were received from the United States and from Commonwealth countries for details of this new analytical method.

The wide interest among chemists in Canada and overseas in a paper presented by the Section on "Methods of Analysis of Iron and Steel Used at the Mines Branch" led to preparation of a booklet describing methods of analyses for 22 constituents of iron, steel, and ferrous alloys. More than 150 copies of the booklet were issued and requests were still being received.

In its general services to the Branch the Section analysed 2,724 metal samples involving approximately 11,100 chemical determinations. It analysed 4,879 samples of minerals and of ore products involving 23,900 determinations.

SPECTROGRAPHIC SECTION

Featuring the Section's activities was its work on determination of the temperatures of formation of minerals in ore deposits. The importance of this project hinges largely on the valuable information it might furnish concerning the origin of ore deposits and the aid it might be in the discovery of mineral deposits. There are indications also that the information that will be gained from the research will prove useful in determining the probable lateral and depth extensions of ore deposits.

Two methods were being investigated, the first based on the thermoelectric conductivity of pyrite, and the second on the fact that most minerals contain entrapped inclusions of the liquid from which they were deposited. Though the study is still in its initial phases the methods appear promising and an attempt is to be made to apply them in the study of the Eldorado deposits at Port Radium, Northwest Territories. Determination of the composition of the liquid occurring in the inclusions by spectrochemical analyses will be investigated.

To meet a long felt need for methods of quantitative spectrochemical analysis that could be applied to powders of minerals and ores the Section launched a program to develop methods sufficiently accurate for the requirements of the laboratories. Development of a method of much improved accuracy for determining the constituents of comparatively simple materials resulted from this work. The method was being extended to embrace complex samples and the determination of trace elements.

A method of steel analysis based on pure physics was shown by experiment to result in precision of an order higher than that achieved to date by comparable methods.

Preliminary work was carried out on a mineralogical study of the uranium ores at the Eldorado mine, Port Radium, Northwest Territories. Material collected in 1949 was studied and further collections and more comprehensive studies will be made in 1950. The results will supplement and extend to depth information previously obtained and will be of value to the company in the development of its property, in its search for orebodies, and in the treatment of its ore.

PHYSICAL METALLURGY DIVISION

Considered as a whole, the activities of the Division were characterized more by the achievement of results on a large number of separate small projects aimed at urgent practical goals than by progress on the major long-term research projects. Nevertheless, considerable headway was made in the latter work,

more particularly in the development and improvement of metals and alloys that can perform satisfactorily under extremes of temperatures, pressures, and atomic radiation. Handling the metallurgical problems of the Atomic Energy Project at Chalk River, Ontario, continued to be one of the most important assignments. This work mainly involves various studies in metal physics and nuclear metallurgy. Much time was spent in the production of prototype structures for the defence services, other government departments, and industry. Such work often involves design or complete redesign of the part, with subsequent advice on production development.

Widely recognized as an outstanding achievement was the development in the Division's laboratories, after several years of effort, of a new alloy known to industry as "Kinsalloy", named after its inventor, H. V. Kinsey. This alloy of nickel, aluminium, and molybdenum, on which a Canadian patent has beeen granted, is capable of withstanding stresses at high temperature in service, and is produced from materials readily available on the American continent, which enhances its industrial and military value. It is particularly well suited for very high temperature uses, such as in the rapidly moving parts of jet aircraft engines, and research has shown that it is thoroughly practical. An appreciable quantity has been produced under industrial conditions, and sufficient data have been collected to permit formulation of a tentative specification. The alloy has successfully passed simulated engine tests and is being tested in an actual engine.

A further important result of research was the development of a high-strength, magnesium casting alloy (ZK61) containing zinc and zirconium, which is a suitable substitute for aluminium and is lighter in weight. This alloy has proved successful in various industrial products, and especially for uses in aircraft and airborne equipment. It has one of the highest strength to weight ratios of all commercial alloys and its use for structural and engine parts effects considerable savings in weight without loss of strength or rigidity. It has been possible in many instances to increase the strength and reduce the weight of a particular aircraft part by using this alloy, and its advantages extend into the field of hand-manipulated industrial and combat equipment.

The development of these two alloys conforms with the trend in defence research toward selective investigations to obtain optimum components in weapons of the future. Aircraft selectivity, for instance, is based on speed, weight, and carrying power, an important aim of research being to develop high temperature equipment, utilizing the lightest structures capable of withstanding bending and torsional strain. In this connection the research of the Division has been planned to assist the overall policy of self-containment that has been adopted by Canada's jet aircraft industry, whose policy has been to build up its own teams of designers, engineers, and technicians, and to design products that utilize, in so far as possible, materials of Canadian origin.

To help maintain Canada's export market for high quality zinc, the Division investigated the effect of various metallic impurities on the properties of zinc alloy die-castings. The presence of these impurities in the zinc adversely influences production costs and sales prices, in which connection it may be noted that approximately half of the 281,000 tons of zinc exported from Canada in 1949 was die-casting grade. Canadian producers of zinc co-operated in the project.

In an endeavour to acquire fundamental knowledge in advance for use of industry, some preliminary work was done on the melting and casting of titanium and of base alloys of the metal, subsequent to which the titanium and its alloys were hot rolled and forged on a dimensional scale. Titanium has a wide range of potential uses, based largely on its high melting point, resistance to creep, and the weight saving of approximately 40 per cent when used in place of stainless steel, gauge for gauge.

Jointly with the American Foundrymen's Society, research was continued on the centrifugal casting of light alloys. In this work an endeavour is being made to improve the casting of non-ferrous alloys and to eliminate much of the machining and cleaning now required as a means of reducing costs. Readjustment and changes in design of the foundry equipment for centrifugal casting was completed and experimental castings were started. Examination of the first castings indicates that the new gating system eliminated turbulence of the metal stream during the filling of the mould cavity. Three progress reports were published (Transaction American Foundrymen's Society, vol. 57, 1949) covering design of special foundry equipment, a study of various sand mixtures, and a preliminary investigation of the metal flow as affected by the pouring method and design of the mould cavity.

The investigation of foundry characteristics and of elevated temperature properties of cast nickel bronzes was continued; one aim being to determine the suitability of certain alloys for high duty steam valves and to enhance their reliability for these uses.

Partly as a follow-up to earlier research, which led to the production by the Division of the first ductile cobalt metal made in Canada, work was done on the production of the special cobalt parts that are the heart of the new cobalt bomb to be used for the treatment of cancer.

Studies aimed at improving existing alloys and their fabricating techniques received chief attention in the work on ferrous metals.

What might prove to be top-ranking achievement in this field was the development of a process for use in steel making, whereby a magnesium-aluminium alloy is added to the molten steel in the ladle in order to eliminate sulphur, which embrittles the steel. Successful tests have been made on the practicability of the process. Present commercial practice is to remove the sulphur while the steel is in the furnace, a process requiring about one hour to complete. In contrast, the aforementioned ladle reaction is instantaneous and in practice could result in an estimated 10 to 15 per cent increase in Canada's steel-melting capacity without addition to present furnace facilities. The success of the tests indicates that use of the process would possibly result in a saving of $3,000,000 a year to the Canadian steel industry, based on an annual production of 2,500,000 tons of steel. This method of desulphurization could also result in economies in the use of manganese, of which there is little production in Canada.

The Division continued its intensive studies on nodular cast iron. Developed and patented in Great Britain and the United States, the new product has the desirable properties of high strength, some ductility, and much improved resistance to shock or impact compared with ordinary cast irons. The properties actually obtainable under regular commercial production, the guarantees that can be met, and the costs of the material are facts that are being worked out, and in due course will be available to all concerned. The new iron has been rolled into bars and plates in the Division's laboratories with a measure of success. When developed to a practical and commercial scale, the work would make possible the direct rolling of high tonnage products such as reinforcing bars for concrete, mine mucking plates, and certain agricultural machinery parts from blast furnace iron without converting first to steel, and without the attendant high cost of this operation.

Deterioration in the type of steel melting scrap available to industry led to research on the effects of small amounts of stray elements on the properties of wrought iron and cast steel. Tin in quantities of over 0·05 per cent, for instance, markedly affects the ductility properties of steel at high temperatures. The maximum tolerance of the various stray elements was worked out and the

steel industry now has a guide to use as a control measure in the melting process and in avoidance of the production of poor quality steel due to these residual elements.

Jointly with the Steel Castings Institute of Canada, the Division investigated samples of commercial core oils, which are mixed with sand to produce cores used to form cavities in castings. Among those tested were rape seed, mustard seed, and fanwood (stinkweed) oils, all of which are in good supply in Canada. Encouraging results were obtained and a foundry supply house is investigating the possibility of using rape and weed seed oils in its core oil formulations. It is hoped that the Division's work will result in the development of acceptance standards based on the actual foundry performance of core oils.

Considerable assistance was given to a Canadian manufacturer in setting up suitable practices and chemical analysis of iron for the manufacture of very hard iron shot in Canada. The shot is used widely in industry for cleaning sand from castings and for cutting and engraving stone in quarries, and until recently all the Canadian requirements were imported. A product comparable in quality to the previously imported shot is now being made in quantity in Canada by the above manufacturer.

The theory and practice of the annealing process used in making malleable iron was studied in detail and the results indicated ways to carry out the annealing under better control and thus give a more uniform product at lower production cost.

Canadian Arsenals Limited was being assisted in the experimental production of a new type of artillery shell to fit existing equipment. This shell will require less than 10 per cent of the former expensive machining operations and should cost less than half the present figure. It is expected to have a greater range and accuracy than existing ammunition.

The Division continued to seek means of reducing the large annual loss caused by the corrosion of iron and steel products. The research is especially concerned with the behaviour of tantalum as an addition to stainless steels. Two of the principal metallurgical problems are intergranular corrosion and the occurrence of sigma phase, a brittle compound that can be very detrimental to toughness under certain conditions at elevated temperatures. To prevent intergranular corrosion it has been the practice to add ferro-columbium containing about 55 per cent of columbium and 5 to 7 per cent of tantalum to the stainless steel. However, columbium ore of commercial grade is in short supply and the claim has been made that part of the columbium can be replaced satisfactorily by tantalum. The results of the research will provide a basis by which the merits of the proposed new ferro-alloy can be appraised.

Work was started to help solve a critical problem of the papermaking industry concerning the present high and costly rate of wear of welded pulp digesters, which convert wood chips into the raw material for paper. Until about 10 years ago the digesters did their work for 30 years. Nowadays they last only 10 years and some of the larger mills are replacing them at the rate of one a year, the replacement cost being in the neighbourhood of $40,000. The Division completed an investigation of one mill. Further work on the problem, with the support of the paper industry, is planned in the hope that means can be found to decrease the wear on the digesters and thereby greatly reduce replacement costs.

Why weld and steel cracks develop in structural steel welding done under winter conditions and what can be done to prevent it occupied much of the attention of the welding staff. This problem is a source of considerable concern to the construction industry as work can be halted repeatedly for long periods by cracking troubles, particularly in areas with sub-arctic climates. Jointly

with the Department of National Defence, the Division, in the winter of 1948-49, investigated the problem at Churchill, Manitoba, and the information obtained was passed on to the welding industry. Further work is planned on the project in an effort to reduce the costly delays of welded construction.

Research in mechanical engineering continued to increase the knowledge pertaining to the fundamental nature of damage to metals and structures caused by repeated loading. Insufficient knowledge has made it difficult for engineers to predict the service life of their designs without expensive and often impractical testing. The problems requiring attention are the fatigue and fracture fatigue in airplane structures, the brittle behaviour in metals, and the significance of cumulative damage in fatigue. A specific example is the study required to obtain basic information on the mechanism of brittle fracture and the factors influencing the transition from shear to cleavage.

Development of serious fractures in the hull plating of a large number of welded merchant ships during the last war led to intensive research and investigation of the mechanism of fracture, and the devising of numerous methods for evaluating the notch sensitivity characteristics of mild or medium steels. Some progress can be reported in this project with regard to the effects of strain rate, temperature, and geometry of the sample on the susceptibility of various metallurgical structures to brittle or cleavage fracture. The phenomenon of brittle fracture, often referred to as cold brittleness, together with the rapidity of its occurrence, makes this investigation of considerable importance to the shipping industry and to the Armed Services. Through work in the Division's Physical Metallurgy Research Laboratories it is hoped that sufficient information will be obtained to enable the results to be directly applied to service conditions, and with correct interpretation there should be logical and useful extension to all types of ordnance.

Good headway was made in research aimed at making available to the mining industry a drill bit that would give much longer service than those now in use, with a consequent substantial reduction in drilling costs. As a step toward the development of a better Canadian drill steel, work was in hand to determine the most suitable chemical composition, heat treatment, and manufacturing procedure. Fatigue properties of SAE 1080 carbon steel and nickel-chromium-molybdenum steel drill rods were investigated by means of a testing method developed in the Division. The effect of water corrosion on the fatigue strength of drill rods of these two steels in the "as-rolled" condition was also studied, and the beneficial influence of shot peening on their dry and water corrosion fatigue strengths were determined.

Jointly with the Canadian metal and paper industries, the Division undertook a long-term investigation to determine the most suitable material for making screen plate for use in the paper industry, more particularly from the viewpoint of fatigue properties.

In the work on metal physics, problems associated with the Atomic Energy Project were predominant, most of the research being of a fundamental nature and necessitating the building and redesign of equipment.

The vertical X-ray diffraction spectrometer designed by the staff, and put into successful operation in 1946, has made possible a large increase in the volume of work that can be handled in qualitative and quantitative analysis by the use of X-rays. Further improvements during the fiscal year have reduced the sampling error and increased the accuracy. A new use for the unit is in the study of the state of metallic crystal alinement in fabricated materials. This is of considerable practical importance, as many physical properties of metals are greatly influenced by the directions in which the crystals lie relative to the direction of magnetization or loading. The new use

eliminates the older time-consuming method of photographic recording and inaccurate intensity measurements, and it is immediately possible to see the effects of reorienting the sample.

For use in studies of what happens when metals are alloyed and in determining how much of one metal will dissolve in another, a highly intense source of X-rays was designed and some of the equipment was received.

An electronic microscope provided by the Defence Research Board was installed for use on projects of direct interest to the Board relating to the examination of metal, mineral, and ceramic specimens at magnifications far in excess of those possible with the best light microscope. The method has already been used successfully in examining graphite nodules in nodular cast iron.

RADIOACTIVITY DIVISION

The Division is concerned with investigations of radioactive ores, in particular with the development and application of methods whereby marketable concentrates may be produced from individual uranium ores. Formal establishment of the Division took place following the announcement in March 1948 by the Federal Government of its decision to reopen mining and concentration of uranium ores to private enterprise and to purchase all concentrates of Canadian origin meeting specific requirements.

The Division's technical services and laboratory facilities are provided primarily to help in bringing new properties into production by determining methods suitable for treatment of particular ores and also to encourage the search for uranium deposits in Canada.

Involved in the investigation of radioactive ores is work in mineralogy, physics and electronics, analytical chemistry, ore dressing, and extractive metallurgy. The Division also has staff engaged in and the facilities for routine and research activities in each of these fields. Its work is done under authority of the Atomic Energy Control Board and it has access to much up-to-date technical information that is available through exchanges with Great Britain and the United States.

Indicative of the deepened interest in the search for and development of radioactive deposits, prospectors and the mining industry in general doubled their demands upon the Division during the fiscal year. These included requests for concentration and extraction tests on ores, mineralogical examinations, and the assay of samples. In chemical analyses alone, the number performed rose from 4,717 in 1948 to 12,072 in 1949.

Research continued to be centred about the development of improved methods for the detection, assay, and treatment of radioactive ores. A major project was the development of a process that promises to provide a means for the economic recovery of uranium from low-grade or complex ore unsuited to conventional methods of treatment. The process can be used in addition to ore in place of standard gravity concentration methods. It was worked out and studied in a pilot plant in the Mines Branch and is to be tried out on a larger scale in 1950 by Eldorado Mining and Refining (1944) Limited.

Improved methods adopted for chemical and physical analyses of uranium ores facilitated handling the increased volume of work. The fluorimetric method now being used for uranium determinations gives speedier and more accurate results and is a ready means of analysing low-grade material. Analysis of such material had not been satisfactory with the methods previously used, which even for higher grade ores were slow and required an unusual degree of skilled manipulation. In physical analyses the ionization chamber was

applied to the assay of mineral samples by activity measurements. It has the advantage that a preliminary activity assay can be normally made without crushing and grinding the sample. The work of sample preparation has thus been minimized by the ready elimination of samples of no interest.

Much research was being done on ores and products from Eldorado properties. This included a considerable amount of work at the company's mine at Port Radium, Northwest Territories. Private industry also took advantage of the services offered, and sixteen bulk samples of ore from newly discovered deposits were shipped to the Division. Test work was completed on the concentration of eleven of these ores.

By means of reports, publications, and otherwise, the Division informed industry of new and useful technical information in its field. It also acted as a clearing house to pass on to industry, the provincial departments of mines, and to universities such previously restricted information as was made available through declassification.

Nine confidential reports on concentration tests were issued to shippers of ore samples. Thirty-two reports dealing with technical subjects, information on which is restricted by security regulations, were prepared for the Atomic Energy Control Board.

The following reports, containing no restricted information, were made available for general distribution.

Progress Report I (a):
The Annulus Counter, by F. E. Senftle.

Progress Report I (c):
The Measurement of Thorium in Ores by the Thoron Method, by F. E. Senftle, J. L. Horwood, and J. B. Zimmerman.

Topical Report No. 19:
Determination of Uranium in Ores by Field Analysis, by F. E. Senftle and C. McMahon. (Also issued as Memorandum Series No. 96, May 1949, and published in the Bulletin of the Canadian Institute of Mining and Metallurgy, November 1949.)

Topical Report No. 25:
The Preparation of Standard Samples for Field Analysis, by F. E. Senftle and C. R. Boyce.

Topical Report No. 27:
Experiments with the Dutch States Mines Cyclone and Application to the Heavy Media Separation of a Mineral of High Specific Gravity, by D. F. Kelsall.

Topical Report No. 35:
Assays of Uncrushed Ore Samples Using a High Pressure Ionization Chamber, by J. L. Horwood and C. McMahon. (Also issued as Memorandum Series No. 106 and published in the Canadian Mining Journal, April 1950.)

Topical Report No. 37:
The Assay of Radioactive Ores by a Scintillation Counter, by F. E. Senftle, R. Wilmot, W. Havercroft, and L. Ficko.

Topical Report No. 38:
Statistical Variations Applied to Radioactive Counting, by R. F. Harris.

Topical Report No. 40:
Flotation of Acid Consuming Minerals from Ore 101-B, by W. A. Gow.

Topical Report No. 42:
The Determination of Free Acid in Solutions, by J. G. Ingles.

Topical Report No. 43:
Low Voltage Self-Quenching Geiger Counters and Directional Counters, by C. Lapointe.

Special Report No. 29/50:
Concentration and Extraction of Uranium from Several Types of Canadian Ores—Paper presented at the C.I.M.M. Convention, April 1950, by A. Thunaes.

Special Report No. 30/50:
Analysis of Uranium in Ores by Geiger Methods—Paper presented at C.I.M.M. Convention, April 1950, by C. Lapointe.

Special Report No. 31/50:
Equilibrium Correction in Geiger Analysis, by C. Lapointe.

The following papers were published in various journals:

Construction of Beta-Geiger Counters from Prefabricated Thin Wall Tubing, by F. E. Senftle, W. Havercroft, and P. Hernandez; Review of Scientific Instruments, vol. 20, No. 5, pp. 370-371 (May 1949).

Determination of Uranium in Ores Modified Mercury Cathode-Cupferron Method, by F. T. Rabbitts; Can. Min. Jour., pp. 84-86 (October 1949).

Determination of Uranium in Ores by Field Analysis, by F. E. Senftle and C. McMahon; Can. Min. and Met. Bull., pp. 618-621 (November 1949).

FUELS DIVISION

The impact of the steadily increasing production of crude petroleum on the coal industry caused the Division to devote much of its efforts to the technological problems of that industry, primarily to assist it in maintaining its markets. The trend toward the use of Diesel locomotives and of domestic oil-burning equipment, coupled with the increasing industrial use of oil, has seriously affected the demand for coal. Various economic factors are involved, such as the distance of the Canadian deposits of coal from the principal markets, but well-planned and co-operative research can do much to lessen the adverse effects of these factors and it is largely to this end that the Division's work on Canadian coals is directed. Meantime, research work on the other fuels proceeded apace.

SURVEY OF COAL MINING METHODS

The Division continued its study of coal mining methods in Canada and the United States, with particular attention to areas in the United States where conditions are similar to those in Canada, namely, where the seams are thick and of varying inclination. The survey has indicated broadly that results in Canada are largely comparable with those under similar conditions in the United States. Wherever feasible, the Canadian operations are mechanized to increase production and reduce costs. However, the more difficult natural conditions, the uncertainty arising from seasonal operations, and the growing competition of other fuels handicap the mechanization of operations to the extent practised in the United States. The survey showed that many Canadian underground operations suffer from excessive strata pressures, which adversely affect the economic development and the conservation of coal seams. The division commenced a study of these pressure phenomena.

CRUDE PETROLEUM AND BITUMEN

Successful development of the so-called "cold water" process for separating the bitumen from the bituminous sands of northern Alberta was among the major achievements of the year and marked the attainment of an important goal toward the eventual development of one of the world's greatest potential sources of petroleum. Using a pilot plant built by the Mines Branch the previous year, the Division, in co-operation with the Mineral Dressing and Process Metallurgy Division, demonstrated that the method can be conducted without difficulty in standard ore dressing equipment and that high recoveries can be obtained. A unique feature of the process is that it is carried out at room temperature, with the result that the heat input is small. The method is relatively simple. Part of the 90 barrels of diluted oil produced was used for experiments on dehydration and coking, which are not yet complete.

In addition to the pilot plant work, the Division carried out laboratory experiments to obtain information on the surface phenomena of the separation process, which will be useful in the design of large-scale plants. The applicability of various wetting agents to the process was tested and a study was made of the effect of stirring or rabbling the bituminous sand in water. The constitution of the bitumen itself was also investigated. Some of the oil was separated from the bituminous sand by distillation at very low pressure in order to minimize thermal decomposition. Part of the oil was further treated by chromatographic methods and yielded two principal fractions, one of which contained practically all of the sulphur compounds. Investigations were being continued to isolate the paraffin constituents of the oil.

PROPERTIES AND BENEFICIATION OF CANADIAN COALS

The program of planned research designed to obtain basic information from the examination of samples of coal from each coal seam operated in Canada was continued. The data provided will serve as a basis for comparing the intrinsic characteristics of a coal with those of other coals in the same or in different mining districts, for estimating mining efficiency, and for indicating to what extent a coal can be beneficiated and improved for different uses. Samples from all the mines working on the two main coal seams in the Sydney area were studied and a report was prepared on them. Two reports were completed on samples from the strip and deep mines of West Canadian Collieries, Limited, at Adanac, Alberta. The true specific gravity of the petrographic constituents did not appear to be useful for the purpose of correlating coal seams, but some evidence was obtained to suggest that the determination of volatile matter might be of some use for this purpose.

A number of processes have been developed for lowering the ash content of a coal by using a heavy medium consisting of a suspension of mineral matter in water to separate coal by gravity from the heavier material that forms ash. As it is important to find a source of material in western Canada suitable for heavy media, samples of pyritic cinder were obtained from Trail, British Columbia, for testing by the American Cyanamid Company.

Briquetting tests were completed with a number of types of asphalt as binder on three different ranks of coal. A series of tests was under way to determine the conditions under which briquettes suitable for use as railway fuel can be made from the wet bituminous coals of western Canada.

In view of the satisfactory results obtained with small-scale coal washing equipment in the laboratory and with larger equipment in the field, it is proposed to set up larger equipment in the laboratory to study certain washing processes applied to coal.

COAL-FIRED GAS TURBINE

The matter of developing a coal-fired gas turbine locomotive has been under investigation by the Locomotive Development Committee of Bituminous Coal Research Incorporated, a United States organization, for the past several years. The successful development of such a locomotive, it is believed, would largely offset the present trend toward the use of Diesel locomotives and thus maintain one of the principal outlets for coal. A number of co-operating organizations, among them being the Fuels Division, have been engaged in some particular phase or phases of the investigation. The Division has been giving chief attention to combustion problems, more especially to the effects of varying the types of coal used and to evaluating various Canadian coals for use in this type of combustor.

Experimental tests made on large samples of nineteen typical coals used by Canadian railways indicated the need of some refinements in the equipment used for the efficiency measurements. After these have been tried out a carefully controlled series of tests will be made on all of these coals.

Other research was under way to obtain fundamental information on the mechanism of combustion of pulverized coal. It is possible that ultrasonic energy influences the rate of combustion. To test this a very powerful sound generator was constructed and a furnace to be used with it was under construction.

SYNTHETIC LIQUID FUELS

Research on these fuels has been in progress for several years. Meantime, developments in the oil fields of Alberta have transformed the Canadian fuel economy to such an extent that the urgency of this work has decreased considerably. However, although Canada is becoming much less dependent than formerly upon outside sources of oil supply, the rate of consumption is rapidly increasing, and it is largely as a means of assuring a continuation of supply indefinitely that the Division is continuing its research on the production of synthetic fuels from various raw materials. Partly to this end it has been proceeding with the design and fabrication of hydrogenation equipment capable of operating for long periods under precisely controlled conditions and using pressures up to 20,000 pounds per square inch. It is believed that use of this equipment would result in development of a process applicable to Canadian raw materials and to commercial conditions that would be more economical than any process heretofore used in this field of endeavour.

Various pieces of equipment such as the primary test vessel, hydrogen generator and compressor, and high pressure valves were ordered during the fiscal year, some of which were received and were tested to ensure that they will function satisfactorily.

ANALYSES SURVEYS AND LABORATORY INVESTIGATIONS

Foundry Coke

Investigation of the electrical conductivity of foundry coke was continued, with the object of improving the quality and uniformity of metallurgical coke used in making iron and steel. Samples of specially prepared cokes were tested and analysed.

Carbonization of Coal

The possibility of producing solid fuels from blends of coking and non-coking coals by carbonization was investigated for the Dominion Coal Board, and a report was issued giving the results.

Analyses of Canadian Coals

The analyses of Canadian coals that have been made by the Division since 1936 were assembled for publication as a source of reference on the characteristics of coal from various parts of Canada.

Peat and Oil-shale Investigations

Samples from peat deposits in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, and British Columbia were collected for analysis and study. A number of samples of oil-shale from New Brunswick were examined and the results were reported to the provincial authorities.

Natural Gas

Determination of the constituents present in natural gas from different fields was continued, with particular reference to samples from new areas. In this work the Division is always on the alert for the presence of helium in commercial quantities, although no unusual concentration of the gas has been observed to date.

Miscellaneous Investigations

Samples of mine air were analysed as a safety measure to ensure adequate mine ventilation in various parts of the country. The desirability and cost of establishing facilities for testing electric mining equipment in Canada was investigated and reported upon as an outcome of recommendations made by Ministers of Mines of the different provinces at a conference held at Fredericton, N.B. An officer of the Division attended the United Nations Conference on Conservation and Utilization of Resources and took part in the proceedings of the section dealing with fuels and energy.

EXPLOSIVES DIVISION

The Division administers The Explosives Act, 1946, which regulates the manufacture, testing, sale, storage, and importation of explosives. Jointly with the National Research Council it maintains an explosives testing and research laboratory.

On April 1, 1949, The Explosives Act became applicable in Newfoundland. Explosives magazines in the province subject to the Act were licensed and preliminary surveys and inspections were made.

The production of commercial blasting explosives in Canada reached the highest level in the history of the industry, the quantity manufactured being 85,200,000 pounds compared with 84,600,000 pounds in 1941, the previous peak year. Not a single accident involving high explosives occurred to mar this achievement. Except for a few special types of high explosives not manufactured in Canada, imports are negligible. Thus, production figures for these explosives are a direct measure of domestic requirements. Two safety fuse lighters of a new type were tested and authorized for manufacture. Detonating fuse, formerly imported, is being manufactured in Canada in quantity sufficient to meet domestic needs.

The excellent work of safety committees in the various explosives factories again proved an invaluable aid in the administration of the Act. The consideration they give to suggestions for eliminating known or conceivable risks helps to maintain high standards of safety.

The Division's pamphlet, "The Handling of Explosives" was reprinted and distributed to interested persons. Its pamphlet "The Storage of Explosives" was brought up to date.

As a means of helping to reduce accidents resulting from inexperience in lighting safety fuses the Division issued a memorandum and poster illustrating a simple and effective way to light the fuses.

Chinese fireworks, chiefly firecrackers, continued to form the bulk of imported fireworks, but British and American fireworks manufacturers showed increasing interest in the Canadian market.

Officers of the Division assisted in the preparation of a technical brief for presentation by the office of the United States Attorney General in a civil suit for damages arising from the explosion of an ammonium nitrate shipment in Texas City in 1947.

EXPLOSIVES TESTING AND RESEARCH LABORATORY

Chemical and physical examinations were made of 658 samples submitted by the Department of National Defence, National Research Council, Post Office Department, Royal Canadian Mounted Police, and the Inspection Service of the Explosives Division. Fireworks received at the port of Vancouver were examined by the Department of National Health and Welfare at its laboratories in Vancouver.

Further headway was made in the investigation into the hazards attending the storage and shipment of ammonium nitrate fertilizer. An advisory conference on ammonium nitrate was organized by the National Research Council in June 1946, following a request by the Federal Department of Transport that the physical and chemical properties of this material be reviewed, and research and test work was assigned to the Explosives Division. As a result of explosions on two ships carrying ammonium nitrate fertilizer at Texas City, Texas, in April 1947, the scope of the conference inquiry was extended. As the manufacture of this material in Canada is extensive, manufacturers, military authorities, railways, harbour boards, and shipping companies are concerned with the outcome of the investigation, the purpose of which is to determine the factors influencing fire and explosion hazards in the handling and packing of ammonium nitrate fertilizer or related materials in order that adequate safety regulations and controls may be designed.

During the fiscal year chemists of the laboratory sought data by laboratory study and field trials to establish the temperature that must be reached to produce detonation, the thermal and explosive characteristics of the gases produced by decomposition, and the effect of temperature and pressure gradients on the rate of decomposition of several types of ammonium nitrate fertilizers.

It was found that temperature as a single factor would not cause detonation. When heated unconfined to the maximum point ammonium nitrate may exhibit a vigorous reaction but nothing more. When heated under pressure, however, decomposition takes place and the confined gases in turn increase the pressure and finally result in detonation. The mechanism of this reaction has not yet been established and further work is necessary to determine this and also to determine the bursting pressures at detonation of containers used to confine the ammonium nitrate.

Two interim reports have been published and tentative regulations have been drawn up based on these. A third interim report is in preparation.

FACTORIES

The licences of the 15 explosives factories in operation during the fiscal year were renewed. The factories include those under the Crown-owned Canadian Arsenals Limited. Previously these were on a stand-by basis, but they entered production in 1949. Quebec Arsenal, now a division of Canadian Arsenals, manufactures small arms ammunition for the Armed Services and for export.

In the manufacture of commercial explosives manual operations are being replaced by mechanized operations as far as this is safely practicable. In the interests of safety the Division gives careful study to proposed changes of this nature before approval.

MAGAZINES—REGISTERED PREMISES

Most of the owners of magazines and registered premises gave good co-operation in maintaining stocks and buildings in accordance with the terms of their licences. In a few instances where warnings were ignored, proceedings were entered against the parties concerned, and on conviction penalties were imposed in accordance with The Explosives Act. Members of the Royal Canadian Mounted Police who are deputy inspectors of explosives gave valuable assistance in making inspections, investigating accidents and thefts, and in prosecutions for violations of the Act and Regulations.

There were 392 permanent and 634 temporary magazines licensed at the end of 1949, compared with 391 permanent and 599 temporary licences at the end of 1948. Registered premises increased from 53 to 59.

INSPECTIONS

—	Factories	Magazines	Registered premises	Unlicensed premises
Explosives Division Inspectors	21	622	107	846
Royal Canadian Mounted Police	.....	371	30	6,583

IMPORTATION PERMITS

Imports of explosives are controlled by permits issued by the Division. These imports comprise such commercial items as: nitrocotton for use in the manufacture of lacquers; nitroglycerine; Christmas snappers; fireworks; distress signals; lachrymatory cartridges; and materials used in the manufacture of detonators and fuses. In all, 461 permits and 15 special permits were issued.

AUTHORIZATION OF EXPLOSIVES

Two new high explosives and 25 fireworks submitted by Canadian manufacturers were found satisfactory and were authorized. Thirteen high explosives and 130 fireworks manufactured elsewhere were authorized for importation. Some fireworks examined were rejected outright, but others were later approved on re-examination when manufacturers made changes suggested by the Division.

A list of authorized explosives, including fireworks, is on file in the office of the Division, and is available for the information of those interested.

ACCIDENTS

There were no accidents in manufacture that resulted in loss of life or major injury to personnel or serious damage to buildings or equipment. Several unusual incidents and minor flashes involving slight injuries to workers were reported by explosives factories. In most cases the causes were determined and necessary changes were made in procedure or equipment.

A total of 141 accidents occurred in the use and handling of explosives. These caused 25 fatalities and injury to 158. Most of these accidents occurred in the use of explosives in mines, quarries, and elsewhere, but 32 accidents in which 3 persons were killed and 43 injured were caused by playing with detonators and other explosives.

	Accidents	Killed	Injured
Mines and quarries	56	11	56
Elsewhere in industry	38	11	34
Manufacture, keeping, and conveyance	15	0	25
Playing with detonators	13	3	19
Playing with other explosives	17	0	21
Miscellaneous	2	0	3
Total	141	25	158

PROSECUTIONS

Twenty prosecutions were instituted under The Explosives Act and Regulations and fines of varying amounts were imposed. Infractions of the regulations were as follows:

Improper storage	10
Selling without a licence	3
Infraction of magazine regulations	1
Having explosives in car while intoxicated	1
Failing to stop at railway crossing when transporting explosives	1
Smoking in explosives factory	4

Eleven persons were charged with theft or illegal use of explosives under the Criminal Code, some of whom were fined and others were sentenced to terms of imprisonment up to 3 years.

Four men were fined and one was sentenced to 1 month in jail for improper use of explosives under provincial mining acts.

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

DESTRUCTION

Destroyed were: 8,924 pounds of dynamite, 99,424 blasting caps and electric blasting caps, and 108 feet of safety fuse. Most of these explosives had been abandoned or were condemned by inspectors and were in a deteriorated condition. Several cases of unauthorized fireworks were destroyed at the port of entry.

GEOLOGICAL SURVEY OF CANADA

W. A. Bell, Director

The Geological Survey of Canada, in the reorganization of departments that occurred during the fiscal year, became a branch of the new Department of Mines and Technical Surveys. Dr. Bell, formerly Chief of the Palæontological Section, was appointed director. No change was made in the work of the Survey, which is concerned with the systematic study of the geology of Canada for the purpose of providing technical guidance and assistance in the search for minerals. With the entry of Newfoundland into Confederation, the range of the Survey's field investigations was extended to that province.

Seventy-two geological parties were assigned to field work, the details of which are given under the Geological Division. Oil and gas developments in the West received special attention in the field and in the office and about 94,000 drill samples were received for study, mostly from wells in the western provinces.

The search for radioactive minerals held a foremost place in the prospecting field and the Geological Survey, as agent for the Atomic Energy Control Board, tested more than 6,800 prospectors' samples for radioactivity. In addition, it received 8,000 samples of rocks and minerals for identification, and supplied 76,697 specimens to prospectors, students, and schools, and to others interested.

Airborne magnetometer surveys were made of areas totalling 21,774 square miles, an increase of about 40 per cent over the areas covered the previous year. The results are expected to provide significant and helpful information in the search for iron and other minerals, and the operations of the Geological Survey were designed to provide basic information for research in this field.

Publications of the Geological Survey during the fiscal year included 25 preliminary papers, 7 geological maps, 3 aeromagnetic maps, 3 memoirs, 3 bulletins, and a set of 52 maps of coal areas in Alberta. A total of 123,793 reports, maps, etc., were distributed.

GEOLOGICAL DIVISION

There were many changes in personnel and a general increase in the staff of the various technical divisions. The field staff was increased by ten, the Radioactivity Laboratories by three, and the Geophysics Division by seventeen. F. H. McLearn was appointed Chief of the Palæontological Division to succeed Dr. Bell. H. C. Cooke retired on superannuation in November 1949 following completion of more than 35 years of service with the Geological Survey.

In the death of M. Feniak by drowning on June 21, 1949, the Geological Survey lost the services of a highy capable geologist who was Resident Geologist in the Survey's new branch office at Yellowknife, Northwest Territories. A geologist was on part time loan to Queen's University to assist in the extra work entailed through the death of E. L. Bruce. Another was granted a period of absence to attend the National Defence College at Kingston.

The many visiting geologists employed by oil companies were again provided with temporary office accommodation and the records and facilities of the Palæontological and Ground Water and Borings Divisions were placed at their disposal.

Field Work

Ten of the 72 parties assigned to field work operated in Northwest Territories, 5 in Yukon, 14 in British Columbia, 9 in Alberta, 1 in Saskatchewan, 5 in Manitoba, 7 in Ontario, 3 in Quebec, 1 in New Brunswick, 5 in Nova Scotia, 1 in Prince Edward Island, 7 in Newfoundland, and 4 in two or more provinces or territories. In the previous fiscal year 60 parties were engaged in field work.

Standard geological mapping on scales of either 1 mile or 4 miles to an inch was conducted in thirty-seven areas across Canada. Detail mapping was continued in the Yellowknife, Giauque Lake, and Matthews Lake gold-bearing belts of Northwest Territories; in the productive silver-lead camps near Mayo in Yukon; and on either side of the Quebec-Ontario boundary in the Rouyn-Larder Lake mineral belt. Other field activities included surface and subsurface stratigraphic studies, supplemented by palæontological collections, mainly in relation to the productive oil and gas fields of western Canada; investigations in coalfields of British Columbia and Nova Scotia; surveys of glacial deposits and ground-water conditions in parts of Alberta, Manitoba, Ontario, and Prince Edward Island; field work with the airborne magnetometer over large areas in Ontario and New Brunswick; examinations of numerous uranium-bearing minerals in various parts of Canada; further studies of iron ore deposits in eastern Canada, with particular reference to those on the Quebec-Labrador boundary and in Newfoundland; and assistance in various engineering projects of interest to industry or agriculture.

The Geological Survey undertook its first field work in Newfoundland where seven parties were engaged, partly in new mapping projects and partly in continuing or completing work previously commenced by the former Geological Survey of Newfoundland.

GENERAL

A. H. Lang continued field investigations of uranium deposits in various parts of Canada. He examined occurrences in British Columbia, and later visited prospects in the Northwest Territories, Saskatchewan, Ontario, and Quebec. At intervals during the course of this work he attended conferences in Canada and abroad.

T. L. Tanton examined banded magnetic iron deposits in Ligneris township, Quebec, and made geological examinations of banded iron deposits at Lakes Albanel and Matonipi and other points between Lake Mistassini, Quebec, and Mount Wright, near the Labrador boundary, easterly along the Otish Mountains.

F. P. DuVernet directed the airborne magnetometer field work, which comprised aeromagnetic surveys of areas in Ontario and New Brunswick totalling 21,774 square miles. It is expected that the information from these surveys will eventually be incorporated on topographic maps, and that it will serve to assist geological mapping and direct mining explorations.

NORTHWEST TERRITORIES

F. Q. Barnes completed geological mapping of the Aylmer Lake area (longitude 108° to 110°, latitude 64° to 65°) about 250 miles northeast of Yellowknife. The geology of this virtually unprospected area is favourable for the occurrence of gold and of a variety of strategic minerals in pegmatite dykes. He continued geological mapping in the Carp Lakes area (longitude 112° to 114°, latitude 63° to 64°) in which considerable prospecting has been done and some significant gold-bearing deposits have been discovered near Giauque Lake.

L. P. Tremblay continued detailed geological mapping in the vicinity of Giauque Lake at longitude 114° and north of 63° in the southwest corner of the Carp Lakes 4-mile area. He examined five properties on which exploratory work had revealed gold occurrences.

I. C. Brown commenced geological mapping of the Christie Bay (longitude 110° to 112°, latitude 62° to 63°) and Reliance (longitude 108° to 110°, latitude 62° to 63°) areas in the basin of the East Arm of Great Slave Lake. Copper sulphide showings have been staked at several places in these areas, and some work has been done on a nickeliferous deposit 5 miles northwest of Sachowia

Point. Prospecting for uranium has been active along Barnston River. Large, rusty mineralized shear zones observed in Yellowknife sedimentary rocks along the shores of Daisy Lake merit prospecting.

R. E. Folinsbee commenced geological mapping of the Walmsley Lake area (longitude 108° to 110°, latitude 63° to 64°). Some prospecting for gold has been done in areas of sedimentary schist, and a greenstone belt in the northeast corner merits prospecting for gold.

Y. O. Fortier commenced a reconnaissance geological survey and mapping in southern Baffin Island, involving a study of the character, extent, structure, origin, and relative ages of the rock formations and of any contained deposits of economic value. Further work is required to assess the potential resources of this little-known region.

J. F. Henderson continued detailed geological mapping of the Yellowknife Bay greenstone belt.

C. S. Lord visited the District of Mackenzie to advise on the work of geological field parties and to acquire information on mineral developments in the western part of the Northwest Territories.

J. C. Moore completed detailed geological mapping of the Matthews Lake mineral belt within the Lac de Gras 4-mile map-area. Significant gold-bearing quartz veins and replacement bodies have been discovered within this limited belt, mainly along the contacts of sedimentary and volcanic rocks.

G. M. Wright commenced and completed geological mapping of the Ghost Lake area (longitude 114° to 114° 30′, latitude 63° 45′ to 64°), in various parts of which gold-bearing deposits occur.

YUKON

H. S. Bostock completed geological mapping of the McQuesten area (longitude 136° to 138°, latitude 63° to 64°). He spent much of the field season in consultation on engineering projects in Yukon.

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

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

K. C. McTaggart continued detailed geological mapping in the Galena Hill-Keno Hill area, Mayo district.

J. O. Wheeler continued geological mapping in the Whitehorse area (longitude 134° to 136°, latitude 60° to 61°), a potential source of a variety of ores and minerals.

BRITISH COLUMBIA

J. E. Armstrong brought geological mapping of the adjoining Vancouver North and Vancouver South areas (longtiude 123° to 123° 30′, latitude 49° to 49° 30′) near to completion. He commenced and completed a ground-water survey of Hazelton Indian Reserve No. 1 and Saanich Indian Reserve No. 1; aided the Dominion Soils Survey in the interpretation of the Pleistocene geology of the Peace River block; and aided the Dominion and United States Soils Surveys in the interpretation of the Pleistocene geology in northwestern Washington and southwestern British Columbia.

R. L. Christie commenced geological mapping of the Bennett area (longitude 134° to 136°, latitude 59° to 60°), the western part of which is almost unknown territory.

W. E. Cockfield assisted the Dominion Water and Power Bureau in investigating the Columbia River drainage systems, and on other engineering work. He did work on the Fraser River drainage system in connection with power

developments and flood control and assisted soil survey parties in the Cranbrook area on Pleistocene geology. He also 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 in which are numerous gold-bearing and other mineral deposits.

E. Hall continued his work at Columbia River dam sites, examining and correlating drill cuttings and cores for the Dominion Water and Power Bureau.

J. W. Hoadley continued geological mapping of the Zeballos area (longitude 126° 30′ to 127°, latitude 49° 45′ to 50°), Vancouver Island. The work is expected to provide useful information on the source and character of the mineral deposits in a mineralized region adjoining that of the Zeballos gold-mining camp.

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

A. G. Jones continued geological mapping of the Revelstoke area (longitude 118° to 119°, latitude 50° to 51°) in which are abundant pegmatitic rocks carrying a variety of strategic minerals.

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

R. Mulligan commenced and completed geological mapping of part (longitude 117° 15′ to 117° 30′, latitude 49° 15′ to 49° 30′) of the Nelson area.

J. E. Muller continued geological examination of the Groundhog coalfield. He collected many coal samples for analyses, and made a detailed section across the southern end of the coalfield in the vicinity of numerous coal outcrops and old workings.

V. J. Okulitch made a brief stratigraphic investigation of early Palæozoic fossiliferous formations on either side of the International Boundary in the vicinity of Pend-d'Oreille River. The work was done to assist geological mapping in southeastern British Columbia.

L. L. Price commenced geological mapping of the McDame Creek area (longitude 128° to 130°, latitude 59° to 60°), which is accessible from the Alaska Highway, and in recent years has been actively prospected. Placer gold is being mined from McDame Creek, and the geology is favourable for the occurrence of lode gold, silver-lead, and other ores.

W. H. Tipper commenced geological mapping of the Nechako area (longitude 124° to 126°, latitude 53° to 54°), of which little is known of the mineral resources.

ALBERTA

H. R. Belyea examined well cores from the Leduc-Woodbend-Golden Spike oil field to assist subsurface correlation and structural interpretation of formations in this highly productive area.

R. deWit continued geological mapping of the Wabamun Lake area (longitude 114° to 115°, latitude 53° to 54°) west of Edmonton; assisted D. J. McLaren in the measurement and correlation of type sections of Devonian formations in the eastern Rocky Mountains; and examined well cores from the Edmonton region.

R. J. W. Douglas commenced and completed geological mapping of the Pincher Creek (longitude 113°45′ to 114°, latitude 49°15′ to 49°30′) and Glenwoodville (longitude 113°30′ to 113°45′, latitude 49°15′ to 49°30′) areas.

P. Harker and F. W. Beales measured a large number of sections of Carboniferous formations in the eastern Rocky Mountains. Study of their collection of fossils will facilitate the surface and subsurface correlation of petroliferous strata in the western oil fields.

E. J. W. Irish commenced geological mapping of the Daniels Flats area (longitude 119° to 119°15′, latitude 54° to 54°15′) in the Foothills belt of Alberta. The area is relatively inaccessible, but is believed to include large reserves of bituminous coal.

D. J. McLaren collected fossils from many measured sections of Devonian formations in the eastern Rocky Mountains. It is expected that the study of these collections and of the lithology of the sections from which they were derived will assist in the subsurface correlation of formations in the productive and potential oil fields of western Canada.

A. M. Stalker continued investigations of ground-water supplies and Pleistocene geology in south-central Alberta. He completed investigations in townships 31 to 34, ranges 21 to 28, west of the 4th meridian.

R. Thorsteinson completed geological mapping of the Grande Cache area (longitude 119° to 119°15′, latitude 53°45′ to 54°) in the Foothills belt of west-central Alberta. The area contains significant coal measures.

ALBERTA AND SASKATCHEWAN

R. B. McLeod commenced subsurface stratigraphic studies of Lower Cretaceous formations of a region extending from Lloydminster to Princess in southeastern Alberta, based on available well records and examination of drill cores. The work is designed to assist correlation and structural interpretation in oil or gas fields related to or occurring in these formations.

R. T. D. Wickenden continued a study of drill cores and other well data from the Lloydminster field, and examined exposed sections of Lower Cretaceous strata along Peace River. The work will assist correlation of these strata and those of Athabasca River, examined the previous year, with the subsurface petroliferous formations of the Lloydminster and other oil and gas fields of the Interior Plains.

SASKATCHEWAN

M. J. Frarey commenced geological mapping of the Ile-a-la-Crosse area (longitude 106° to 108°, latitude 55° to 56°), much of which is drift covered, and of little economic interest at present.

MANITOBA

J. A. Elson continued investigations of Pleistocene geology and ground-water supply in south-central Manitoba, mainly within townships 1 to 6, ranges 14 to 17, west of the Principal meridian.

E. C. Halstead continued investigations of ground-water resources and Pleistocene geology in southwestern Manitoba, mainly within townships 11 to 14, ranges 26 to 29, and townships 7 to 10, ranges 18 to 21, west of the Principal meridian.

J. Kalliokoski completed geological mapping of the Weldon Bay area (longitude 101°15′ to 101°30′, latitude 54°45′ to 55°) northeast of Flin Flon and south of Sherridon. A number of low-grade copper prospects occur in the northern part of the area.

G. C. Milligan made a reconnaissance geological survey of the Sipiwesk area (longitude 96° to 98°, latitude 55° to 56°) in which evidence of iron and copper sulphides mineralization is widespread, but little vein quartz was seen.

D. S. Robertson completed geological mapping of the Batty Lake area (longitude 100°30′ to 101°, latitude 55° to 55°15′) and commenced geological mapping of the adjoining Elbow Lake area (longitude 100°30′ to 101°, latitude

54°45′ to 55°) to the south. He completed the mapping of about two-thirds of the west half of the latter area and examined several old gold properties and prospects.

ONTARIO

J. F. Caley supervised systematic geological mapping east of the Lake Simcoe district and made inspection trips through the oil and gas fields of southwestern Ontario to secure a record of all wells recently drilled and any additional data on the subsurface stratigraphy of these fields.

B. A. Liberty continued systematic geological mapping of Palæozoic formations east of Lake Simcoe, mainly in the Peterborough district between longitude 78°30′ to 79° and latitude 44°15′ to 44°45′. The rocks exposed are of Ordovician age, and their study will assist correlation with subsurface formations in oil and gas fields of southwestern Ontario.

J. B. Currie completed detailed geological mapping of Ossian township just west of the Quebec border, and continued this work westerly into Katrine township. Some gold-bearing quartz veins and mineralized shear zones have been prospected in volcanic rocks, which occupy much of these areas and lie along or near the Larder Lake-Rouyn gold belt.

R. E. Deane supervised mapping of the Pleistocene deposits, and collection of data on the ground-water supply, of Scott and Uxbridge townships, Ontario county, and Eldon, Emily, Fenelon, and Mariposa townships, Victoria county, in south-central Ontario.

E. B. Owen commenced geological study and mapping of Quaternary deposits and ground-water conditions in the area between Cornwall and Prescott tributary to the International Section of the St. Lawrence Waterways Project.

J. Dugas commenced and completed geological mapping of the Perth area (longitude 76° to 76° 30′, latitude 44° 45′ to 45°), using a base map provided with both magnetic and land contours. Part of this area was mapped in 1929 and 1930 but the results were not published. The area is of interest chiefly for the number of mica (phlogopite) and phosphate (apatite) deposits associated with numerous pegmatite dykes.

G. B. Leech continued geological mapping of the Renfrew area (longitude 76° 30′ to 77°, latitude 45° 15′ to 45° 30′), on which work was done about 30 years earlier. The area contains many magnetite iron deposits and numerous molybdenite prospects.

QUEBEC

K. R. Dawson and C. H. Stockwell continued detailed geological mapping in Dasserat township, which lies along the western extension of the Malartic-Rouyn mineral belt and Cadillac break, and presumably on the eastern extension of the Larder Lake break of Ontario.

A. S. MacLaren continued revision of geological 1-mile map-areas in northwestern Quebec along or near the Rouyn-Malartic mineral belt. His work was confined mainly to the Kinojevis area (longitude 78° 30′ to 79°, latitude 48° to 48° 15′).

QUEBEC AND LABRADOR

J. M. Harrison commenced geological study and mapping in the Labrador-Quebec iron belt. This project is concerned with the character, distribution, structure, origin, and age of the rock formations of this belt and their relationships to the contained iron deposits or other mineral occurrences of possible economic value. A major fault was discovered along the eastern boundary of the iron belt, with which is associated considerable evidence of sulphide mineralization.

NEW BRUNSWICK

R. Skinner commenced geological mapping of the Austin Brook area (longitude 65° 30′ to 66°, latitude 47° 15′ to 47° 30′) between Bathurst and Newcastle.

NOVA SCOTIA

D. G. Crosby commenced geological mapping of the Wolfville area (longitude 64° to 64° 30′, latitude 45° to 45° 15′) in which, at Pembroke, is the largest known barite deposit in Canada.

T. B. Haites and P. Hacquebard continued a detailed structural, stratigraphic, and petrographic study of the coal measures of the Sydney coalfield. Interim reports were submitted to assist mine operations, and for the advice of the Nova Scotia Department of Mines and of the Nova Scotia Research Foundation.

R. D. Hutchinson made a palæontological study of the Cambrian rocks of Cape Breton Island. These occupy five main areas:. Indian Brook Valley, north of Eskasonie; MacLeod Brook Valley, near Boisdale; the Barachois Long Island area, along the south shore of St. Andrews Channel; Gillis Lake Valley, north of East Bay; and the valley of Mira River. It is expected that this study will facilitate geological mapping on Cape Breton Island and will assist correlation of Cambrian formations elsewhere in Canada.

W. S. Shaw commenced a restudy of the Springhill coalfield and map-area (longitude 64° to 64° 30′, latitude 45° 30′ to 45° 45′), in which he gave close attention to the area about the Springhill colliery.

L. J. Weeks completed systematic geological mapping of a group of 1-mile areas in southeastern Cape Breton Island, centred about the Stirling lead-zinc-copper deposits, of which special study has been made. He supervised geological mapping in other parts of the province.

PRINCE EDWARD ISLAND

E. I. K. Pollitt collected data on the ground-water resources of the O'Leary area (longitude 64° to 64° 30′, latitude 46° 30′ to 46° 45′), the superficial deposits of which were mapped the previous year. He commenced a survey of ground-water conditions and surface deposits in the adjoining Tignish area (longitude 64° to 64° 30′, latitude 46° 45′ to 47°).

NEWFOUNDLAND

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

A. M. Christie commenced geological mapping of the Bonavista area (longitude 53° to 54°, latitude 48° to 49°), which contains clay pits and slate quarries, and scattered iron, lead, and copper prospects.

J. J. Hayes completed geological mapping of the Hodges Hill-Twin Lakes area (longitude 55° 45′ to 56°, latitude 49° to 49° 30′), on which he spent the season of 1947 for the Geological Survey of Newfoundland. The area contains iron and copper sulphide deposits, and its northeast quarter is considered to be most favourable for prospecting.

E. H. Kranck studied and mapped an area along the southern coast of Labrador in the vicinity of Hamilton Inlet.

E. R. Rose commenced and completed geological mapping of the St. John's area (longitude 52° 30′ to 53°, latitude 47° 30′ to 47° 50′), which includes the important Wabana iron ore deposits of Bell Island, and has produced large quantities of pyrophyllite.

L. J. Weeks made an inspection trip through Newfoundland to gain knowledge of its geological problems and those of the mining industry, and to become acquainted with work done by the Geological Survey of Newfoundland.

Office and Laboratory Work

GENERAL

Many special maps and reports, based largely on field examinations, were prepared for use of Government departments, national or international committees, and mining companies, or for presentation at mining meetings and publication by various scientific societies.

ECONOMIC GEOLOGY RECORDS

The work of filling all available geological information on Canadian mineral occurrences was being rapidly brought up to date from the earliest years of mining activity in Canada.

SPECTROSCOPIC WORK

Additional equipment and facilities were provided to cope with the increasing demand for spectroscopic analyses. Thirty-two reports were issued on 83 samples received, and more than 2,100 exposures were made on 187 photographic plates. An index has been prepared of all available information relating to spectroscopic analysis of rocks and minerals.

X-RAY LABORATORY

X-ray powder photographs taken amounted to 650, most of them in connection with investigations of radioactive minerals.

Over 80 samples were received for identification of their radioactive mineral content. Purchase of a superpanner greatly facilitated the work involved in segregating finely disseminated radioactive minerals from the gangue.

S. C. Robinson, in charge of the laboratory, collected representative samples of radioactive minerals in the Goldfields area, Saskatchewan. He spent a week in the laboratories of North American Philips Inc., New York, investigating the usefulness of the X-ray fluorescence technique in uranium, thorium, and related elements in radioactive ores.

RADIOACTIVE INVESTIGATIONS

Prospectors samples tested amounted to 6,820, compared with 4,285 in the preceding year.

MINERALOGY

More than 8,000 specimens of rocks and minerals were examined and the results were reported to the parties concerned. Mineralogical information and oral reports were provided to about 1,000 visitors.

During the year 2,100 collections of Canadian rocks and minerals comprising 76,697 specimens were distributed, the distribution by collections and specimens respectively, being: British Columbia and Northwest Territories, 446 and 15,521; Alberta, 238 and 8,995; Saskatchewan, 195 and 6,894; Manitoba, 106 and 3,673; Ontario, 485 and 16,348; Quebec, 492 and 20,486; and Maritime Provinces, 138 and 4,780. Among the materials distributed were 65 special or miscellaneous collections, 60 collections of strategic minerals, and 75 pitchblende specimens.

Two large collections, one of minerals submitted by the Honourable A. Robert, P.C., High Commissioner for South Africa, and the other of minerals and rocks submitted by M. W. Maxwell, Chief of the Development Division, Canadian National Railways, were identified and labelled.

Early in May, through the activities of P. M. Millman of the Dominion Observatory, the Chief of the Section identified a meteorite that fell on

January 16, 1949, near Benton, New Brunswick, and was picked up by Cecil Lozier on his farm a few minutes afterwards. The meteorite is an aerolite, consisting mainly of stony matter with disseminated nickeliferous iron and troilite and weighs 1,338·6 grams. It is now the property of the Geological Survey.

A special exhibit of meteorites was placed on display in the National Museum of Canada.

A large group of calcite crystals from the Engineer gold mine, Atlin district, British Columbia, was presented to the Geological Survey by R. L. Christie.

PALÆONTOLOGY

Reports were prepared on 41 fossil collections submitted for identification and determination of the age of the rocks containing them. These came from various parts of Canada, including the Arctic Islands. In addition, plant collections were examined from Nechako and Nelson areas, British Columbia, from the west coast of British Columbia, and from Pincher Creek area, Alberta.

G. W. Sinclair of University of Michigan reported on Silurian fossils from Victoria and Prince of Wales Islands, Arctic Archipelago; Dr. M. A. Fritz of the Royal Ontario Museum examined Devonian fossils from McDame Post in northern British Columbia; Myra Keen of Stanford University studied Pleistocene collections from Vancouver, British Columbia, and from Moosonee, Ontario, and some Tertiary material from Prince Patrick Island, Northwest Territories; Ralph Stewart of the United States Geological Survey examined Tertiary fossils from the west coast of British Columbia; and Teng-Chien Yen, also of the United States Geological Survey, studied Lower Cretaceous fossils from Ootsa Lake, British Columbia.

A valuable collection of Ordovician graptolites was presented to the Geological Survey through the courtesy of Dr. O. M. Bullman of Cambridge University and the Geological Faculty of Birmingham University. Fossil collections were donated by Socony Vacuum Exploration Company, and by several individuals and explorers.

GROUND WATER AND BORINGS

The Division collects, organizes, and files records and samples from wells drilled for petroleum, natural gas, and water in all parts of Canada, and studies and interprets this material to make it useful in correlating subsurface geological formations and in solving ground-water problems.

A total of 1,294,631 drill samples is now available for reference and study, of which 94,055 were received during the year and 71,662 were prepared for examination. Of those received, 84,141 samples were from 280 wells in Alberta. These samples were mainly from deep wells drilled within known oil and gas fields, but many were from exploratory wells in unproven territory; 818 samples were from 2 wells in southwestern Manitoba; 6,877 were from 46 wells in Ontario, mainly in the southwestern part of the province; and 219 were from 2 wells in Quebec, one in the St. Lawrence Lowlands and the other in Gaspe Pensinula.

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

Acknowledgment is made to T. B. Williams, Petroleum Controller, British Columbia Department of Lands and Forests, for information on gas wells in the Pouce Coupé region; to personnel of the Alberta Petroleum and Natural Gas Conservation Board for all periodical drilling reports, interim reports,

electrologs, and maps dealing with drilling in Alberta; to F. H. Edmunds, University of Saskatchewan, Saskatoon, who supplied logs of Saskatchewan wells; to the Department of Resources and Industrial Development, Saskatchewan, for monthly provincial drilling reports; to I. W. Jones of the Department of Mines, Quebec, for logs of Quebec wells; and to officials of many oil companies for much useful information.

Samples were examined from, and stratigraphic logs compiled of: Hay River test wells in Northwest Territories; scattered wells in Alberta (particularly the north-central part) and Ontario; and Gaspe county wells in Quebec. Maps were compiled of subsurface Devonian horizons in Alberta, and others were maintained showing well locations in Alberta, generally, and in the Redwater and Leduc-Woodbend oil fields.

The Alberta Petroleum and Natural Gas Conservation Board forwarded copies of records of water wells drilled in Alberta. Records of Saskatchewan water wells are kept by the Provincial Government, but a great many logs of such wells were received from F. H. Edmunds, under whose supervision samples from the wells were examined. Acknowledgment for water-well samples is made principally to J. H. Rainsford, Royal Oak, British Columbia, and to D. McLean of Ottawa.

COAL

Activities comprised field mapping, map compilation, and laboratory investigations relating to Canada's coal resources and the solution of geological problems connected with mining development in various coalfields across Canada.

Field and laboratory work was continued in the Sydney coalfield as a cooperative research project with the Nova Scotia Department of Mines and the Nova Scotia Research Foundation. Primary objective of the investigation is to determine the sedimentary relationships of the coal so that its quality can be predicted prior to mining. Detailed mapping was commenced in the Springfield Colliery area (longitude 64° to 64°10′, latitude 45°35′ to 45°40′), where coal is being mined at a depth of 4,000 feet, the deepest coal mining operations in North America.

Sixty-eight geological maps pertaining to Canada's coal resources were published. These were: 13 maps on a scale of 1 inch to 3 miles, relating to the 12 commercial coal seams of the Sydney submarine coalfield; 2 preliminary geological and 2 preliminary coal maps of the Minto and Chipman areas, New Brunswick, on a scale of 1 inch to 12 miles, showing all known lignite occurrences and locations of coal mines and stripping operations; and a set of 52 maps, all but two of which are on a scale of 1 inch to 4 miles, of coal areas in Alberta, showing all coal mines and other occurrences of coal.

GEOPHYSICS

The office staff was increased from 12 to 29 and much time was spent in training new personnel in the compilation of aeromagnetic data. Three separate units were set up to deal with field work, compilation and plotting, and research and technical service.

Aeromagnetic surveys of areas totalling 21,774 square miles were made in Ontario, Quebec, and New Brunswick, as follows: (1) in Ontario: longitude 77° to 80°, latitude 44° 30′ to 45° 30′ (10,150 square miles); in Quebec and Ontario: longitude 76° to 77°, latitude 45° 30′ to 46° 30′ (3,324 square miles); (2) in New Brunswick, a triangular area running northeast within longitude 65° 30′ to 68° and latitude 45° 30′ to 48° (8,300 square miles). These surveys required the flying of 62,700 line miles of magnetic profile, and a flying time of approximately 752 hours.

The work of plotting and compilation may be summarized in terms of 15′ x 30′ 1-mile map-sheets as follows: completed for publication, 9; being plotted, 34; on hand, 46 full sheets and 17 part sheets.

BRITISH COLUMBIA OFFICE

A total of 3,977 visitors registered at the office, and many inquiries were handled by mail and telephone. Altogether, 4,071 reports and 3,508 separate maps were issued in response to requests from the public. Determinations were made of a number of mineral and rock specimens.

YELLOWKNIFE OFFICE

The office is serviced jointly by a Resident Geologist of the Geological Survey and by representatives of the Lands and Development Services Branch of the Department of Resources and Development. Advice and assistance relative to mining and prospecting were given to the many persons visting the office; 395 maps and 332 reports were distributed; and close touch was maintained with mining developments in western Northwest Territories.

GEOLOGICAL MAPPING DIVISION

Maps Published From April 1, 1949, To March 31, 1950

Publication number	Title	Remarks
	YUKON TERRITORY	
373A	Ogilvie Sheet (reprint); scale, 1 inch to 4 miles	Topography. For separate distribution.
48-25A	McQuesten; scale, 1 inch to 2 miles	Preliminary geological map. Paper 48-25.
49-24A	Dezadeash; scale, 1 inch to 4 miles	Preliminary geological map. Paper 49-24.
	NORTHWEST TERRITORIES	
690A	Snare River, District of Mackenzie (reprint); scale, 1 inch to 4 miles	Geology. For separate distribution.
697A	Ingray Lake, District of Mackenzie (reprint); scale, 1 inch to 4 miles	Geology. For separate distribution.
49-8	Carp Lakes, District of Mackenzie; scale, 1 inch to 4 miles.	Preliminary geological map. Paper 49-8.
49-10A	Indin Lake (East Half), District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 49-10.
49-14	Wecho River (East Half), District of Mackenzie; scale, 1 inch to 2 miles	Preliminary geological map. Paper 49-14.
49-16A	Pitchblende Occurrences between Beaverlodge and Hottah Lakes (Northeast Sheet), District of Mackenzie; scale, 1 inch to 500 feet	Preliminary geological map. Paper 49-16.
49-16B	Pitchblende Occurrences between Beaverlodge and Hottah Lakes (Southwest Sheet), District of Mackenzie; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 49-16.
49-19A	MacAlpine Channel (Great Bear Lake), District of Mackenzie; scale 1 inch to ½ mile	Preliminary geological map. Paper 49-19.
49-26A	Yellowknife (Sheet 3), District of Mackenzie; scale, 1 inch to 500 feet	Preliminary geological map. Paper 49-26.

Publication number	Title	Remarks
	BRITISH COLUMBIA	
962A	McConnell Creek, Cassiar District; scale, 1 inch to 4 miles	Geology. For Memoir 251 and separate distribution.
979A	Carp Lake, Cariboo District; scale, 1 inch to 4 miles	Geology. For separate distribution.
980A	Carp Lake, Cariboo District; scale, 1 inch to 4 miles	Surface deposits. For separate distribution.
49-22	Nelson (West Half), Kootenay District; scale, 1 inch to 2 miles	Preliminary geological map. Paper 49-22.
	ALBERTA	
963A	Moberly Creek, West of Sixth Meridian; scale, 1 inch to 1 mile	Geology. For separate distribution.
978A	Gap, West of Fifth Meridian; scale, 1 inch to 1 mile	Geology. For Memoir 255 and separate distribution.
49-3	Cardston, West of Fourth Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-3.
49-7A	A la Pêche, West of Sixth Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-7.
49-15	Some Cretaceous sections along Athabaska River from the mouth of Calling River to below Grand Rapids; scale, 1 inch to 4 miles	Preliminary geological map. Paper 49-15.
	Atlas of coal areas containing fifty maps; scale, 1 inch to 4 miles	Geology. For separate distribution.
	SASKATCHEWAN	
49-17A	Goldfields; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-17.
49-17B	Martin Lake; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-17.
49-18A	Snake Rapids; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-18.
49-27A	Pine Channel Area (Lake Athabasca); scale, 1 inch to 1,500 feet	Preliminary geological map. Paper 49-27.
	MANITOBA	
49-9	Collins Point, West of Principal Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-9.
49-12A	Brochet; scale, 1 inch to 4 miles	Preliminary geological map. Paper 49-12.
49-20	Moody Lake, scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-20.
50-1	Elbow Lake; scale, 1 inch to ½ mile	Preliminary geological map. Paper 50-1.
	ONTARIO	
	Ottawa; scale, 1 inch to 1 mile	Aeromagnetic series.
	Kemptville; scale, 1 inch to 1 mile	Aeromagnetic series.
	Merrickville; scale, 1 inch to 1 mile	Aeromagnetic series.
50-6A	Ossian Township, Timiskaming District; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 50-6.

Publication number	Title	Remarks
	QUEBEC	
681A	Lac au Sorcier, Laviolette, St. Maurice, and Maskinongé Counties (reprint); scale, 1 inch to 2 miles	Topography. For separate distribution.
49-23	Southwest Dasserat, Témiscamingue County; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 49-23.
49-25	Southeast Dasserat, Témiscamingue County; scale, 1 inch to 1,000 feet	Preliminary geological map. Paper 49-25.
	NEW BRUNSWICK	
243A	Hillsborough Sheet, Albert and Westmorland Counties (reprint); scale, 1 inch to 1 mile	Topography. For separate distribution.
49-13A	Minto (geology), Queens and Sunbury Counties; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-13.
49-13B	Minto (coal deposits), Queens and Sunbury Counties; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-13.
49-21A	Chipman (geology), Queens and Sunbury Counties; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-21.
49-21B	Chipman (coal deposits), Queens and Sunbury Counties; scale, 1 inch to ½ mile	Preliminary geological map. Paper 49-21.
	NOVA SCOTIA	
	Atlas of thirteen maps showing estimate of reserves of Sydney coalfield, Cape Breton Island; scale, 1 inch to 3 miles	For separate distribution.
	PRINCE EDWARD ISLAND	
49-6A	O'Leary, Prince County; scale, 1 inch to 1 mile	Preliminary geological map. Paper 49-6.
	MARITIME PROVINCES	
910A	New Brunswick, Nova Scotia, and Prince Edward Island; scale, 1 inch to 12 miles	Geology. For separate distribution.

Five maps for Ground Water Resources were drawn for distribution. One hundred and seven maps and scientific figure drawings were draughted for reproduction by zinc-cut process for illustrating memoirs, reports, articles, and papers.

LIBRARY

Acquisitions:

Books acquired by purchase	310
Books (complete unbound volumes by purchase)	309
Books by transfer, exchange, and gift	880
Canadian Government documents—individual issues (by gift and exchange)	1,953
British and foreign Government documents—individual issues (by gift and exchange)	2,707
Canadian periodicals, individual issues	1,222

LIBRARY—*concluded*

Acquisitions—*Concluded:*

British and foreign periodicals, individual issues	1,833
Scientific societies' bulletins, proceedings, and transactions—individual issues (by gift and exchange)	5,477
Total	14,691

Other data:

Recorded loans of books, pamphlets, and periodicals	16,897
Inter-library and occasional loans	2,022
Books borrowed from other libraries	588
Maps and charts added to the library	1,884
Maps and charts borrowed from the library	482
Lantern slides borrowed	1,073
Lantern slides added to library	34
Photographs loaned (exclusive of albums)	1,603
Volumes bound	505
Volumes accessioned	1,528
Cards added to general catalogue	13,663
Cards added to map catalogue	634
Cards added to slide catalogue	100
Letters and cards received	3,071
Letters and cards sent	5,047

PHOTOGRAPHIC SECTION

The photographic work included developing of 42,630 feet of magnetometer film and printing of 71,060 feet of this film; developing of 6,139 exposures in connection with the field work of the Geological Survey; and making of 19,296 contact prints.

REPRODUCTION PROCESSES

Blueprint	299,512 square feet
Océ prints	33,129 square feet
Photostat	11,437 sheets
Mimeograph	680,528 impressions

Preliminary reports, etc., collated, assembled, stapled, etc. 32,356 copies

SURVEYS AND MAPPING BRANCH

W. H. Miller, Director

The demand for surveys, maps, and charts necessary for the investigation and development of Canada's natural resources continued at a high level, and the facilities were taxed to the limit to complete even those projects given a high priority. The entry of Newfoundland into Confederation added a great length of coast line for which the provision of adequate charts is a responsibility of the Hydrographic Service. The staffs of all services were enlarged within the limits of available suitably trained men, particularly engineers and draughtsmen. Modern equipment was added that improved the quality, and in many instances reduced the cost, of the finished product. Provincial authorities doing similar work were consulted from time to time to avoid duplication of effort.

Close co-operation was maintained between the Branch and the Army Survey Establishment, Department of National Defence, and all maps produced by either organization meet both defence and civilian needs. In the field work the resources of the two organizations are pooled in order that the most urgent needs of both Departments may be met. The reproduction of the Branch's 1- and 4-mile maps is done by the Army Survey Establishment.

Reports on the activities of the five divisions of the Branch follow.

TOPOGRAPHICAL SURVEY

The Topographical Survey carries out the field surveys and completes the resultant map manuscripts, on medium and large scales, up to the stage of final draughting, for all mapping by the Federal Government. It also includes the National Air Photographic Library, which is responsible for indexing, preserving, and distributing prints from all air photography done by or for the Federal Government. The Survey provides the staff of the Canadian Board on Geographical Names and its vote includes funds for the expenses of the Board.

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

The work of the Survey has been greatly expanded since the end of the war to meet the requirements of the accelerated mapping program, as approved by the Cabinet. This has necessitated extensive recruiting for field engineers and technicians. Shortage of graduate engineers and higher salaries paid by industry have been a serious handicap in building up a field staff. It has been possible, however, to recruit and train an efficient group of technicians, who are engaged in producing maps from air photographs. The result of that training is reflected in the map production of the Air Survey Section, which increased 45 per cent in this fiscal year compared with the previous year.

Many of the areas in which field surveys are carried out are rugged and difficult of access and thus much of the time of field officers is spent in reaching their observation points. This prompted the experimental use on topographical mapping of two helicopters during the year, one in the mountainous district of northern British Columbia in association with the Army Survey Establishment, and the other in the iron ore areas in Quebec-Labrador. Although it was found that the helicopter is subject to certain operational limitations, the results indicated that this type of transportation has great possibilities both in speed and economy.

Operation of the highly technical equipment of the multiplex plotting subsection was expanded as rapidly as thorough training of personnel would

permit. Another modern stereoscopic plotting device, the Wernstedt-Mahan plotter, was added to the map plotting equipment and has proved efficient for plotting certain types of topography.

A total of 8,849 advance information prints were distributed. The preparation and distribution of these prints, which make recent surveys quickly available to federal and provincial organizations and to the public, is an important service that was inaugurated by the Topographical Survey several years ago.

TOPOGRAPICAL MAPPING SECTION

This Section did original ground surveys for control of mapping from aerial photographs over areas totalling 116,175 square miles. These surveys were widely distributed across Canada and were made by methods considered to be best suited to the varied conditions and purposes. Thirteen field parties were provided by the Army Survey Establishment under an arrangement with the Department of National Defence. The sixty-eight field projects carried out are listed below:

Province or territory	Number of parties	Type	Scale	Area (square miles)
Northwest Territories	3	Topographical	1 in. to 1 mile	1,990
	1	Planimetric	1 in. to 1 mile	2,650
	1	Topographical (special)	1 in. to 1,000 ft.	50
Yukon	9	Photo-topographical	1 in. to 4 miles	30,000
	3	Triangulation	200 mile net	
	1	Winter base line party		
British Columbia	3	Photo-topographical	1 in. to 1 mile	1,190
	15	Photo-topographical	1 in. to 4 miles	46,580
	1	Winter traverse party	Transit and stadia	300 linear miles
Alberta	1	Field interpretation	1 in. to 1 mile	3,740
	1	Winter traverse party	Transit and chain	200 linear miles
Saskatchewan	1	Topographical	1 in. to 1 mile	2,000
Manitoba	2	Planimetric	1 in. to 1 mile	3,960
Ontario	1	Planimetric (special)	1 in. to 1,000 ft.	180
	1	Topographical (special)	1 in. to 1,320 ft.	75
Quebec	6	(Topographical and planimetric)	1 in. to 1 mile	8,740
Quebec-Labrador	4	(Topographical and planimetric)	1 in. to 1 mile	6,120
New Brunswick	6	Topographical	1 in. to 1 mile	3,500
Nova Scotia	6	Topographical	1 in. to 1 mile	3,200
Newfoundland	2	Topographical	1 in. to 1 mile	2,200
	68			116,175

One of the four senior officers assigned to field supervision gave his attention to the photo-topographical parties in Yukon and northern British Columbia; the second supervised the control, by triangulation, of a large project around Great Slave Lake; the third carried out an experimental project in the iron ore area in Quebec-Labrador, which involved the use of the helicopter as a means of transportation; and the fourth supervised topographical mapping in New Brunswick and Nova Scotia.

AIR SURVEY SECTION

This Section is organized in two subsections of four plotting units each and one multiplex subsection of two plotting units. This organization provides for a close control of all phases of the work and forms a complete chain of responsibility both for training and production. The Section completed the following mapping work:

Province or territory	Number of map-sheets	Publication scale	Area (square miles)
Planimetry—			
Northwest Territories	12	1 in. to 1 mile	3,317
	1¾	1 in. to 4 miles	6,975
	1	1 in. to 1,000 ft.	63
Yukon	5¾	1 in. to 4 miles	26,052
British Columbia	1	1 in. to 1 mile	420
	5	1 in. to 4 miles	26,405
Alberta	59½	1 in. to 1 mile	21,076
Saskatchewan	35	1 in. to 1 mile	13,538
Manitoba	28	1 in. to 1 mile	7,721
	2	1 in. to 4 miles	9,824
Ontario	5	1 in. to 1,000 ft.	180
Quebec	20	1 in. to 1 mile	7,632
	2	1 in. to 1,000 ft.	76
Nova Scotia	3	1 in. to 1 mile	311
Labrador	12	1 in. to 1 mile	4,122
Part of Quebec and Newfoundland	½	1 in. to 4 miles	2,836
Coastal areas (for Hydrographic Service)—			
Northwest Territories	1	1 in. to ½ mile	75
	4	1 in. to ½ mile	1,413
	4	1 in. to 1 mile	3,738
	1	1 in. to 1,000 ft.	2
Quebec	1	1 in. to ½ mile	15
	3	1 in. to 1 mile	2,462
Coast of Labrador	5	1 in. to ½ mile	2,672
Total of planimetric mapping			140,925
Topographical maps—			
British Columbia	2	1 in. to 1 mile	658
Alberta	½	1 in. to 1 mile	190
Ontario	1	1 in. to 1 mile	20
Total	3½		868
Mosaics—			
Quebec and Labrador	29	1 in. to 1 mile	9,950
Newfoundland	17	1 in. to 1 mile	6,000
Yukon	8	1 in. to 2 miles	4,000
Total	54		19,950

Although the planimetric mapping shows an increase of about 45 per cent over 1948-49, the number of man days on this type of work was approximately the same in both years, the increase being attributable to a higher degree of training and more efficient methods.

Equipment

With the new equipment received the multiplex-plotting subsection now comprises fifteen full units and two small units designed for plotting single overlaps. This will allow a normal complement of seventeen operators, which can be increased when required to twenty-seven. One Wernstedt-Mahan plotter is in operation with very satisfactory results. The acquisition of the stereoscopes and additional sketchmasters has relieved the shortage of this type of photogrammetrical equipment.

MAP EDITING SECTION

This Section processes map manuscripts to their final stage before being forwarded to the Map Compilation and Reproduction Division for reproduction and publication. It also prepares tracings for "advance information prints", draws projections for the whole organization, and prepares metal mounted manuscript sheets. The work of the Section is tabulated below:

Map-sheets Forwarded for Reproduction

Province or territory	Publication scale			Total	Area (square miles)
	1 mile	2 mile	4 mile		
Northwest Territories	10	.....	1	11	6,818
Yukon	.....	.....	1	1	4,728
British Columbia	.....	2	1	3	7,539
Alberta	14	3	.....	17	9,150
Saskatchewan	10	.....	1	11	8,303
Manitoba	11	.....	2	13	13,978
Ontario	8	.....	.....	8	3,336
Quebec	2	.....	.....	2	796
New Brunswick	17	.....	.....	17	6,926
Nova Scotia	4	.....	.....	4	1,677
	76	5	6	87	63,251

Special Map Projects Forwarded to Geological Survey

Province or territory	Projects	Area (square miles)
Quebec	1	92
Ontario	5	174
Northwest Territories	2	183
	8	449
Total projects forwarded	95[1]	63,700

[1] This total comprises 123 map manuscripts.

Advance Information Tracings Prepared

Northwest Territories	24
Yukon	1
British Columbia	4
Alberta	58
Saskatchewan	44
Manitoba	22
Ontario	11
Quebec	21
New Brunswick	3
Nova Scotia	9
Quebec-Labrador	15
	212

Two hundred and ninety-seven projections were drawn to various scales and 283 manuscripts were mounted on metal. Numerous index maps, charts, and special drawings were prepared.

COMPUTING SECTION

This Section did the computations, adjustment, and filing of control traverse, triangulation, and related observations executed by various field parties. It made the computations and adjustments for certain provincial surveys and for various meridians, base lines, and range lines of the Dominion Lands System and supplied the positions thus determined to other federal government units, to the provinces, and to various private organizations.

NATIONAL AIR PHOTOGRAPHIC LIBRARY

This Library serves as a central reference library of aerial photography in Canada. It has on file one print of each air photograph taken by or for federal government agencies and has indices showing the geographical location of each photograph. It maintains a record of all other aerial photography in Canada and has facilities for stereoscopic study of its photographs, in which studies it assists in interpretation of the photographs. The Library arranges for the reproduction of prints for those who wish to purchase copies. It added one print each of 236,294 new aerial negatives to its collection in the fiscal year and now has on file one each of approximately 2,025,000 aerial negatives, covering areas totalling over 3,000,000 square miles. The prints added during the fiscal year covered areas totalling 378,648 square miles by vertical photography, including areas in British Columbia, Yukon, Northwest Territories, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland. The trimetrogon photography covered 493,798 square miles, most of which was in the Northwest Territories and the Arctic Islands.

The importance of aerial photography to modern mapping techniques and to the development of natural resources was evidenced again by the broad and increased use of aerial photographs by government departments and commercial concerns. This was doubly reflected by the number of visits to the Library of scientists, teachers, engineers, geologists, foresters, town planners, etc., to examine photographs covering areas in which they were concerned.

Two thousand and sixteen requisitions, covering the purchase of 501,905 prints of aerial negatives, were forwarded to the Photographic Establishment of the Royal Canadian Air Force, a number almost double that of the previous fiscal year. These prints were for transmission to Dominion and Provincial Government services, engineering, commercial, and educational institutions, and to private individuals.

CANADIAN BOARD ON GEOGRAPHICAL NAMES

Names for 171 maps and 25 charts were adopted, and many new names, name changes, and other items of related business were considerd. Numerous inquiries from the public and the departments of the public service were investigated and the required information supplied. Considerable work was done in preparing for the publication of the forthcoming Gazetteer of Canada series.

Seven provincial members or their representatives attended the February 1950 meeting of the Board at which several items of particular interest to the provinces were discussed.

P. E. Palmer, Chief Topographical Engineer, was elected Board Chairman on the retirement of K. G. Chipman. The present membership of the Board is: chairman, P. E. Palmer; executive committee, C. H. Smith, R. J. Fraser,

M. G. Cameron; members, Norman Fee, A. McFarlane, J. G. Wright, J. W. Watson; provincial members, W. G. H. Firth, British Columbia; H. P. Brownlee, Alberta, A. I. Bereskin, Saskatchewan; H. E. Beresford, Manitoba; F. W. Beatty, Ontario; J. G. B. Pugh, New Brunswick; A. E. Cameron, Nova Scotia; The Honourable J. Walter Jones, Prince Edward Island; secretary, L. B. Skinner. The province of Quebec has an independent Board that co-operates with the Canadian Board on Geographical Names on matters pertaining to that province.

HYDROGRAPHIC SURVEY

The chief function of the Canadian Hydrographic Service is the production of nautical charts and other hydrographic aids to navigation for the protection of life and property at sea. The work includes detailed charting of the coastal and inland navigable waters of Canada, investigation of tides, and precise recording of the fluctuating water levels of the Great Lakes-St. Lawrence Waterway. This Service issues the official Canadian navigation charts, volumes of sailing directions, and the standard tide prediction tables for Canadian seaports.

The technical work of the Service is conducted by four principal operating sections: Chart Production and Sailing Directions; Hydrography and Ships; Tidal and Current Survey; and Precise Water Levels. Administration is directed from Hydrographic headquarters at Ottawa, which is also the clearing centre for general navigational information. The district office at Victoria supervises charting and tidal operations on the Pacific coast and is the principal distributing centre for hydrographic publications pertaining to that seaboard.

With the entry of Newfoundland into Confederation the Hydrographic Service assumed responsibility for the production of hydrographic aids to navigation for the new province. Many of the charts covering the coast of Newfoundland were made at a time when mercantile and naval requirements were less exacting than at present. The advent of echo sounding as standard navigational equipment for determining positions at sea has raised doubts as to the accuracy of meagre information given on old charts.

The coasts and bordering seas of Labrador, from Belle Isle to the entrance of Hudson Strait, form one of the unsurveyed regions in the world. The long, intricate coast is fringed inshore with shoal summits and submerged menaces, with many dangerous reefs rising abruptly from the sea-floor, and shipping has been hampered by lack of accurate charts. The Hydrographic Service began charting operations in the vicinity of Belle Isle in 1949.

THE HYDROGRAPHIC FLEET

Considerable progress was made in the ship, motor launch, and equipment development program. The two main charting vessels, the C.G.S. *Fort Frances* and the C.G.S. *Kapuskasing,* joined the surveying fleet in September and commenced their charting careers on the Atlantic seaboard. They bring to six the number of principal Canadian surveying vessels in operation, four on the Atlantic and two on the Pacific. In addition, there are six motor cruisers and a flotilla of twenty other sounding launches. Two of the larger and several of the smaller launches were constructed during the fiscal year and mark a step forward in hydrographic design. The *Fort Frances* and *Kapuskasing* have a fuel oil bunkerage sufficient for a cruising radius of approximately 4,600 miles. Technical equipment includes the most modern hydrographic and oceanographic instruments with complete bathythermographical gear. Navigation equipment consists of radar, gyro compasses, supersonic echo sounders, and telephonic communication from ship to sounding launches. Accommodation is provided for a complement of 6 persons, including 8 hydrographers, 4 navigating officers, and 5 marine engineers.

HYDROGRAPHY

Reviews of the work on a geographical basis follow.

Atlantic Coast and Inland Waters

Bay of Fundy. Charting of the Grand Manan area was continued with use of the motor cruisers *Dawson* and *Anderson.* On October 1, the new hydrographic ship *Fort Frances* was also assigned to this project. The complete Grand Manan area, including the extensive group of outlying islands with their bordering shoals, was charted out to the deep open water of the Bay. Several hitherto unknown dangers were found and previously charted information about other areas was radically revised. An instance of the latter is the Kent Shoal over which a depth of only 11 feet was found where previously a depth of 21 feet was indicated on the old charts. As a result of this project a new edition of the provisional chart "Grand Manan Channel" is to be published, and a new standard chart "Grand Manan" is to be issued for regular navigation purposes. Other field projects by this unit included detailed charting off White Point, N.S., where H.M.C. aircraft carrier *Magnificent* was grounded earlier in the season.

An echo sounding test was conducted in Passamaquoddy Bay to ascertain the capability of this instrument to determine depths of sea-floor overburden. A detailed survey was made of Courtenay Bay Channel in Saint John Harbour at the request of the local harbour authorities. The recharting of Halifax Harbour was extended, and, at the request of the Royal Canadian Navy, an official "measured mile", by which vessels may try out their speeds, was laid out and marked in Bedford Basin.

The season's work included 4,085 linear nautical miles of sounding, 80 linear nautical miles of coastlining, and examination of 196 shoals.

Nova Scotia. Several of the student technical assistants were employed in stretch-line soundings about the wharves and jetties in Halifax Harbour during the conversion and fitting-out of the new hydrographic vessel *Kapuskasing.* As the ship was not ready for sea until November 3, she was unable to commence any major charting. Her first hydrographic work was calibration of the Camperdown wireless direction-finding station at the request of the Department of Transport. On completion of this, detailed soundings were taken between Balache Point and Cape Porcupine in the Strait of Canso, and the ship then returned to her base at Dartmouth.

Gulf of St. Lawrence. Two charting projects were carried out by the hydrographic motor cruiser *Henry Hudson.* Chief of these was the modern charting of Port aux Basques and approaches, Newfoundland. Heretofore, the only chart available was one issued as a result of a survey made about 70 years ago—10 years before the establishment of the port as a main ship and railway terminus. Since then, navigational conditions have greatly changed: wharves have been built, and a system of aids to navigation installed, and because of the much larger vessels that visit the port, chart requirements are much more exacting.

The other project undertaken at the request of the Federal Department of Public Works was the detailed survey of the dredged channel of East River, N.S., from Pictou to Trenton. The survey of the most critical parts of the river was made on a scale of 200 feet to 1 inch and a detailed plan of the results was supplied.

As a result of the season's operation, a chart "Port aux Basques and Approaches" will be issued, the existing official "Sailing Direction" will be revised, and tidal data will be made available. The work included: 254 linear nautical miles of boat sounding, 32 linear nautical miles of coastlining, and examination of 56 shoals.

St. Anthony and St. Mien Bay; Belle Isle, Newfoundland. The C.G.S. *Cartier* carried out a survey of St. Anthony Harbour and St. Mien Bay, Newfoundland, the previous charting of which was conducted by the French Imperial Navy in 1850-58. This important harbour is a port of call for schooners bound for the Labrador fishing grounds. As weather permitted, areas at the southern end of Belle Isle and at Lark Harbour, on the west side of the island, were charted. Later in the season, a detailed survey was started of Little Southern Harbour in Placentia Bay. Other charting operations by this unit consisted of examinations in Miramichi Bay, Wood Island (Northumberland Strait), and in the Strait of Canso. Water temperatures and water samples were taken at regular intervals wherever the ship was on passage and the results were forwarded to the Atlantic Oceanographical station at St. Andrews, N.B.

As a result of the operations two new nautical charts, "St. Mien Bay and St. Anthony Harbour", and "Belle Isle" will be published. The season's work included: 173 linear nautical miles of sounding, 50 linear nautical miles of coastlining, and examination of 4 shoals.

Grand Bank; Fogo; Hare Bay, Newfoundland. The hydrographic vessel *Acadia,* before embarking on the regular charting work of the season, conducted oceanographical trials to familiarize the staff with the uses and purposes of various new oceanographical gear. The ship then did the detailed charting of Grand Bank and approaches, and the important area of Cape Race and the immediate vicinity. A major undertaking was the modern charting of Fogo Harbour, Seal Cove, and approaches on the east coast of Newfoundland. When weather conditions prevented further work in this exposed area, the ship proceeded to Hare Bay where preliminary hydrographic operations were undertaken as a commencement for future work. Continuous sounding records were made during the ship's passage, for comparison with depths shown on older charts. Bathythermographic observations at 27 stations were made. Other work of this unit included examination of Caribou Island Channel (off Pictou) and special chart revision work in Pictou Harbour.

Three new charts will be published as a result of the charting operations, "Grand Bank and Approaches", "Fogo Harbour, Seal Cove and Approaches" (provisional edition), and "Cape Race". The season's work included: 906 linear nautical miles of boats sounding, 26 linear nautical miles of coastlining, and examination of 79 shoals.

Chesterfield Inlet—Baker Lake. This project was concentrated on the shoal-ridden area at the east end of Baker Lake. This stretch of the waterway had never been charted and ships using the route frequently grounded there. The work was done with the echo-sounding launch *Grebe,* and disclosed a channel of sorts. However, it proved to be tortuous and extremely difficult to navigate without the erection of a system of navigation buoys and ship ranges. Accordingly, an exploratory sounding survey was made through the unknown waters north of Christopher Island to locate a better channel. Results indicated that more detailed charting would likely disclose a safe, deep-water route leading into the open lake. Owing to the lateness of the season it was impossible to spend more time in development of the prospective channel. Two lines of soundings were run on the usual ship route through Baker Lake.

As a result of the charting a provisional edition of a new chart "Baker Lake (Eastern Portion)" and preliminary "Sailing Directions for Chesterfield Inlet" will be made available. A total of 460 linear nautical miles of sounding was accomplished, much of it consisting of extremely short, closely spaced courses run through currents that attained speeds of 7 knots. Twenty shoals were examined.

Great Lakes. In a joint project, the Hydrographic Service and the Geographical Branch of the Department inspected the eastern shores and inner waters of Georgian Bay and Lake Superior from Midland to Port Arthur. The marine work, in which the new hydrographic motor cruiser *Bayfield* was used, was done to revise navigation information as given in existing volumes of Pilots and Sailing Directions and to make recommendations regarding aids to navigation for assistance of the many yachts and other craft that comprise a large part of the water-borne tourist trade. The Trent-Severn Waterway was then examined to obtain information to be added to the new set of charts of this unique navigation route. For chart use, mid-channel depths were obtained by echo sounder throughout the 240-mile stretch of the waterway. On completion of this project the waterfront at Kingston was surveyed for chart revision purposes.

As a result of the season's work important revisions were obtained for two volumes of Sailing Directions, and publication of five new Trent-Severn Waterway charts was expedited.

Great Slave Lake. Charting of the Great Slave Lake-Mackenzie River Waterway was continued. The part of Great Slave Lake surveyed extended from Northwest Point to beyond Gypsum Point. A 95-mile stretch of the lake has now been surveyed for an average distance of 10 miles offshore. In addition, several good harbours of refuge and sheltered anchorages were located and charted during the season to assist the shallow-draught shipping on the Fort Norman-Yellowknife run. Feature of the operations in Great Slave Lake was the finding of a deep channel into the lake through the Slave River delta. This hydrographic examination, undertaken at the urgent request of the Federal Department of Public Works, made unnecessary what would have been an expensive dredging project.

The season's activities will result in publication of a chart, "McIver Point to Mirage Point", and the addition of extensive hydrographic data to existing sheets. The work included: 1,160 linear statute miles of boat sounding, 56 statute miles of coastlining, and examination of 24 shoals.

PACIFIC COAST

Good headway was made in the established charting program for the inside passages from Vancouver to Prince Rupert. The hydrographic vessel *Wm. J. Stewart* continued major survey operations in a wide area in the vicinity of Banks Island and in the North Passage of Queen Charlotte Strait and made minor surveys in Gillen Harbour, Campbell River, Comox, Powell River, and Welcome Passage. The hydrographic work accomplished comprised 536 linear nautical miles of ship sounding, 1,608 linear nautical miles of boat sounding, 429 linear nautical miles of coastlining, and examination of 879 shoals.

The smaller ship C.G.S. *Parry* did detailed hydrographic operations in the vicinity of Redonda Islands and in Sheet Passage, Methieson Channel, Fraser and MacKay Reaches, Wright Sound, Ursula Channel, Verney Passage, Douglas and Whale Channels, and Skeena River. The season's work included: 327 linear nautical miles of ship sounding, 604 linear nautical miles of boat sounding, and 228 linear nautical miles of coastlining.

As a result of recent field operations, nine new Pacific coast charts were either completed or in course of final compilation.

Activities of the hydrographic district office at Victoria also included revision of Coast Pilots of the British Columbia coast, and preparation of a gazetteer of British Columbia geographical names, the latter in co-operation with the Canadian Board on Geographical Names.

CHART CONSTRUCTION AND REPRODUCTION

This Section produces nautical charts from field sheet to pre-printing stage, and corrects the large stocks of published charts to the date of issue to the public, in accordance with the latest navigational information received in the Hydrographical Office. Modern production techniques have been adopted to meet the steadily growing demand for navigation charts and to reduce the backlog of work inherited from the war and earlier.

Included in the standard and special charts produced were: a set of provisional charts of Arctic harbours; a general sailing chart of the Atlantic coast from the Bay of Fundy to Belle Isle; five sheets covering the Trent-Severn Waterway; and charts of the upper Ottawa River from St. Joachims to Mattawa. The Ottawa River charts, based mainly on data supplied by the Topographical Survey, show the nagivational conditions existing after flooding of the area for power development.

The following series of hydrographic charts are now published regularly: sailing or general charts; coast, lake, and river charts; harbour and approach charts; wireless charts; naval plotting charts; special charts such as those showing the limits of territorial waters. The series is kept up to date in accordance with navigational requirements. A catalogue of nautical charts and other navigational publications may be obtained by mariners or interested persons from the Dominion Hydrographer, Department of Mines and Technical Surveys, Ottawa.

PILOTS AND SAILING DIRECTIONS

Much important navigational information that cannot be shown conveniently on the charts is published in the form of "Pilots and Sailing Directions". The volumes are featured by the explicit navigational directions for traffic in difficult waters.

A new edition of the St. Lawrence River Pilot (Montreal to Kingston) and supplements to the British Columbia Pilot, Vol. I, and to the Nova Scotia and Bay of Fundy Pilot were issued.

NAUTICAL RESEARCH

Navigational matters dealt with included nautical geodesy, depths, changes in channels, recommendations for aids to navigation, buoyage, ship ranges, ice conditions, and coastal shipping routes. Reported dangers to navigation were investigated and information on them was furnished to shipping. Inland water route mileages were calculated as a basis for setting the authorized freight and passenger rate structures. Other work pertained to the length of Canadian coastlines, delimitation of the continental shelf, territorial waters of Canada, the laying down of broad charting schemes for the coastal and inland navigable waters, and preparation of individual field charting project specifications. There was urgent demand for hydrographic data pertaining to Arctic waters. For consultative purposes, a repository containing over 25,000 plans and documents is maintained as well as complete sets of Canadian and foreign charts and other hydrographic publications.

TIDE AND CURRENTS

The Tidal and Current Survey investigates tides and tidal currents in Canadian waters and prepares the official tide prediction tables and other tidal publications. These data are used by navigation and fishing trades, marine scientists, and port authorities, and in general by those who gain their means of support from the sea. Sixteen principal or reference tidal coast stations are

maintained in continuous operation for the improvement and refinement of tidal predictions, and for other practical and scientific purposes. Seasonal gauges are operated in localities where tidal data are required for special purposes.

PUBLICATIONS

"Tide Tables for the Atlantic Coast of Canada" contains all the information available for the eastern seaboard, including Hudson Bay. Four pocket editions are issued as follows: Quebec and Father Point (bilingual); Charlottetown and Pictou; Halifax and Sydney; and Saint John and Yarmouth. Special tables were prepared for Nelson, Manitoba; the "Bore" at Moncton; and St. Augustin in the St. Lawrence Ship Channel.

"Tide Tables for the Pacific Coast of Canada" contains all the information available for the Pacific coast. Three pocket editions are printed: Vancouver and Point Atkinson; Prince Rupert; and Port Alberni and Clayoquot, the first edition of which was published in 1950.

Publications dealing with tides and currents are as follows: "Tables of the Direction and Velocity of the Currents in the Bay of Fundy and its Approaches"; "The Currents in the Gulf of St. Lawrence"; "The Currents in the Entrance to the St. Lawrence"; "The Currents in the Estuary of the St. Lawrence, Ste. Anne des Monts to Father Point"; and "Tidal Current Charts for the hourly stages of the tide, Orleans Island to Father Point".

Other publications of a special nature are: "Tide Levels and Datum Planes, Atlantic Coast"; "Tide Levels and Datum Planes, Pacific Coast"; "Temperatures and Densities"; "Tides at the Head of the Bay of Fundy"; and "Tides and Tidal Streams".

SPECIAL INVESTIGATIONS OF TIDES AND TIDAL CURRENTS

New seasonal tide stations were established at five localities on the north shore of the Gulf of St. Lawrence and on the east and south coasts of Newfoundland. On the Pacific coast, investigations were made of the tides and tidal currents in four areas, including the lower reaches of Skeena River.

Plans were formulated for co-operative tidal current surveys with the Vancouver Sewerage and Drainage Board, and the Pacific Oceanographical Group, in the Vancouver Harbour area, including the construction of a special tidal survey launch.

The Hydrographic Service co-operated with the Meteorological Division, Department of Transport, in establishing temporary tidal stations in the Arctic Archipelago. Four stations were in operation during the short open season.

OCEANOGRAPHY

The Dominion Hydrographer is a member of the Canadian Joint Committee of Oceanography. Basic data on oceanography are used in connection with fishery, scientific, and defence activities. To further the progress of studies of Canadian waters, hydrographic ships are equipped with deepsea water bottles, reversing thermometers, bathythermographs, and accessory gear. As opportunity permits the ships collect oceanographical data in conjunction with the performance of their regular charting operations. The results are sent to the Atlantic Oceanographic establishment at St. Andrews, N.B.

PRECISE WATER LEVELS

Chief function of the Section is the continuous recording of the fluctuating water levels of the Great Lakes-St. Lawrence Waterway, for which the basic data are obtained by means of a completely inter-related system of 48 self-registering permanent observation stations maintained in strategic lake and

river locations from Quebec to Port Arthur. It also investigates the water levels of the Great Slave Lake-Mackenzie River system. At Ottawa the original field records are reduced and the collated data in the form of water-level bulletins, graphs, and reports are supplied for navigation, waterpower, municipal, and other purposes.

Well over 800,000 water surface elevations were compiled into comprehensive reports during the fiscal year from the 530 months of continuous field recordings. Twelve monthly, five annual, five graphical, and six general data bulletins were issued. The Canadian Press was furnished with a synopsis of each monthly bulletin for publication in the marine section of many newspapers.

Frequent requests were received for technical information on diverse water-level problems. To provide the data, special analysis was required in most cases. Contact was maintained with related services in the United States and valuable water-level data for the information and improvement of waterborne transportation and engineering purposes were exchanged.

CHART DISTRIBUTION

Chart sales rose to the highest level in several years, the increase being attributable largely to defence requirements, development of northern transportation to serve mining and other interests, and growth of the waterborne tourist trade. The chart standardization program necessitated replacement of many out-of-date charts in ships' chartrooms.

Hydrographic publications distributed during 1949 were as follows:

Catalogue of Charts, Sailing Directions and Tidal Information with Index Maps	1,550
Navigation charts	52,752
Pilots and Sailing Directions	1,344
Supplements to Pilots	580
Tide Tables	53,816
Water-level bulletins, graphs, etc., exclusive of those distributed through Notice to Mariners	11,003

For the convenience of shipping, chart distribution agencies are established in all principal sea and inland water ports. Canadian Hydrographic charts and publications are reproduced by other hydrographic offices for use of their own vessels and then total world circulation of Canadian charts and related publications is greatly in excess of the above figures.

GEODETIC SURVEY

The Survey endeavours to meet the increasing demands of federal, provincial, municipal, and other agencies and organizations for positional and height control for use as a basis for mapping and charting in various engineering projects such as electric power development and the development of harbours.

Changing economic conditions, the heightened development of the country's natural resources, the problems of national defence, and the union of Newfoundland with Canada have necessitated an expansion and to some extent a realinement of former activities.

For horizontal control where a high degree of precision is required, primary and secondary networks of triangulation have been advanced in certain areas and new networks inaugurated in others. Where time rather than accuracy has been of first importance in obtaining control, astronomical observations have been employed to obtain what are known as exploratory fixes, and several hundred of these control points have been established, particularly in

the Far North as aids to aerial navigation. Recent developments in the application of Shoran indicate that this method will play an increasing part in obtaining horizontal control in those areas where visual triangulation methods may not be economical for many years.

For vertical control several hundred miles of precise levels were run and many additional precise level bench-marks were added to the previous large total established throughout Canada. Information of lesser accuracy in vertical control was obtained by trigonometric levelling and by aneroid determination in those areas where precise levelling is not feasible at present.

Information on horizontal and vertical control is collected and published as quickly as the field results of a large area can be computed and adjusted to the main framework of the triangulation and levelling nets.

From field work in 1949 the following information was added to the available system of control: triangulation, axial length 410 miles, 73 stations; levelling, 855 miles, 419 bench-marks; exploratory astronomical fixations, 137 stations; Shoran, 28 measured lines, 8 stations.

SHORAN

Use of electronic methods of distance measurement towards a more rapid expansion of control for mapping Canada's northern regions was initiated late in 1947 as a joint effort by the Royal Canadian Air Force, the National Research Council, the Army Survey Establishment, and the Geodetic Survey.

Early in 1948 experimental work in equipment modification and the training of personnel had advanced to the stage where Shoran measurement could be undertaken of lines that join accurately determined geodetic stations in Ontario and Quebec, 200 to 300 miles apart, to obtain concrete data on the degree of accuracy that might be found in a practical survey. The flights were made at intervals throughout the winter of 1948-49 over three lines forming a triangle. Very good agreement between Shoran and Geodetic lengths was obtained, even though the ground-set cases were ice-coated, and during operation were covered with moisture. From the experience gained it was decided that sixteen crossings of a line must be made to measure lengths to an accuracy of acceptable standard. As a further test of the accuracy and utility of this method of control, a Shoran controlled aerial survey was made of a small area east of Ottawa previously mapped by ground methods and it gave a degree of accuracy surpassing expectation.

This experimental work indicated that the personnel and equipment could be used to greater advantage by being assigned at once to the control scheme selected in 1948 in northern Manitoba and Saskatchewan. Accordingly, line-crossing operations were commenced in this area in May 1949, with headquarters at Stevenson Field, Winnipeg.

About 58 days were lost on account of weather. The solution for this is to increase the number of beacon stations so that areas under adverse weather can be avoided and the work can be done in areas remote from weather-frontal conditions. Twenty-eight lines were measured to establish eight new stations in the net over an axial length of 450 miles.

The results obtained show a remarkable consistency in value over the several lines and appear to satisfy the geometrical conditions arising in the figures. This is a prerequisite to accuracy but no such check is yet available as to whether measurements are systematically long or short, and the answer to this cannot be obtained until 1950 when the net is completed between two geodetic bases.

In anticipation of further work to be done northwest of the present Shoran net the sites of eleven stations were selected and this will permit preparation in 1950 well in advance of measurement requirements. An effort was being

made to place some of these stations in productive mining areas and thus provide definite points upon which local surveys may be based on the datum used in the settled areas.

From October 31 to November 16, the Assistant Dominion Geodesist was attached to the "R.C.A.F. Liaison Visit to the R.A.F. in England" as lecturer and consultant on Shoran. He gave lectures to R.A.F. personnel at Benson, Farnborough, and at the Navigational School at Shawbury; also to a group composed of officers of the three survey establishments, namely, Military Surveys, Colonial Surveys, and the Ordnance Survey. Two Lancaster bombers, one with photo and one with Shoran equipment, were flown to England and were available for demonstration of instruments and techniques used in both of these operations in the Canadian North.

Shoran techniques are being improved as more experience is gained. It has been necessary to enlist the co-operation and knowledge of other services, a notable contribution being the reduction of barometric data to elevations by the Meteorological Bureau.

TRIANGULATION

The Geodetic Survey continued to provide control for the systematic mapping and development of Canada by the initiation and extension of primary and secondary triangulation networks in areas considered to be of the most pressing economic and strategic importance.

Some additional work was undertaken in Newfoundland and British Columbia, and control was provided for an aerial photographic test range in the Ottawa area.

Six field parties operated in the following areas: along the Alaska Highway between Teslin and Watson Lake in Yukon and northern British Columbia; the Lake Superior area of Ontario; the Knob Lake area of Quebec and Labrador; the southeasterly coast of Newfoundland; the Ottawa area; and in central British Columbia from the Pacific coast to Smithers, and from Prince George to Dawson Creek. The last party also did some work at Regina and Vancouver.

The primary net in northern British Columbia and Yukon was projected in 1945 as an extension of the United States Coast and Geodetic Survey Yukon-Alaska Highway from Whitehorse to the vicinity of Watson Lake. It is intended to continue this net along the entire length of the Alaska Highway and farther until a junction is effected with the Alberta primary net in the vicinity of Edmonton.

At Dawson Creek the Alaska Highway net will connect with one now planned as an extension of the British Columbia Fraser River Valley net northerly and easterly from Prince George.

The Alaska Highway net will provide immediate control for surveys and mapping along the British Columbia-Yukon boundary, and also control for survey of the highway itself and the area adjacent to it. Stations convenient for control of Shoran operations are to be established.

In Ontario the primary network, completed to the vicinity of Grassett on the main line of the Canadian Pacific Railway east of Lake Superior, forms one link of the extensive network comprising the nets of eastern Canada and the net along the International Boundary from the Pacific coast to eastern Manitoba. When completed Canada will have its first continuous east-west chain of triangulation from the Atlantic to the Pacific. The present net provides control for the aerial mapping program being undertaken by Ontario in its survey of timber resources.

A secondary network was projected in 1945 to provide control for surveys in and adjacent to the mineralized area of central Ungava, and for a possible survey of the Quebec-Labrador boundary. This net was projected from the

primary net along the north shore of the Gulf of St. Lawrence and extends in a northerly direction following Moisie and Ashuanipi Rivers, with the ultimate aim of being carried as far as Fort Chimo on Koksoak River. When completed this 750-mile net will provide a base from which lateral nets may be extended into other areas of economic importance in Quebec and Labrador.

During 1947 and 1948 triangulation of a tertiary order of accuracy was instituted by the then Commission of Government for Newfoundland as an extension from the primary nets established in previous years by the Geodetic Survey of Newfoundland under an arrangement between the Canadian Government and the Commission of Government for Newfoundland. This net was intended to provide control for the area adjacent to the easterly coast of Newfoundland, and when Newfoundland entered Confederation it was considered advisable that the Geodetic Survey of Canada continue this work and extend its operations into other areas where control is lacking.

The work in the Ottawa area to be done jointly by the Geodetic and Topographical Surveys was instituted at the request of the Associate Committee of Photographic Research of the National Research Council. It will provide horizontal and vertical control for an aerial photographic test range covering an area of approximately 480 square miles and including a wide variety of topographic features that will enable the committee to assess the accuracy of aerial photographic mapping under varying topographic conditions. The work is to be done if possible before and after the regular field seasons.

To provide a stronger determination of the loop comprising the Pacific Coast and the Fraser River Valley nets, which at present is closed by means of a precise traverse from Prince Rupert to Smithers, it has long been felt advisable to attempt to replace the traverse with primary triangulation. A small party was detailed to investigate, by means of ground and aerial reconnaissance, the possibility of locating a feasible route through the difficult area lying between the coast and easterly end of the precise traverse at Smithers.

On completion of their investigation in this area the party undertook a similar investigation to locate a route for a triangulation net from Prince George to Dawson Creek that will provide control of the Alaska Highway net when the work along the highway has reached the stage where the existing gap between Watson Lake and Edmonton has been completed.

This party also undertook some work to provide control in and adjacent to Regina, and to relocate a number of stations in the City of Vancouver triangulation net.

TRIANGULATION ADJUSTMENTS

Final loop-closure adjustments were completed of the Arrowstone-Spokin section of the British Columbia primary arc and of the Edmonton-Kitscotty, the Kitscotty-Prince Albert, and the Hague-Eddyside nets in Alberta and Saskatchewan, as was the non-closure adjustment of the 125-mile section of the Canada-Alaska Highway net between Teslin and McNaughton Lakes. The non-closure adjustment of the Manitoulin Island-Lake Superior net as far north as the Goudreau base line was partly completed.

Of the secondary arcs, final loop-closure adjustments were made of the Newfoundland Notre Dame Peninsula and the Fogo Peninsula nets. The old Dominion Lands Survey Railway Belt triangulation between Calgary and Salmon Arm, B.C., was recomputed to effect circuit closure between the terminal stations that are comprised in the Geodetic Survey main triangulation scheme. Preliminary adjustments were made of the Moisie River-Knob Lake triangulation in Quebec to provide technical data for use in developing the Labrador iron ore deposits. Some work was done on the adjustment on the 1927 N.A. datum of the Lucerne-Sheep Creek triangulation adjacent to the British Columbia-Alberta boundary.

All survey ties in Alberta and Saskatchewan from geodetic triangulation stations to section corners of the Dominion Lands Surveys System were recomputed on the 1927 N.A. datum and the results were tabulated for the use of mapping bureaux, provincial survey organizations, and oil exploration companies operating in western Canada.

Precise astronomical observations for azimuths at East Base, McNaughton Lake area, B.C., and at stations Laird and East Base, Goudreau, in Ontario, comprised in the Manitoulin Island-Lake Superior net, were computed for use as Laplace azimuth controls in the adjustment of triangulation arcs.

LEVELLING

One double-unit field party operated in Newfoundland, one in Quebec and Ontario, and one in Alberta and Northwest Territories.

As a result of their work 855 miles of precise levelling was added to the Canadian level system and 419 bench-marks were established. The field work also included completion of an inspection of precise level bench-marks in Saskatchewan. This work was done to ascertain the condition of existing bench-marks and to revise descriptions in preparation for a revised edition of "Precise Levelling in Saskatchewan", now out of print.

Newfoundland

A start was made to supply Newfoundland with a system of precise levels similar to that provided by the Geodetic Survey in the other provinces of Canada. During the season 252·2 miles of precise levelling were completed and 128 bench-marks were established. To establish the required vertical control it was first decided to run a line across the island from St. John's to Port aux Basques, following the main line of the Newfoundland railway, and to run branch lines corresponding to the railway branches off the main line. Late in the spring, however, it was realized that equipment for railway work could not be obtained in time for the summer's operations and it was finally decided to run the levels along the "highroads".

The line of levels was started in St. John's from two tidal bench-marks established by the Hydrographic Survey in 1937. At the start of the main line in St. John's, 14 bench-marks were placed at suitable intervals throughout the city, in co-operation with the city engineer.

The branch line to Argentia terminated on United States Coast and Geodetic tidal bench-marks established for the Navy base in 1942. The field closure for this line from St. John's to Argentia, a distance of 112·7 miles, was under two-tenths of a foot.

The details follow:

—	Miles	Bench-marks
St. John's to Shoal Harbour, main line, on highroads	145·2	80
Branch to Carbonear, on Newfoundland railway	23·3	11
Branch to Argentia, on highroads	47·1	22
Branch towards Bonavista, on Newfoundland railway (as far as Summerville)	36·6	15
	252·2	128

Quebec and Ontario

A beginning was made in 1948, on a line of levels along the Quebec provincial highway from Mont Laurier to Senneterre to provide basic levels in the

area adjacent to hydro reservoirs, developed and potential, at the headwaters of Gatineau and Ottawa Rivers, and to provide level control for geological investigations in that part of the province of Quebec.

In the fiscal year 1949-50 a party carried the levels from a point 70 miles northwest of Mont Laurier, where work was discontinued in 1948, to Senneterre; connecting there with a precise level line along the Canadian National railway from Quebec city to Winnipeg.

On completion of the Mont Laurier-Senneterre line, the party ran levels along the Rouyn road from Louvicourt through the mining region to Noranda, and a line from Val d'Or to Amos. These lines provide levels for development and exploratory purposes in the immediate localities traversed, and in effect divide a large circuit of levelling into five smaller circuits, thereby strengthening the Canadian level net.

The party then re-levelled a line along the New York Central railway from Ottawa to Finch in Ontario. The re-levelling covered about 40 miles, in the course of which 17 new bench-marks were placed.

Alberta and Northwest Territories

This party extended levels northward along the Mackenzie highway in northern Alberta and Northwest Territories. It extended the level datum line from Matis Colony to Hay River settlement on Great Slave Lake, a distance of 248 miles, and ran a branch line of levels from a connection at High Level Junction to Fort Vermilion, a distance of 48 miles. During the course of the work 152 bench-marks were established.

At the request of the Geodetic Shoran Division a pier was constructed on the 25th base line and was connected by levels with a bench-mark on the Mackenzie highway line.

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

—	Precise	Secondary	Public works	Total
Newfoundland	252	.....	.....	252
Prince Edward Island	284	.....	.....	284
Nova Scotia	779	.....	309	1,088
New Brunswick	1,106	.....	403	1,509
Quebec	4,322	1,288	1,750	7,360
Ontario	7,307	1,324	2,012	10,643
Manitoba	2,963	368	113	3,444
Saskatchewan	4,203	5,098	.....	9,301
Alberta	4,052	3,799	.....	7,851
Northwest Territories	93	.....	.....	93
British Columbia	5,434	52	.....	5,486
Yukon	1,023	26	.....	1,049
Minnesota, U.S.A.	89	.....	.....	89
Vermont, U.S.A.	6	.....	.....	6
New York State	15	.....	.....	15
	31,928	11,955	4,587	48,470

Mileage by Provinces 1949

—	Mileage	Bench-marks
Newfoundland	252	128
Quebec	257	122
Ontario	40	17
Alberta	213	110
Northwest Territories	93	42
	855	419

Summary

	Miles	Bench-marks
Precise levelling		
Prior to 1949	31,073	10,994
Levelling in 1949	855	419
	31,928	11,413
Secondary levelling		
Prior to 1949	11,955	4,224
1949	.....	.....
	11,955	4,224
Public works		
Prior to 1949	4,587	
1949	.....	.....
	4,587	

GEODETIC ASTRONOMY AND ISOSTASY

Two Laplace stations were completed, one base line was measured, and astronomic positions were determined at 137 points for control of aeronautical charts and maps. This work took the parties into Quebec and Newfoundland and the districts of Mackenzie, Franklin, and Keewatin. Computation and compilation of the relative data were almost completed and were carried out in the order required by the relative urgency of demand of the different government services.

Latitude and Longitude Determinations

Two parties determined the astronomic positions of 28 map control points in northern Quebec and Labrador, and four parties determined the astronomic positions of 90 map control points in the districts of Mackenzie, Franklin, and Keewatin. These parties obtained photographic and magnetic information relating to the location of these stations. The astronomic operations of the Geographical Branch expedition furnished the data for 19 control points in Foxe Basin and Hudson Bay, which this Survey calculated and compiled for release to mapping and other associated services.

Laplace Determination and Base Line

Precise latitude, longitude, and azimuth were determined at Laird Station in Ontario, and latitude and azimuth at Teslin, British Columbia.

Latitude Determination

Precise latitude observations were required at about 25-mile intervals to determine the 60th parallel along the northern boundary of Alberta westward from Little Buffalo River to British Columbia. The eastern section between Little Buffalo River and the Mackenzie highway was nearing completion by the end of the fiscal year.

INTERNATIONAL BOUNDARY COMMISSION

The International Boundary Commission functions by virtue of the treaty of 1925 between Canada and the United States. Under the provisions of this treaty the International Boundary Commissioners, one for Canada and one for

the United States, appointed under the treaties of 1903 and 1908, were re-appointed "to provide for the maintenance of an effective boundary line between the Dominion of Canada and the United States and between the Dominion of Canada and Alaska". The treaty further stipulated:

> "The said Commissioners shall submit from time to time, at least once in every calendar year, a joint report containing a statement of inspections made, the monuments and buoys repaired, relocated, rebuilt, moved, and established, and shall submit with their reports, plats and tables certified and signed by the Commissioners, giving the locations and geodetic positions of all monuments moved and all additional monuments established within the year, and such other information as may be necessary to keep the boundary maps and records accurately revised."

Four successive Canadian Commissioners have been appointed since the treaty of 1925 was signed. Owing to departmental reorganization, the present appointee, J. Leslie Rannie, Dominion Geodesist, on March 1, 1950, was named to succeed James M. Wardle, now Director of Special Projects, Department of Resources and Development.

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

CONFERENCE OF THE COMMISSIONERS

At their first meeting of the year, held in Ottawa from April 26 to April 29, the Commissioners (James M. Wardle for Canada and John A. Ulinski for the United States) agreed: that maintenance operations should be continued eastward along the Ontario-Minnesota boundary by the United States party, which had terminated its season's work at the west end of Basswood Lake in 1948; that another United States party should commence similar operations on Hall Stream on the Quebec-Maine boundary; that a Canadian party should inspect and repair monuments and re-clear the boundary vista in the vicinities of the highway crossings on the Quebec-New York and Quebec-Vermont boundaries; and that plans and specifications should be drawn up for the removal of the off-shore range marks at Point Roberts on the Pacific coast and the erection of a single tower on the boundary line at the middle of Point Roberts to serve as a rear range mark for the boundary in both east and west directions. They arranged for the replacement of a destroyed boundary reference monument at Point Edward at the south end of Lake Huron, and for the establishment of buoys to mark the boundary at certain critical points in Lake Erie.

INSPECTION BY THE COMMISSIONERS

The two Commissioners and the United States Engineer to the Commission inspected conditions at Point Roberts in August and made some changes in the manner of work formerly agreed upon for the removal and relocation of the west off-shore range tower. They then inspected the monuments in the vicinity

of the Peace Garden at Blaine, Washington, and the boundary in the vicinity of Monuments 71 and 72 in the Skagit River area. They found that clearing of timber was well advanced in the valley that will be flooded by the impounded water of the dam to be constructed about 12 miles downstream in the state of Washington. As the water level will approach 1,700 feet above sea-level, Monument 72 will be moved. Monument 71 is just above the 1,700-foot contour and it may not be flooded.

MAINTENANCE OF THE BOUNDARY

Maintenance work on the section of line commonly known as the 45th Parallel Boundary, between the province of Quebec and the states of Vermont and New York, was confined to the vicinity of the seventy-three highways that cross the line. During the season 63 miles of line and 238 monuments were inspected, 38·5 miles of vista were re-cleared, 7 monuments were repaired, and 2 new monuments (653-A and 653-B) erected at Blackpool, 10 feet east and west from the edges of concrete on highway No. 9.

Monument 535-D at the edge of the sidewalk in front of the convent at Stanhope had been damaged by a snow-plow. To preserve the boundary point, the granite post was removed, the base of the monument was rebuilt to ground level, and a bronze boundary tablet was placed to mark the original position.

The Canadian Section of the Commission also inspected the boundary reference monuments on the Ontario side of St. Clair River from Point Edward to Corunna, all of which were in good condition with the exception of No. 57 at Point Edward where a new reference monument was constructed in a safer location. The centre of the monument is marked by a Boundary Commission reference tablet, with the arrow pointing toward Boundary Turning Point 215 in Lake Huron.

MISCELLANEOUS

Various sets of maps, the geographic positions of boundary monuments, etc., and information were supplied to other federal and provincial government services, to the Scott Polar Institute of Cambridge, England, and to many private individuals.

LEGAL SURVEYS AND AERONAUTICAL CHARTS

The Division makes and records legal surveys of lands owned or administered by the Federal Government; prepares and maintains aeronautical charts and flight manuals; prepares electoral maps; maintains an office for plotting planimetric base maps for tri-camera aerial photographs; a central office for recording and indexing survey returns and plans; and a central office for distributing plans, maps, and aeronautical charts.

LEGAL SURVEYS SECTION

Field Work

Three field parties were organized for legal survey work in Yukon, three for legal survey work in the Northwest Territories, and one for Indian Reserve surveys in Ontario. Other survey work was done by surveyors employed at tariff rates.

Northwest Territories

Two field parties extended the scheme of governing surveys adopted in 1944 as control for such cadastral surveys as may be required in the Northwest Territories. They surveyed 192 miles of line in accordance with the provisions of the Dominion Lands Surveys Act and thus completed a total of 692 miles of connected control survey, commencing at a point on the sixth meridian near Fort Providence, and extending northwesterly to a point on Mackenzie River about 20 miles above Norman Wells, and northeasterly to a point on the west shore of the Northwest Arm of Great Slave Lake about 35 miles in a straight line southwesterly of Yellowknife.

The third party made subdivision surveys at Hay River settlement, Fort McPherson, Aklavik, Port Brabant, Rocher River, Thompson Landing, Fort Simpson, and Fort Franklin; surveyed 60 miles of rights-of-way for power transmission and telephone lines of the Snare River Power Project for the Northwest Territories Power Commission; and made surveys at Norman Wells, Fort Good Hope, Arctic Red River, Reindeer Station, and Fort Norman settlement.

Yukon

One party established control, another was engaged on miscellaneous legal surveys, and the third surveyed ninety-one mineral claims in Mayo mining district.

The control consisted of: 90 miles of semi-precise traverse and right-of-way surveys comprising 30 miles along the road from Carcross northeasterly to the Alaska Highway, and 60 miles along the highway from Haines Junction to the British Columbia-Yukon boundary; and of 32 miles of semi-precise traverse surveys comprising 12 miles along the railroad between Carcross and the British Columbia-Yukon boundary, and 20 miles along the trail leading from the Dawson Road to Freegold Mountain.

The miscellaneous work comprised surveys at Crag Lake, Haines Junction, Mayo, Burwash Landing, Marsh Lake, Rainbow Lake, Robinson Station, and Whitehorse. The survey of the Dominion Agricultural Experimental substation near Haines Junction was completed, and preliminary work was done for a lot subdivision survey at Haines Junction. A lot was laid out on the Alaska border for the Department of National Revenue, and the Territorial Government road from the Alaska Highway to Whitehorse Rapids was surveyed.

British Columbia

Eighteen cottage lots were laid out in Sliammon Indian Reserve No. 1, and the boundaries of Shaughanaught Indian Reserve No. 22 and of Tsooahdie Indian Reserve No. 15 were retraced. Lot subdivision surveys were made in Hazelton Indian Reserve No. 1 and in Stony Creek Indian Reserve No. 1.

Alberta

Mountain View cemetery, consisting of 1,328 grave lots, was laid out in Banff National Park; 48 residential lots were surveyed in Banff; Sarcee Indian Reserve No. 145 was partly subdivided into quarter-sections; sites for use of the Dominion Observatories were surveyed for a Magnetic observatory station at Meanook, and for a Meteor observatory station at Newbrook.

Saskatchewan

A subdivision survey was made in Waskesiu townsite in Prince Albert National Park, and 14 miles of the revised south boundary of the park were run; the north and east boundaries of Montreal Lake Indian Reserve were retraced; subdivision into quarter-sections of Pasqua Indian Reserve No. 79, Okemasis Indian Reserve No. 96, and Beardy Indian Reserve No. 97 was completed; subdivision into quarter-sections of One Arrow Indian Reserve No. 95 and Muskoday Indian Reserve No. 99 was partly completed.

Ontario

In Manitoulin Island Indian Reserve No. 26, 110 miles of line were surveyed through bush, twenty farms of from 10 to 30 acres in area were laid out, and 20 miles of road traverse surveys were run.

Quebec

The boundaries of Seven Islands Indian Reserve No. 27 were surveyed, and 177 lots and parcels were laid out within the reserve. Part of the boundary of Pierreville Indian Reserve was retraced.

New Brunswick

Surveys were made of the boundaries of Big Cove Indian Reserve and of an historic site at Frosty Hollow near Sackville, commemorating the Beaubassin-Memramcook River portage.

Nova Scotia

A parcel of Ordnance land was surveyed at Annapolis Royal.

British Columbia-Yukon Boundary

Under the direction of the British Columbia-Yukon and Northwest Territories Boundary Commission, approximately 46 miles of the British Columbia-Yukon boundary were finally located and monumented. This part of the boundary lies between longitudes 127°43′ and 126°53′.

Miscellaneous

Two hundred and seventy-three legal descriptions to be used in land conveyances and 100 descriptions for mineral claims were prepared; 255 plans, tracings, and location ticket sketches were drawn; 180 plans of legal surveys and 129 field books were examined; and 85 plans and 32 field books were recorded in Indian Affairs Survey Records. Letters of instruction were prepared for 49 subdivision and boundary surveys and for 80 mineral claim surveys. Survey returns were examined for the Ontario-Manitoba boundary survey of 1948; for the British Columbia-Yukon boundary surveys of 1946 and 1948; for the Yellowknife branch of the Northwest Territories control survey of 1949; and for the levels run on Northwest Territories control surveys in 1947. A report was prepared giving the acreages of all Indian Reserves as of March 31, 1949. Parts of the "Supplement to the Manual of Instruction for the Survey of Dominion Lands" were revised in preparation for a new edition. Plans and files covering 21 settlements were investigated in connection with official instruments for title to lands in Northwest Territories.

AERONAUTICAL CHARTS SECTION

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

Air Photogrammetry

One mile to one inch planimetric base maps from tri-camera photographs.

16-mile National Topographic Series No.	*Area plotted Square miles*
16	9,273
25	9,883
26	40,421
27	24,936
33	3,700
34	6,500
35	10,492
36	37,918
37	41,450
38	9,118
45	7,374
46	22,425
47	32,118
48	18,953
56	5,000
57	3,812
58	3,443
	286,816
Special plots	204
Total	287,020

Operational maps were compiled for tri-camera air photography of Canada's northern islands and of all major gaps in previous photography to be flown by the R.C.A.F. in 1950.

Tri-camera photographs indexed and filed totalled 66,075.

Chart Construction and Air Information

Revision was made of 151 air information plates of the 8 mile to 1 inch series of aeronautical charts.

Twelve of the 65 sheets of the 1:1,000,000 International Civil Aviation Organization series required to complete coverage of Canada were published and air information plates were prepared for 15 more.

Revision of the World Aeronautical Planning Chart was completed.

Amendments to "The Canada Air Pilot" were sent to subscribers fortnightly. Revision was made of 290 pages, and 11 pages for new airports were compiled. Pages 1 to 30 of "The Canada Air Pilot" were revised and sent to subscribers.

The index for the Radio Facility charts for the Canada Air Pilot was revised. Topographical bases showing isogonic lines were compiled for 16 charts of a new series, and air information was drawn on two of them. Of the old series 45 charts were revised and amendment lists were prepared .

Landing and Approach charts, printed in three colours, were being prepared for all Canadian airports where radio range facilities are available. For those airports where instrument landing systems are installed the Landing and Approach charts are being augmented by supplementary charts showing procedures and facilities for low approach let-downs.

Radar Altimeter

The radar altimeter profiles obtained in 1948 were processed and the contour information was entered on the 8 mile to 1 inch aeronautical charts. The area involved was 88,000 square miles, being north of Georgian Bay and Lake Huron.

Radar altimeter profiles were obtained in 1949 over an area of 125,000 square miles north of the St. Lawrence in Quebec and Labrador, and covering the approaches to Goose Bay airport, and good progress was made in drawing the resulting contours.

Under the Survey Research Committee of the National Research Council a sub-committee on radar altimetry was formed for experimentation, to increase the accuracy of measurements and extend the usefulness of this method of obtaining ground elevations.

Columbia River Basin Project

This project was undertaken for the Canadian Section of the International Columbia River Engineering Board to enable it to plan the utilization of the water resources of Columbia River. It calls for 78 detailed and contoured topographical map-sheets on a scale of ½ mile to 1 inch, 21 of which have been printed. Sixteen manuscripts were completed. Four field parties provided data for another 15 sheets.

Miscellaneous

The Canadian Arctic Air Navigation Chart on a scale of 30 nautical miles to 1 inch was revised for reproduction.

Work was commenced on the compilation of air information for seven charts of the eastern Canadian seaboard for use by carrier-based aircraft. The charts are on a Mercator's projection at a scale of 1:1,000,000 at 46 degrees north latitude. They are drawn to the specifications for Royal Navy Flight Charts as published by the British Admiralty.

SURVEY RECORDS AND ELECTORAL MAP SECTION

Survey Records

Township plans to the number of 25,386 were distributed.

All stocks of township plans of Alberta were transferred to the province.

Extensive control information was supplied for a large co-operative mapping project in Alberta.

Electoral Maps

Prior to the general election in June 1949, there was a heavy demand for electoral maps and for information concerning descriptions and boundaries of constituencies. In anticipation of this demand the maps had been lithographed and were a great improvement upon the blue-line prints of earlier editions.

The Printing Bureau bound 240 volumes of electoral district maps for each of the provinces of Ontario and Quebec. Combined volumes of Manitoba-Saskatchewan, British Columbia-Alberta, and Nova Scotia-New Brunswick-Prince Edward Island were bound in quantities of 200 each.

Also bound were 900 volumes of electoral district maps of cities. These were delivered to the Chief Electoral Officer for distribution to returning officers.

Miscellaneous

Astronomical field tables for the altitude and azimuth of the pole star and for the right ascension and declination of the sun for 1950 were computed and printed for distribution on request to land surveyors and others.

Official air line distances were supplied to the Air Mail Service of the Post Office Department to serve as basis for drawing up air mail contracts.

Preliminary values were computed for latitudes and longitudes of a number of monuments of the Alaska Highway between Lower Post and the Yukon-Alaska border.

MAP DISTRIBUTION OFFICE

During the year 35,074 requests for maps, charts, and publications were dealt with.

The following material was distributed:

National Topographic series maps	210,621
National Topographic series maps published by the Army Survey Establishment, R.C.E.	71,312
Aeronautical and Plotting charts	122,328
Sectional maps	25,666
Old Geographic Series	4,768
Miscellaneous maps	198,046
Forestry maps	1,012
Electoral district maps	14,162
Publications	6,834
Canada Air Pilot, books	389
Canada Air Pilot, amendments	52,626
Canada Air Pilot, sheets	14,675

BOARD OF EXAMINERS FOR DOMINION LAND SURVEYORS

The Board held the regular annual meeting called for by Section 9 of the Dominion Lands Surveys Act. During the meeting examinations were held at Ottawa, Winnipeg, Saskatoon, and Edmonton. The preliminary examination was written by forty candidates and the final by ten. Fourteen candidates were successful in the preliminary and six in the final examinations. Five commissions were issued to candidates who had passed the final examination, furnished oaths of office and allegiance, and had been bonded for the sum of $1,000 as required by Section 25 of the above Act. Seven certificates of preliminary examination were issued to successful candidates who had complied with the requirements of the Act.

Six Dominion standard measures of length were issued to Dominion and Provincial land surveyors.

MAP COMPILATION AND REPRODUCTION DIVISION

The Division produces maps and charts of Canada of various types and scales and provides many services to Government departments such as photographic reproductions, photostats, black and blue line work, and some draughting jobs for printing elsewhere.

A total of 654,749 maps, aeronautical charts, etc., were distributed by the map distribution office, Surveys and Mapping Branch, an increase of 20,000 over the previous year. A total of 35,074 requests for maps were received, compared with 30,957 in 1948-49. Greater numbers of maps than ever before were requested by tourists, private individuals, and business firms, in addition to the regular users such as dominion and provincial governments, airlines, railroads, etc.

COMPILATION SECTION

In the National Topographic series full or limited revisions were compiled for twenty-two 8-mile aeronautical charts, incorporating the latest topographic information gathered from aerial photographs and many other sources.

Compilation was completed for two new 1:250,000 maps replacing out-of-date sectional sheets, and one in British Columbia replacing two half-sheets of the "A" series. Ten 4-mile maps were partly or wholly revised, along with six 2-mile and ten 1-mile sheets.

New compilations, incorporating information contained in the 8-mile series with the latest aerial photography, were done for eleven more Canadian charts in the World aeronautical charts series on a scale of 1:1,000,000, and four others were in hand.

A new compilation of a 100-mile map of Canada was in hand, constructed on a Lambert projection, and having standard parallels of 49°N. and 77°N.

Other maps compiled included: a northern extension to the 64-mile map of Canada; and a plotting chart of the Canadian Arctic regions for the R.C.A.F. at 30 nautical miles to the inch.

Summary of Compilation

—	Scale	First editions	Revised editions
Standard aeronautical charts	8 mi.	.....	10
Preliminary aeronautical charts	8 mi.	.....	12
National Topographic series	4 mi.	3	10
National Topographic series	2 mi.	.....	6
National Topographic series	1 mi.	.....	10
World aeronautical charts	1:1,000,000	11	.....
Miscellaneous	.....	11	5

COMPUTING SECTION

A composite Mercator projection was computed for six Royal Canadian Navy aeronautical charts on the east coast of Canada, along with two transverse Mercator projections for the Canadian Hydrographic Service.

DRAUGHTING SECTION

This Section draughts all the maps and charts produced by the Division and by the Topographical Surveys Division, and also draughts maps, charts, and diagrams for other government organizations not having these facilities. In October 1949, the Section took over all the draughting of the magenta air information overprints for the 8-mile and World aeronautical charts.

Statistics of new and revised drawings completed and passed to the Photomechanical Section are:

—	Scale	Number
Standard aeronautical charts	8 mi.	10
Preliminary aeronautical charts	8 mi.	14
National Topographic series	4 mi.	10
National Topographic series	2 mi.	7
National Topographic series	1 mi.	11
World aeronautical charts	1:1,000,000	22
Columbia River Basin series	.....	7
Overprints	.....	45
Miscellaneous	.....	53
Miscellaneous for other departments	.....	20

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

Statistics on these maps are:

—	Scale	Number
National Topographic series	4 mi.	2
National Topographic series	2 mi.	2
National Topographic series	1 mi.	42

PHOTO-MECHANICAL SECTION

This Section photographs the drawings and produces a lithographic plate from the negatives for each colour of each map and chart to be printed. It makes the plates for printing the charts and maps produced by the Canadian Hydrographic Service and Legal Surveys Division; the maps of the Forestry Branch of the Department of Resources and Development and those maps of the Geological Survey of Canada formerly printed at the Army Survey Establishment.

The Section handled an increasing volume of photography, processing, and print work for other government departments. To expedite this work a precision enlarger and a printer-developer to turn out OCE prints were installed.

Summary

Photo Processing	
Wet plate negatives	616
Film negatives	2,727
Film negatives (plastic)	3
Photo-litho plates	1,099
Photography	
Infra red (plates developed)	3,075
Infra red (contact)	3,024
Roll film (developed)	229
Bromide enlargements	477
Velox prints	6,888
Mosaic	3
Transaloid	3
Sensitized linen	525
Photostats (sheets)	22,561
Contact and Blue Printing	
Blue prints (sq. ft.)	235,652
Blue prints (contact)	175
Vandyke prints (sq. ft.)	4,106
Vandyke prints (contact)	6,009
OCE prints	10,079
Mounted blue lines	281

LITHOGRAPHIC SECTION

New Maps

Among the maps printed were: a new 8-mile aeronautical chart in the vicinity of Lake Superior, which completes that series of charts; a new 4-mile map, in eight colours, of the National Topographic series; ten more Canadian

sheets of the world aeronautical charts series in from five to nine colours; six additional large-scale maps of the Columbia River Basin series; six outline maps showing Department of Veterans Affairs district boundaries; a grid navigation plotting chart for southeast Canada; a map of northern Canada for the Geographical Branch; and six electoral maps.

Reprints

Thirty sheets of the 8-mile aeronautical charts were reprinted, as were: four 4-mile maps, seven 2-mile maps, and one 1-mile map in the National Topographic series; 25 sectional sheets; the 100-mile map of Canada; the 100-mile natural resources map of Canada; forest classification of Canada in English and French for the Canada Year Book; two sheets of the old Chief Geographer's series; map of the world (trade routes); New Brunswick 10-mile; the 3·95-mile map of Prince Edward Island, Nova Scotia, and New Brunswick; and one special 2-mile map of the Red Lake district.

Summary of Printing

A total of 735,789 maps and charts were printed. Overprints showing aeronautical information in magenta were printed on 190 8-mile maps of the National Topographic series and 8 world aeronautical charts.

Details of Printing

	Maps published	Total copies
New maps printed	51	136,975
Revised maps printed	72	226,130
Reproductions printed	18	10,025
Maps reprinted	88	203,125
Hydrographic charts	98	142,215
Miscellaneous	20	17,319
Total	347	735,789
Overprints	198	132,895

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1949-1950

(i) Aeronautical Charts—National Topographic Series

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Labrador	13 SE.	Battle Harbour-Cartwright	8 mi.	52° 00′ to 54° 00′	55° 30′ to 60° 00′	Prelim. edn.-revision
Que.-Labrador	24 SE.	Indian House	8 "	56° 00′ " 58° 00′	64° 00′ " 68° 00′	" "
Quebec	22 NE.	Clarke City-Mingan	8 "	50° 00′ " 52° 00′	64° 00′ " 68° 00′	" "
Quebec	35 SE.	Povungnituk River	8 "	60° 00′ " 62° 00′	72° 00′ " 76° 00′	" "
Quebec	34 NW.	Port Harrison	8 "	58° 00′ " 60° 00′	76° 00′ " 82° 00′	" "
Ontario	42 NE.	Moosonee	8 "	50° 00′ " 52° 00′	80° 00′ " 84° 00′	" "
Ontario	42 NW.	Kowkash-Martin Falls	8 "	50° 00′ " 52° 00′	84° 00′ " 88° 00′	Standard edn.-revision
Ontario	43 NE.	Henrietta-Maria	8 "	54° 00′ " 56° 00′	80° 00′ " 84° 00′	Prelim. edn.-revision
Ontario	43 SW.	Attawapiskat	8 "	52° 00′ " 54° 00′	84° 00′ " 88° 00′	" "
Ontario	53 SE.	Wunnumin Lake	8 "	52° 00′ " 54° 00′	88° 00′ " 92° 00′	" "
Ont.-Man.	53 NE.	Severn River	8 "	54° 00′ " 56° 00′	88° 00′ " 92° 00′	" "
Ont.-Man.	53 SW.	Berens River	8 "	52° 00′ " 54° 00′	92° 00′ " 96° 00′	Standard edn.-revision
Man.-Ont.	54 SE.	Cape Tatnam	8 "	56° 00′ " 58° 00′	88° 00′ " 92° 00′	Prelim. edn.-revision
U.S.A.-Ont.	51 NE.	Duluth-Houghton	8 "	46° 00′ " 48° 00′	88° 00′ " 92° 00	Standard edn.-first edn.
Manitoba	54 SW.	York Factory	8 "	56° 00′ " 58° 00′	92° 00′ " 96° 00′	Prelim. edn.-revision
Sask.	74 NE.	Black Lake	8 "	58° 00′ " 60° 00′	104° 00′ " 108° 00′	" "
Sask.	74 SE.	Mudjatik-Geikie	8 "	56° 00′ " 58° 00′	104° 00′ " 108° 00′	" "
Alberta	84 NE.	Fort Vermilion	8 "	58° 00′ " 60° 00′	112° 00′ " 116° 00′	" "
N.W.T.	55 N.	Chesterfield Inlet	8 "	62° 00′ " 64° 00′	88° 00′ " 96° 00′	" "
N.W.T.	65 SE.	Nueltin Lake	8 "	60° 00′ " 62° 00′	96° 00′ " 100° 00′	" "
N.W.T.	65 SW.	Kazan River	8 "	60° 00′ " 62° ,00	100° 00′ " 104° 00′	" "

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1949-1950—Continued

(i) Aeronautical Charts—National Topographic Series

Location	Number	Name	Scale	Latitude	Longitude	Remarks
N.W.T.	77 N.	Victoria Island East	8 mi.	70° 00′ to 72° 00′	104° 00′ to 112° 00′	Prelim. edn.-revision
N.W.T.	85 N.	Rae	8 "	62° 00′ " 64° 00′	112° 00′ " 120° 00′	" "
N.W.T.	95 SE.	Simpson-Liard	8 "	60° 00′ " 62° 00′	120° 00′ " 124° 00′	" "
B.C.-Alaska	114 NE.	Alsek River	8 "	58° 00′ " 60° 00	136° 00′ " 140° 00′	" "
Yukon-Alaska	116 N.	Porcupine River	8 "	66° 00′ " 68° 00′	136° 00′ " 144° 00′	" "
		(ii) Other National Topographic Series Maps				
Quebec	31 P/SE.	La Tuque	2 "	47° 00′ " 47° 30′	72° 00′ " 73° 00′	Revision
Quebec	31 I/10	Shawinigan	1 "	46° 30′ " 46° 45′	72° 30′ " 73° 00′	"
Quebec	31 J/SE.	Ste. Agathe	2 "	46° 00′ " 46° 30′	74° 00′ " 75° 00′	"
Quebec	31 O/SE.	Kempt Lake	2 "	47° 00′ " 47° 30′	74° 00′ " 75° 00′	"
Quebec	31 J/SW.	Maniwaki	2 "	46° 00′ " 46° 30′	75° 00′ " 76° 00′	"
Ontario	52 A/NW.	Kaministikwia	2 "	48° 30′ " 49° 00′	89° 00′ " 90° 00′	"
Ontario	52 B	Quetico	4 "	48° 00′ " 49° 00′	90° 00′ " 92° 00′	"
Manitoba	62 P	Hecla	4 "	51° 00′ " 52° 00′	96° 00 " 98° 00′	"
Manitoba	62 J	Neepawa	4 "	50° 00′ " 51° 00′	98° 00′ " 100° 00′	First edition
Man.-Sask.	63 N	Kississing	4 "	55° 00′ " 56° 00′	100° 00′ " 102° 00′	Revision
Sask.	63 L	Amisk Lake	4 "	54° 00′ " 55° 00′	102° 00′ " 104° 00′	"
Sask.	73 P	Lac la Ronge	4 "	55° 00′ " 56° 00′	104° 00′ " 106° 00′	"
Sask.	74 P	Stony Rapids	4 "	59° 00′ " 60° 00′	104° 00′ " 106° 00′	"
British Columbia	93 A/11	Spanish Lake	1 "	52° 30′ " 52° 45′	121° 00′ " 121° 30′	"
British Columbia	93 A/14	Cariboo Lake	1 "	52° 45′ " 53° 00′	121° 00′ " 121° 30′	"

British Columbia	94 A/12	Hydraulic	1 "	52° 30′ " 52° 45′	121° 30′ " 122° 00′	"
British Columbia	93 A/13	Swift River	1 "	52° 45′ " 53° 00′	121° 30′ " 122° 00′	"
British Columbia	92 B/NW. /SW.	Victoria	2 "	48° 15′ " 49° 00′	123° 05′ " 124° 00′	"
Northwest Territories	75 F	Nonacho Lake	4 "	61° 00′ " 62° 00′	108° 00′ " 110° 00′	"
Northwest Territories	75 E	Taltson Lake	4 "	61° 00′ " 62° 00′	110° 00′ " 112° 00′	"
Northwest Territories	85 O	Wecho River	4 "	63° 00′ " 64° 00′	114° 00′ " 116° 00′	"
Northwest Territories	85 N	Marian River	4 "	63° 00′ " 64° 00′	116° 00′ " 118° 00′	"

(iii) World Aeronautical Charts

Newfoundland	2260	Harbour River	1:1,000,000	44° 00′ " 48° 00′	48° 00′ " 56° 00′	First edition
Newfoundland	2224	Gander River	1:1,000,000	48° 00′ " 52° 00′	48° 00′ " 56° 00′	"
Newfoundland-Quebec	2223	Natashquan River	1:1,000,000	48° 00′ " 52° 00′	56° 00′ " 64° 00′	"
Labrador-Que	2178	Hamilton River	1:1,000,000	52° 00′ " 56° 00′	54° 00′ " 64° 00′	"
Nova Scotia	2311	Roseway River	1:1,000,000	40° 00′ " 44° 00′	61° 00′ " 69° 00′	"
Quebec-Ont	2263	Gatineau River	1:1,000,000	44° 00′ " 48° 00′	72° 00′ " 80° 00′	"
Ontario	2181	Ekwan River	1:1,000,000	52° 00′ " 56° 00′	80° 00′ " 88° 00′	"
Ontario	2144	Hudson Bay	1:1,000,000	56° 00′ " 60° 00′	80° 00′ " 88° 00′	"
Ontario-Manitoba	2219	Ogoki River	1:1,000,000	48° 00′ " 52° 00′	88° 00′ " 96° 00′	"
Northwest Territories	2111	Maguse River	1:1,000,000	60° 00′ " 64° 00′	88° 00 " 96° 00′	"

(iv) Columbia River Basin Maps

British Columbia	12 A and B	Kootenay R.—Kootenay L. area	1:31,680	50° 07′ " 50° 23′	116 °53′ " 117° 03′	First edition
British Columbia	50	Upper Kootenay R. area	1:31,680	49° 00′ " 49° 08′	115° 02′ " 115° 22′	"
British Columbia	51	Upper Kootenay R. area	1:31,680	49° 08′ " 49° 16′	115° 05′ " 115° 23′	"
British Columbia	57	Upper Kootenay R. area	1:31,680	49° 43′ " 49° 51′	115° 36′ " 115° 52′	"
British Columbia	58	Upper Kootenay R. area	1:31,680	49° 51′ " 49° 59′	115° 36′ " 115° 52′	"
British Columbia	72 A and B	Similkameen River area	1:31,680	49° 13′ " 49° 26′	120° 00′ " 120° 16′	"

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1949-1950—Concluded

(v) Miscellaneous Maps

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Southeast Canada		Grid Navigation Plotting Chart SE. Canada.	30 mi.			First edition
Que., S. Ont., N. Ont., Sask., Alta., Canada.		Outline maps showing DVA dist. boundaries.				First edition for DVA
Western Canada		Lines of levels run in Western Canada	40 "	49° 00′ to 60° 00′	92° 00′ to 126° 00′	Rev. for Geodetic Survey.
Northwestern Canada		NW. Canada transportation map	50 "	54° 00′ " 71° 00′	110° 00′ " 136° 00′	Overprint of new road information on NW. Can. base.
Northern Canada		Northern Canada	80 "	60° 00′ " 80° 00′	60° 00′ " 142° 00′	New. For Geographical Bureau.
Canada		Magnetic Map of Canada	100 "	43° 00′ " 75° 00′	30° 00′ " 155° 00′	Revised magnetic information on Can. 100-mi. base. For Dominion Observatory.
Canada		Orographical Map of Canada	300 "	43° 00′ " 84° 00′	50° 00′ " 145° 00′	Rev. for Canada Year Book.
Canada		Guide for VHF frequency assignments.	1:5,000,000	43° 00′ " 75° 00′	48° 00′ " 144° 00′	Overprint on World Aeronautical Planning Chart base. For Dept. of Transport.
Northwest Territories		East Arm of Great Slave Lake	4 mi.	62° 00′ " 63° 00′	108° 00′ " 112° 00′	Red overprint showing underwater contours in Great Slave Lake for Fisheries Research Bd. U. of T.
Northwest Territories and Yukon.		Magnetic Map of Northwest Territories and Yukon.	80 "	60° 00′ " 80° 00′	60° 00′ " 142° 00′	Revised magnetic information N.W.T. and Yukon 80-mi. base

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment, Fiscal Year 1949-1950

New Brunswick	21 I/10	Richibucto	1 "	46° 30′ " 46° 45′	64° 30′ " 65° 00′	First edition
New Brunswick	21 P/6	Tabusintac	1 "	47° 15′ " 47° 30′	65° 00′ " 65° 30′	"
New Brunswick	21 P/11	Burnsville	1 "	47° 30′ " 47° 45′	65° 00′ " 65° 30′	"
New Brunswick	21 G/9	Hampstead	1 "	45° 30′ " 45° 45′	66° 00′ " 66° 30′	"
New Brunswick	21 G/11	McAdam	1 "	45° 30′ " 45° 45′	67° 00′ " 67° 30′	"
New Brunswick	21 J/12	Andover	1 "	46° 30′ " 46° 45′	67° 30′ " 68° 00′	"
New Brunswick	21 J/13	Aroostook	1 "	46° 45′ " 47° 00′	67° 30′ " 67° 50′	"
New Brunswick	21 O/10	Upsalquitch Forks	1 "	47° 30′ " 47° 45′	66° 30′ " 67° 00′	"
New Brunswick	21 O/11	Kedgwick	1 "	47° 30′ " 47° 45′	67° 00′ " 67° 30′	"
Ontario	31 D/12	Orr Lake	1 "	44° 30′ " 44° 45′	79° 30′ " 80° 00′	"
Ontario	31 L/1	Brent	1 "	46° 00′ " 46° 15′	78° 00′ " 78° 30′	"
Ontario	31 L/8	Magnasipi	1 "	46° 15′ " 46° 30′	78° 00′ " 78° 30′	"
Ontario	31 L/2	Kiosk	1 "	46° 00′ " 46° 15′	78° 30′ " 79° 00′	"
Manitoba	62 N/2	Grandview	1 "	51° 00′ " 51° 15′	100° 30′ " 101° 00′	"
Manitoba	64 /B	Uhlman Lake	4 "	56° 00′ " 57° 00′	98° 00′ " 100° 00′	"
Manitoba	64 /F	Brochet	4 "	57° 00′ " 58° 00′	100° 00′ " 102° 00′	"
Saskatchewan	63 D/NE.	Etomami	2 "	52° 30′ " 53° 00′	102° 00′ " 103° 00′	"
Saskatchewan	63 E/NE.	Cumberland House	2 "	53° 30′ " 54° 00′	102° 00′ " 103° 00′	"
Saskatchewan	63 E/NW.	Ravendale	2 "	53° 30′ " 54° 00′	103° 00′ " 104° 00′	"
Saskatchewan	63 L/10	Hanson Lake	1 "	54° 30′ " 54° 45′	102° 30′ " 103° 00′	"
Alberta	83 N/NW.	Watino	2 "	55° 30′ " 56° 00′	117° 00′ " 118° 00′	"
Northwest Territories	86 K/4	Port Radium	1 "	66° 00′ " 66° 15′	117° 30′ " 118° 00′	"
Northwest Territories	86 K/5	MacAlpine Channel	1 "	66° 15′ " 66° 30′	117° 30′ " 118° 00′	"
Yukon	105 /D	Whitehorse	4 "	60° 00′ " 61° 00′	134° 00′ " 136° 00′	"

DOMINION OBSERVATORIES

C. S. Beals, Director

The work consisted in part of a program of astronomical observation and research that was carried on jointly by the Dominion Observatory in Ottawa and the Dominion Astrophysical Observatory at Victoria, British Columbia; and in part of a series of geophysical investigations that were centred at the Dominion Observatory in Ottawa.

A major feature of the astronomical work at Ottawa was the observation of accurate positions of stars in conjunction with other national observations throughout the world to provide accurate star catalogues for use by navigators and surveyors. Closely allied with this work was maintenance of the Time Service of Canada with wire and radio broadcast services to provide accurate time to all parts of the country. A program of meteor observations was carried out in co-operation with the National Research Council to study the properties of the upper atmosphere, and a project was started for observation of the sun's radiation, its transmission through the atmosphere, and its effect on earthly conditions. At Victoria, work was continued on a program of astrophysical research concerned with the motions and physical characteristics of the stars and of interstellar material.

The chain of six seismograph stations across Canada was maintained and good progress was made, with the aid of new equipment, in the seismic surveying of areas of the Canadian Shield north of Ottawa. Magnetic observations to maintain the accuracy of the magnetic map of Canada were continued, and new stations were occupied in the Arctic regions. Considerable development work was done on new instruments. Gravity observations were continued in the Prairie Provinces and in the Precambrian areas of northern Ontario. Special investigations were made in the vicinities of a number of known ore deposits.

DOMINION OBSERVATORY, OTTAWA

POSITIONAL ASTRONOMY

Astronomical observations with a broken-type transit for determining clock corrections were made on 214 nights, during which 2,732 star transits were taken. Reliance was still placed on the Shortt pendulum clock for observing and controlling the time signals; but since October 1949 a crystal clock has been used as the primary standard for interpolating between periods of observation. Seconds beats from two other crystal clocks, one at the National Research Council Laboratories and the other at the monitoring station of the Department of Transport, were monitored each day and the results were used in maintaining accurate time.

The time distribution system of the Observatory was maintained and in some instances extended. Time signals were sent continuously by wire to the Canadian Broadcasting Corporation, National Research Laboratories, the monitoring station of the Department of Transport, and to Naval Headquarters, Ottawa, the last for relay to Halifax twice daily for broadcast over CFH to ships in the Atlantic. The Canadian National Railways and the Canadian Pacific Railways received time signals by wire for a period of 2 minutes daily direct from the Observatory. These were sent by them across their system from coast to coast, serving as local standards of time in many communities.

Time signals were also supplied to the Canadian Broadcasting Corporation's chain of stations for daily broadcast at 1 p.m. eastern standard time. This service makes time of the highest accuracy available to all Canadians with standard

receiving sets. A broadcast service available to short-wave receivers was maintained continuously, 24 hours a day over station CHU, operated by the Observatory in co-operation with the Department of Transport. In this service, which is the major effort of the Observatory in the distribution of time, seconds time-signals, coded for identification of minutes and half minutes, were broadcast on the frequencies 3330 k.c., 7335 k.c., and 14670 k.c. The broadcasts are primarily intended for surveyors, navigators, and persons living or travelling in remote parts of Canada where other sources of time are not available.

The 695 electrically operated clocks in government buildings in Ottawa, synchronized from the Observatory, were maintained. Observatory clocks, watches, and other timing mechanisms were kept in repair and numerous time pieces were overhauled for other government offices. An electronic watchmaster for rating watches in a few seconds was acquired and its use greatly facilitated the watch-repair work.

It has been recognized for some time that the best pendulum clocks keep better time than can be observed with present telescopes. As the crystal clocks now in use as primary standards have a still higher order of accuracy the need for more accurate methods of astronomical observation has become urgent. With this in mind, a new type of transit instrument known as a photographic zenith tube was ordered and partly completed. This instrument is designed to carry out by photographic means the time transits that are now made visually. The 10-inch photographic objective lens for the instrument is on order. Plans for the supporting piers and the building to house the instrument are well advanced.

Observations with the meridian circle telescope to determine stellar positions were made on 60 nights, during which 1,215 observations were obtained. A total of 244 readings of the direction of the vertical was made by reflections from a mercury bath, and a similar number of instrumental constants was determined.

The computations of the star observations made from 1923 to 1935, inclusive, were completed and, along with comparisons with other systems of stars, were being prepared for publication.

Automatic cameras were installed for photographing the declination circle readings. These devices do away with some of the most tedious and laborious aspects of meridian circle observing by substituting photographic for visual methods. The photographs are made on 35 mm. film. A micrometer machine was built for measuring the photographed images of the declination scales.

Tables of sunrise, sunset, moonrise, moonset, phases of the moon, and eclipses were supplied to many business firms and other organizations where these data are necessary.

STELLAR PHYSICS

The observation of meteors by radio, photographic, and visual methods was continued at Ottawa in co-operation with the National Research Council. Observations were made on 23 nights, the average number of observers being seven. The following well-known showers were observed: Lyrids, Eta Aquarids, Delta Aquarids, Perseids, Leonids, and Geminids. Observations of non-shower meteors were made during dark-of-the-moon periods. More than 60 meteor photographs were obtained and a meteor train spectrum was photographed for the first time. Visual observations of 2,340 meteors were made.

Construction of observatory buildings at Meanook and Newbrook, Alberta, was underway. They are to be used in the international program of photographic triangulation of meteors to be operated jointly with the Department of National Defence and with military and scientific agencies in the United States. Surveys were made by the Surveys and Mapping Branch to delineate the

properties and to accurately fix the latitudes and longitudes of the observatory locations, which are approximately 25 miles apart. Plans were drawn for a residence for the meteor observing staff at Meanook.

The fall of a new Canadian meteorite near Benton, New Brunswick, was investigated in April, and its purchase for the Geological Survey of Canada was arranged.

The measurement of meteor photographs for position of trail, and the photometry of meteor trails, was continued. A study was under way of over a hundred meteor spectra obtained in Canada and elsewhere.

The work on the design and construction of a new totally reflecting, high-dispersion spectrograph formed the chief solar project. This instrument will have photographic recording for visible and ultraviolet light and automatic photo-conductive recording for the infra red region of the spectrum.

A Lyot monochromatic filter that was ordered for observing the hydrogen red line will make possible a systematic survey of solar flares and prominences, these being the most important types of solar eruptions that produce disturbances in the earth's atmosphere.

Sunspot photographs were taken each clear day. Inclusion of an additional lens in the optical system of the present solar telescope makes it possible to obtain smaller and more convenient photographs.

Theoretical investigations were made of several problems relating to the emission and equilibrium of radiation in stars characterized by extended and expanding envelopes. It has been shown that an outwardly moving shell, which merely scatters radiation from a central star, can impress such features on stellar spectra as are typical of P Cygni profiles. A series of numerical calculations based on a new mathematical procedure developed for this problem showed that the scattering mechanism can explain violet absorption borders, central reversals, and occultation of the red edge in stellar emission-absorption lines. These results will be published.

A generalization of Milne's integral equation for radiation density was obtained by removing the restriction to plane-parallel stellar media. A start was made toward solving this equation along the lines of the Wiener-Hopf method.

Measurement and interpretation of spectrograms of stars were continued. A study of the emission line star H. D. 190073 was completed and prepared for publication. An extended investigation of all P Cygni type emission line stars, involving 15 years of observing, was nearing completion, and a summary of the work was presented to a meeting of the American Astronomical Society in June 1949. Headway was made on a similar extended program on interstellar material.

SEISMOLOGY

The stations at Halifax, Saskatoon, Victoria, Seven Falls, and Shawinigan Falls forwarded their records to the central station in Ottawa for inclusion in the monthly bulletin. The seismographs at the two Quebec stations, Seven Falls and Shawinigan Falls, and at Ottawa were checked. Plans were made to install a new vault and new seismic equipment at Halifax on the campus of Dalhousie University.

Although fewer earthquakes were recorded on the seismographs of the Canadian stations than in the previous fiscal year, those that did occur were of greater intensity.

In Canada, an earthquake occurred on August 22 off the northwest tip of Queen Charlotte Island, and although it is rated in magnitude as one of the world's greatest, there was no loss of life and only scattered incidents of serious damage. A systematic study was proceeding of the seismograms of this earth-

quake that were collected from the stations throughout the world. Only two local earthquakes of consequence occurred in eastern Canada. On October 16, 1949, there was a sharp tremor a few miles west of Alexandria, Ontario, which was felt in Ottawa. The location of the epicentre was definitely determined, and it agreed with evidence from the seismograph recordings at Seven Falls and Shawinigan Falls, Quebec, Ottawa and Rolphton, Ontario, and Weston, Massachusetts. On March 6, 1950, Ste. Agathe, Quebec, was shaken by a somewhat smaller earthquake. No damage was reported from either of these shocks.

Both in the West and in the East small local tremors continue to be recorded. As these usually record only at Victoria and Ottawa respectively, no location of the tremors can be made. Those at Victoria record at the rate of about three a week, and at Ottawa about three a month.

Using rockbursts at Kirkland Lake, Ontario, as a source of energy, the Observatory at Ottawa continued its seismic survey in areas of the Canadian Shield. Two stations near Earlton, Ontario, were occupied during the summer, bringing the total completed profile up to 52 kilometres. A winter station at Ville Marie and another at Timiskaming produced completed burst records, and two more, at La Cave and Rolphton, were being occupied. The records from previous years were being worked, so that after completion of the next few stations the current phase of the research will have been concluded. Part of the success of the year's work arose from the use of a new type of seismograph designed in Cambridge University, England, and loaned to the Observatory by Toronto University. By permission of the original designer, this instrument is being copied by a Canadian firm, and six of them will be available for the field season of 1950.

Preparations were continued for inauguration of a first-class seismic station at Resolute Bay, Northwest Territories. Part of the equipment was transported to Resolute Bay by air, and it is hoped that the station will be in full operation by the autumn of 1950. Tests made in Ottawa of the various items of equipment under winter conditions showed that the signals from a seismometer can be conducted through a 1,600-foot insulated cable to the necessary recorders. This will permit placing the seismometers on a rock outcrop a considerable distance from the recording station.

What is known as the fault-plane project, was initiated. Briefly, the aim is to develop a method of obtaining the strike, dip, and direction of motion of a fault along which an earthquake occurs by studying the direction of first motion of the earthquake as recorded on seismographs stationed throughout the world. This method was first applied in Canada to the earthquake in British Columbia in 1946, and has since been extended to include an Aleutian earthquake, an Alaskan earthquake, and that of August 22 off Queen Charlotte Islands. In all cases the fault obtained by seismological methods is in agreement with the geology of the area determined by other means. The project is to be extended to include more earthquakes in the same region, some in other regions, and a few deep-focus earthquakes. It is hoped that this research will eventually give some indication of the overall structure of the Pacific basin.

TERRESTRIAL MAGNETISM

Magnetic observations for declination, inclination, and force were made at twenty-eight field stations. All the stations, with the exception of two in The Pas area, Manitoba, and one on the Labrador coast, were north of latitude 60 degrees, and all were occupied with the co-operation of the R.C.A.F. and the Royal Canadian Navy. One station was occupied on Ellef Ringnes Island, one on Prince Patrick, one on Victoria, four on Devon, one on Prince of Wales, two on Somerset, and four on Baffin Island. A station was established at Pasley

Bay, Boothia Peninsula, near the former location of the north magnetic pole as determined by Ross in 1831, and another was established on the shore of Ommanney Bay, Prince of Wales Island, not far from the present location of the magnetic pole at approximately latitude 73° N. and longitude 100° W.

The Observatory, for the first time, undertook a program of magnetic observations at sea, in which the facilities afforded by H.M.C.S. *Swansea* were utilized. Valuable data were recorded during the cruise in Davis and Hudson Straits. Tabulation of all field magnetic measurements made during the years 1938 to 1943, inclusive, was completed for publication.

Two declination maps for the epoch 1948·5 were published, one of Canada south of latitude 75° N. on the 100-mile sheet, and the other of the Northwest Territories and Yukon on the 80-mile sheet. These were given priority owing to the many practical purposes for which they are adapted, and to the increasing demand for new and accurate declination maps for air navigation. A map depicting lines of equal total force and annual change was constructed and work on a vertical force map was nearing completion.

The Observatory supplies magnetic information necessary for the construction of maps and charts. Declination values computed for 388 topographical squares in northern Saskatchewan were supplied to the Department of Natural Resources and Industrial Development, Saskatchewan, and similar information was supplied to private prospecting companies.

Three-hour-range indices, which provide measures of the frequency and intensity of magnetic disturbance resulting from the effects of solar corpuscular radiation on the earth, were measured from magnetograms obtained at Agincourt and Meanook, and were supplied monthly to research centres in Holland, Germany, and the United States. These indices, known as K-indices, have an immediate application in studies of the upper atmosphere, particularly in relation to radio wave transmission and cosmic ray incidence.

An investigation was commenced at Meanook of disturbance phenomena in the vertical component of the magnetic field following a suggestion made by a commercial prospecting company. Disturbance values derived from magnetograms obtained at Agincourt and Meanook for the years 1944 to 1949, inclusive, were used. The daily variation disturbance pattern at Meanook was found to be remarkably constant, the most disturbed period of the day being between 11 p.m. and 5 a.m., and the least disturbed between 8 a.m. and 8 p.m. M.S.T. The amplitude of the daily variation at Agincourt was less than at Meanook, but the pattern was definite, the most disturbed period being betweeen 10 p.m. and 4 a.m. E.S.T.

The temporary observatories at Baker Lake and Resolute Bay were in fairly continuous operation. Experiments were carried out with electrical recording variometers with some success. Photographic records of declination from Resolute Bay, approximately 150 miles from the north magnetic pole, supplied evidence to support the opinion held for many years by the Observatory that magnetic variation phenomena in high magnetic latitudes are not so consistently erratic as was formerly assumed.

Good progress was made in the construction programs for the improvement of facilities at the magnetic observatories. The office building and a power house at Meanook were practically completed, and construction work on an office building at Agincourt was well advanced. A non-magnetic building was constructed at Baker Lake to house the magnetic instruments.

Encouraging progress was made in developing and constructing a universal airborne magnetometer, in which work the National Research Council, Toronto University, and the Department of National Defence co-operated. Improvements were made in stability and sensitivity of the field-measuring part of the

magnetometer. Investigations were concentrated on the design of a gyro-stabilization system for use with the magnetometer. Mechanical filters required by the system were constructed at the Observatory whereby continuous recordings of the performance of the equipment and the acceleration of the aircraft and magnitude of variations from the vertical can be indicated. This is a new approach to recording the movements of an aircraft relative to the absolute vertical and should have an important use apart from its connection with the magnetometer. This part of the equipment performed efficiently when tested on flights by the R.C.A.F.

Construction work was completed on two universal, electrical magnetometers for field use and was under way on a third. This type of magnetometer was designed by the Observatory in 1947, and following its successful use for three seasons in the Arctic it has been adopted as the standard field instrument for the Observatory.

GRAVITY

The work consisted partly of field observations and partly of calculations, reductions, and interpretation studies aimed at producing a gravity map of Canada on the basis of approximately 4,000 observations of gravity between the Rocky Mountains and the Atlantic, obtained during the past 4 years.

Using a Mott-Smith gravimeter mounted in an automobile, the Observatory made a total of 718 observations in the summer of 1949 in Ontario, Manitoba, Saskatchewan, and Alberta. The principal aim was to make a complete areal coverage, another objective being to correlate by field observations a number of local gravimetric surveys made by commercial geophysical companies in the western provinces. Much of the work was in northern Saskatchewan and was done in co-operation with the Saskatchewan Government, which was undertaking extensive drilling operations in the region. The field work included completion of a series of traverses over the Sudbury basin, the results of which, it is hoped, will prove useful in studies by geologists of the sub-surface structure of this important mineralized region.

It included also extension of the airborne gravity survey of Canadian Shield areas, initiated 3 years ago, eastward into northern and eastern Ontario. In this work gravity observations were made on the borders of the numerous lakes in this region. Repeat observations were made in eastern Manitoba and western Ontario to connect with stations occupied in preceding years. The work in these regions was extended northward to God's Lake, Manitoba, and to the Sachigo River area in Ontario. Ten pendulum stations were re-occupied and the observations were extended eastward to a line running from Sudbury to Cochrane and Lake Abitibi.

In the project a total of 350 new stations were occupied.

The Observatory made a detailed survey of the gravity field over the MacDonald and Eldona orebodies in western Quebec, the purpose being to determine the limitations of the gravimetric method in outlying ore deposits arising from the dimensions and density of the ore, the varying depth of cover, and the ruggedness of terrain. The results indicated that, under favourable conditions, an orebody of sufficient density contrast, if not too far from the surface, can be well outlined by the gravity method.

Studies made of several thousand gravity observations east of the Rocky Mountains have indicated numerous interesting correlations with the geology and topography of the country. Road traverses across the Prairie Provinces have indicated in their broad outlines the existence of almost complete isostatic

equilibrium over a range of altitudes from 770 feet at Winnipeg to 2,990 feet at Edson, Alberta. Local anomalies of a very interesting character are of frequent occurrence, and in the mineralized areas of northern Ontario they have a direct correlation with the known surface geology. That is, small, well-defined highs are observed over belts of relatively dense Keewatin lavas, the geological contacts being accurately demarcated by the inflexion points of the gravity profiles. By a comparison of the observed curves with those calculated for type bodies, an estimate can be made of the depth to the base of the Keewatin rocks. Such estimates are of interest because of the ore deposits found within the lavas. For some of the broader lava belts depths up to 10,000 feet are indicated.

Extensive data were supplied by a number of the major oil companies and geophysical prospecting organizations for use in constructing more complete gravity maps of the western provinces. The Observatory co-operated in a program sponsored by the Shell Oil Company of Houston, Texas, designed to measure variations of gravity due to earth tides. These observations provided helpful data to the project.

DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA

Substantial progress was made in all phases of the Observatory's activities. Fundamental astrophysical research programs were actively advanced and reports on a large number of completed researches were published. The Observatory was represented at four important scientific congresses at which invited addresses were delivered and numerous papers were presented. A 2·8-acre parcel of land adjacent to Observatory Hill and the buildings thereon were purchased by the Department to complete the Observatory grounds and to provide a residence for the caretaker.

OBSERVING STATISTICS

The telescope was used on 171 nights, wholly or partly clear, for a total observing time of 1,022 hours. Owing to the unusually severe winter the number of observing hours was 14 per cent below the 31-year average. The telescope was used exclusively for stellar spectroscopy, and 1,186 spectrograms were obtained.

Quarterly Summary of Observations

—	Nights	Hours	Spectrograms
Spring quarter	53	283	281
Summer quarter	59	346	397
Autumn quarter	41	295	391
Winter quarter	18	98	117
Totals 1949–50	171	1,022	1,186
31-year average	194	1,192	1,276

RELATIONS WITH OBSERVATORIES AND LEARNED SOCIETIES

The Observatory was represented at the following scientific meetings:

1. Annual meeting of the Royal Society of Canada, Halifax, Nova Scotia, June 5 to 8, where five research papers were presented by the Dominion Astrophysicist, who was elected president of the society for 1949–50.

2. Meeting of the American Astronomical Society, held at the Dominion Observatory, Ottawa, June 19 to 23, where five papers were presented.

The Society accepted an invitation to hold its 1952 meeting in Victoria.

3. Joint meeting of the American Physical Society and the Astronomical Society of the Pacific, Seattle, June 27 to 30, where an invited paper on "Isotopes in Stellar Atmospheres" was presented by a senior officer of the Observatory and three research papers were read.

4. The Symposium on Spectroscopy held March 31 to April 1 under the joint auspices of the Royal Society of Canada and the University of British Columbia, at which the four senior members of the staff participated. This conference was attended by scientists from the universities of Alberta, Wisconsin, Washington, and British Columbia, and from the National Research Council and the Defence Research Board. Over four hundred persons were in attendance at the lecture on "Celestial Spectra" delivered by Dr. Pearce.

STELLAR MOTION STUDIES

Radial Velocities Programs

The most important of these is determination of the line-of-sight speeds of approximately 750 early-type stars in the galactic plane at great distances from the sun. This investigation is designed to obtain more accurate and detailed knowledge of the dynamics of the galactic system, including the interstellar material and to extend this knowledge to greater distances from the sun. A total of 590 spectrograms on this program was measured for radial velocity.

A related program concerns the motion of stars, in the galactic polar cap, at right angles to the plane of the galaxy. Good progress was made on the observational side of this work but measurement of the spectrograms was deferred because of the pressure of other researches.

Headway was made in the study of the radial velocities of members of the Pleiades Cluster. More than 100 spectrograms of spectral types A0 to F2 were measured, making velocities of all the brighter members of the cluster.

Effective Wave-Lengths

Fundamental work was continued on wave-length standards for the early-type stars. Progress was curtailed by the practical difficulty of finding suitable control stars, but there was a steady accumulation of data. The galactic clusters I.C. 4665 and N.G.C. 6633 were surveyed and a number of suitable standards were found. Some new visual binaries were studied and the clusters M 35 and h and χPersei were partly covered. Most of the spectrograms obtained on this program were measured during the year.

Orbital studies of interesting systems were continued, with special emphasis on two-spectra objects that provide information on masses and absolute dimensions. The following binaries were investigated in detail.

H.D. 47732. Preliminary orbital elements were derived of this massive early-type system. Both spectra are visible so that accurate mass-ratios and density-ratios are obtained.

DI Herculis. Definitive orbital elements were calculated. The system is eclipsing and absolute dimensions result from a combination of the spectrographic and photometric results.

RY Geminorum. Orbital elements were derived for this A-type eclipsing binary. A series of spectra made at minimum light showed that the spectrum of the giant K-type star was not visible at other times. The system was shown to be accompanied by a ring of gas the dimensions of which were determined.

Pegasi. A new orbit based upon high-dispersion spectra was determined. A comparison with the earlier orbit showed that the system is very stable, fulfilling the conditions of the two body problem.

25 Serpentis. A new determination was made of the orbital elements of this binary system from spectra obtained at Victoria and the University of Michigan. The orbital eccentricity, 0·77, is very high for a spectroscopic system. Comparison with earlier observations established the constancy of the elements. The new study revealed, for the first time, the spectral lines of the fainter star.

In addition to the above completed studies several interesting systems were under observation. H.D. 23642 in the Pleiades was discovered to be a binary, showing two spectra. The interesting composite system H.D. 192909-10, now known to be eclipsing, was under study, as was the early-type massive eclipsing binary H.D. 190967. The brighter component of the visual binary A.O.S. 14864 was also studied. This component itself is double, a rare combination of an early-type normal star and a cool late-type supergiant.

Astrophysical Studies

Determination of Δm for Two-spectra Binaries. This program, undertaken in 1935, was concluded and the results were prepared for publication in two papers. One hundred and five spectroscopic binaries were observed and their spectra were measured. Essentially all the binaries available from this latitude and bright enough to photograph with sufficient dispersion have been observed. As a result, the magnitude and spectral type differences between the component stars are determined, the ratio of radii and mean densities of the component stars are found directly the masses and absolute dimensions of the stars and orbits may be estimated with relatively little uncertainty; values of Δm are made available for a number of eclipsing systems, for many of which this datum is required to analyse the light curves; and the mass-luminosity relation is found from the measurements without requiring a knowledge of stellar masses and parallaxes. The last forms a valuable check on the fundamental relation found from visual binaries and eclipsing stars and will be of interest in theories of stellar structure and evolution.

Spectrophotometric Analysis of Late-type Stars. The detailed measurement of line intensities and their analyses by curve-of-growth methods was continued. These data are applied chiefly in finding the ionization temperatures and the pressures in stellar atmospheres, and finally to determine the chemical composition. Using laboratory measures, and theoretical intensities, various stratification effects have been found such as the degrees of turbulence at different atmospheric levels. Comparison of results obtained for the sun, α Persei, Arcturus, and γ Draconis suggests that the physical processes in stellar atmospheres are more complicated than those envisaged in theoretical studies. The results will be of interest in the physical theory of stellar absorption-line formation.

Theoretical Studies. Theoretical studies of high-temperature stellar atmospheres were initiated. These take the form of solving the differential equations of mechanical and radiative equilibrium under conditions known to prevail for actual stars. The results enable determination of the march of temperature, pressure, and density at various depths in the stellar atmosphere and calculations of the quality and the amount of the emitted radiation.

Paralleling the above studies are investigations into the absorption coefficients of certain lines of neutral and ionized helium, in which consideration is given to the influence of electric fields and thermal motions of the gases. The study should make possible the eventual prediction of the appearance of these spectral lines under stellar conditions.

When considered as a whole, these researches will enable the identification of a model atmosphere with actual stars. This will give the temperatures, surface gravities, and luminosities of the high-temperature stars, which data are not accurately obtainable at present from direct observation.

Resonance Fluorescence in Variable Stars. A study was undertaken of the mechanism of resonance fluorescence to explain emission lines in late-type (cool) giant variable stars. These objects possess extensive atmospheres and have low surface temperatures. The periodic appearance and disappearance of bright spectral lines associated with the light curves has long defied explanation. The mechanism proposed and studied was used with outstanding success in explaining the emission lines in cometary spectra, and its application to the variable star R Coronae Borealis has partly explained some of the difficulties in interpreting the spectrum. Solution of the problem of the Long Period Variables is not essentially advanced by the mechanism as at present contemplated, but further studies may lead to clarification of the spectra of the stars of this type.

Spectroscopic Luminosities of Early A Stars. A study of the stars of spectral-type B8 to A3 has led to a calibration of the true brightness in terms of the measured absorption of the hydrogen lines. The calibration is tested by comparison with stars in moving clusters, with eclipsing binaries, and from a statistical study of the proper motions. The correlation is now considered to be satisfactory and the work is complete. The applications are twofold, namely, to measure the luminosities, and hence the distances, of A-type stars, and to assist in calibrating the B-type luminosities for use in galactic studies.

Stark Effect in Hydrogen in Early-type Stars. Observations were made of the spectra of a number of B and A stars of known luminosities. The purpose is to study the formation of the hydrogen absorption lines as affected by Stark effect in order to confirm the knowledge of the relation between hydrogen absorption and stellar luminosity. Theoretical studies are paralleling the accumulation of the observational material.

Cepheid Variables. Spectra of the Cepheid variables δ Sephei and η Aquilae were obtained, to study the rise and fall of emission at the K and H lines of ionized calcium and their relation to the light curve. The resulting information will probably lead to an improved estimate of conditions in a Cepheid atmosphere.

Shell Spectra. A program was undertaken of studying stars with extensive "shell-like" atmospheres. The spectra will be studied for line intensities and will be analysed to find the chemical abundance and the physical conditions prevailing in these little-understood objects.

Nova Lacertae 1950. Some spectrograms were obtained of this latest nova, which will be useful in studying its spectroscopic behaviour.

SEISMOLOGY

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

PUBLICATIONS

Seven Publications and nine Contributions were distributed to the mailing list of nearly 400 observatories and universities throughout the world.

PUBLIC RELATIONS

An estimated 28,000 people visited the Observatory. It was opened to the public every week day from 9.00 until 4.30 p.m. and the public observation periods were held on 33 Saturday evenings from 8.00 to 10.00 p.m. More than 4,600 persons attended these observation periods and were shown selected celestial objects through the 73-inch reflector. The Observatory was visited also by many organized groups and societies who were addressed by staff members. These included a convention of 250 farmers from Nebraska who were addressed on the research work under way; a delegation from the International Mathematical Congress meeting in Vancouver, B.C., who made a special visit to inspect the equipment; and over 200 members of the Victoria Centre, Royal Astronomical Society of Canada, who held their annual observational meeting at the Observatory for the eighteenth consecutive year.

GEOGRAPHICAL BRANCH

J. W. Watson, Director

The Geographical Branch collects, organizes, and makes available to all branches of the Federal Government geographical data on Canada and on foreign countries that might be of use in promoting the economic, commercial, and social welfare of Canada. The Branch is establishing a central reference depository of maps of Canada and of foreign countries for the use of Federal Government departments and interested agencies and is assembling a library of geographical books, pamphlets, periodicals, and reports on Canada and on foreign countries for research and reference purposes. Its main work consists of compiling and collating material from such publications, making specific surveys of regions of Canada for various uses, placing the information on maps, and making it available through publications and reference and information services.

Chief project under way was compilation of the Atlas of Canada, in which work the Branch is advised by an Inter-Departmental Committee. The reference service for foreign geographical information has increased as a result of requests from the Department of External Affairs, Trade and Commerce, and Resources and Development. Data obtained from field work supplemented the information on Canada available from other sources.

J. W. Watson, formerly Head of the Department of Geography at McMaster University, was appointed Chief of the Geographical Bureau in the former Department of Mines and Resources on June 1, 1949. Prior to his appointment, Dr. F. J. Alcock, Chief Curator of the National Museum of Canada, served as Acting Chief of the Bureau. When the Bureau became the Geographical Branch of the Department of Mines and Technical Surveys in January 1950, Dr. Watson became its Director. Other additions to the staff brought the number of professional geographers up to eight by the end of the fiscal year.

THE ATLAS OF CANADA

Preparation of an Atlas of Canada by the Federal Government was approved by the Cabinet at the end of 1948. The intention is to produce the type of atlas that can present to the Canadian people and the world at large a selection of authoritative maps that will show the nature, extent, and use of the physical resources of the country and their effect on economy and society. An organization to guide the work of the project was set up in March 1949 under which an Inter-Departmental Committee was appointed and an Executive Committee was chosen from its members. A senior officer of the Geographical Branch was appointed Secretary of both committees to implement their decisions and to act as liaison officer between them and the various departments concerned. Five committee meetings were held up to the end of the fiscal year, as a result of which a comparative analytical study was made of other national and world reference atlases. This led to preliminary decisions with regard to the size of the maps to be included in the Atlas, and their scales and projections. Work was commenced on the scope of the contents of the atlas and an examination was begun of source material.

GEOGRAPHICAL SERVICES

The Branch supplied information and reports on request to many branches of the government, to national and international organizations, to commercial firms, and to individuals engaged in research. Chief among these were: a report, illustrated with maps, dealing with the history of discovery, exploration, and settlement, prepared in connection with Canada's sovereignty in the Arctic;

a report on the status of geography in Canada, with particular reference to the work of the Branch, prepared for the Pan-American Geographical Congress held in September 1949; and a brief on the geography of Bolivia prepared for a United Nations' Mission on Technical Assistance to Underdeveloped Countries before its departure to that country.

English and French colour versions of a filmstrip entitled "The Geographical Regions of Canada" were completed in collaboration with the National Film Board. This filmstrip divides Canada into eleven geographical regions and describes pictorially the outstanding characteristics that give each of them unity. It gives an overall, yet systematic, approach to the geography of Canada.

FIELD WORK

In its field work, the Branch again gave chief attention to the Arctic and sub-Arctic areas.

The Director of the Branch made a reconnaissance survey of part of the District of Mackenzie, mainly in the Mackenzie River Valley, to appraise the problems that might be assisted by scientific geographical work in that region.

A party of five, consisting of three geographers, a botanist, and a geologist, sailed northward in the Geographical Branch's ship the *Nauja*, along the east coasts of James and Hudson Bays to survey the physical resources of the islands recently discovered in Foxe Basin. They landed at several points, in addition to the islands in Foxe Basin, carrying out scientific investigations of the land forms and the soil and vegetation patterns and collecting geological and botanical specimens. Nautical and geodetic data were also obtained for use of the Hydrographic Service and Geodetic Survey.

Somewhat similar studies were made by a geographer in company with a biologist, who joined forces with a party from the Arctic Institute of North America to Holman and Banks Islands, in investigations in the western part of the District of Franklin.

A geographer attached to the Magnetic Survey party of the Dominion Observatory travelled by air to nineteen places between Great Bear Lake and North Devon Island, where he collected information on ice, land forms, soils, vegetation, and conditions of life and work.

A representative of the Branch accompanied the joint United States-Canada Weather Station Supply Mission on board the U.S.S. *Edisto*. He collected valuable data on a number of islands north of Lancaster Sound that have proved useful for revising existing maps and charts. Another geographer travelled on board the Hudson's Bay Company's vessel *Rupertsland* and visited twenty-four ports along the coasts of Hudson Strait and Hudson Bay. His purpose was to collect geographical data for the Branch on the settlements visited, information on conditions of Eskimo welfare for the Northwest Territories administration, and navigational data for the Hydrographic Service.

Along the Labrador coast, a party of three geographers made a preliminary investigation at a number of settlements of the extent and use of the resources upon which the people depend for a living. They sailed with a party sponsored by the Arctic Institute of North America and assisted them in carrying out hydrographic soundings.

Another water-borne expedition, consisting of four geographers, carried out a lake-shore investigation in Georgian Bay, the North Channel, and Lake Superior to the lakehead. They sailed in the new Canadian Hydrographic Service vessel *Bayfield*. Inshore channels and anchorages were sounded and sketch surveys were made of a number of harbours, all of which information

will be used for the revision of hydrographic charts. Numerous photographs were taken that will be useful to the Hydrographic Service and to the Canadian Government Travel Bureau. The work was supplemented by a study in botanical geography. Plant associations were mapped at selected places and botanical specimens were collected for Dominion and Provincial authorities.

Two geographers commenced a study of ranching conditions on the interior uplands of British Columbia. They investigated the relation of the ranch industry to the region as a whole and studied a typical ranch unit in relation to its local setting and ranch organization, with a view to obtaining a better understanding of the regional and sub-regional problems of the area.

SCIENTIFIC AND OTHER MEETINGS

Dr. F. J. Alcock represented the Branch at the International Geographical Union Congress in Lisbon, Portugal, in April 1949.

The Branch was represented at the meetings of the Inter-Departmental Meteorological Committee, the Sub-Committee on Pleistocene Geology of the National Advisory Committee on Research in the Geological Sciences, and the Canadian Board on Geographical Names.

One geographer attended the National Convention of the Community Planning Association of Canada in Winnipeg and another the meeting of the American Society of Photogrammetry in Washington. The Branch Director attended a meeting of the Commission on the World Land Use Survey of the International Geographical Union at Worcester, Massachusetts.

PUBLICATIONS

Department of Mines and Technical Surveys

English Publications

Annual Report for the Fiscal Year Ended March 31, 1949.
Emergency Gold Mining Assistance Act for the Fiscal Year Ended March 31, 1949.

French Translations

Annual Report for the Fiscal Year Ended March 31, 1948.
Emergency Gold Mining Assistance Act for the Fiscal Year Ended March 31, 1949.

Mines Branch

English Publications

Report No.

826 *Bituminous Sands of Northern Alberta:*
Vol. I. Results of Investigations, 1942-47.
*Vol. II. Detailed Drilling and Sampling Records.
*Vol. III. Cross-sections and Plans of the Areas Drilled.

827 *The Canadian Mineral Industry in 1947,* by the staff, Mines Branch.
Prospector's Guide for Uranium and Thorium Minerals.

French Translations

Prospector's Guide for Uranium and Thorium Minerals.
**The Canadian Mineral Industry in 1947.*

Memorandum Series

*96 *Determination of Uranium in Ores by Field Analysis,* by F. E. Senftle and C. McMahon.

*103 *Determination of Uranium in Ores—Modified Mercury Cathode Cupferron Method,* by F. T. Rabbitts.

*104 *Silica in Canada,* by A. R. MacPherson.

*105 *Determination of U_3O_8 in Ores and Solutions, Cellulose Column Method,* by F. T. Rabbitts *et al.*

Lists of Mines and Mine Operators

1-2. Milling Plants, 1949.
3-5. Gypsum Mines in Canada, 1949.
4-1. Coal Mines in Canada, 1949.
5-2. Petroleum Refineries in Canada, December 1948.
6-4. Lime Kilns in Canada, 1949.

Geological Survey

English Publications

Report No.

2487 Memoir 250. *Geology and Mineral Deposits of File-Tramping Lakes Area, Man.,* by J. M. Harrison.

2488 Memoir 251. *McConnell Creek Map-area, Cassair District, B.C.,* by C. S. Lord.

2490 Memoir 252. *Fort St. James Map-area, B.C.,* by J. E. Armstrong.

Bulletin 12. *Jurassic Formations of Maude Island and Alliford Bay, Skidegate Inlet, Queen Charlotte Islands, B.C.,* by F. H. McLearn.

Bulletin 13. *Uppermost Cretaceous and Paleocene Floras of Western Alberta,* by W. A. Bell.

Bulletin 14. *Geology of Part of the Selkirk Mountains in the Vicinity of the Main Line of the Canadian Pacific Railway, B.C.,* by V. J. Okulitch.

*Paper 48-25. *McQuesten, Yukon Territory,* by J. S. Bostock. (Map and descriptive notes.)

*Paper 49-3. *Cardston, Alberta,* by E. P. Williams. (Map.)

*Mimeographed.

*Paper 49-5. *Weldon Bay, Man.*, by J. Kalliokoski. (Map and descriptive notes.)
*Paper 49-6. *Pleistocene Deposits of O'Leary Map-area, Prince County, P.E.I.*, by E. B. Owen.
*Paper 49-7. *A La Pêche Map-area, Alberta*, by E. J. W. Irish.
*Paper 49-8. *Carp Lakes, N.W.T.*, by M. L. Miller. (Map.)
*Paper 49-9. *Collins Point, Man.*, by M. J. Frarey. (Map.)
*Paper 49-10. *Indin Lake Map-area, N.W.T.*, by Y. O. Fortier.
*Paper 49-12. *Brochet, Man.*, by N. R. Gadd. (Map.)
*Paper 49-13. *Minto, N.B.*, by J. E. Muller.
*Paper 49-14. *Wecho River (East Half), N.W.T.*, by D. H. Yardley. (Map.)
*Paper 49-15. *Some Cretaceous Sections along Athabaska River from the Mouth of Calling River to Below Grand Rapids, Alberta*, by R. T. D. Wickenden.
*Paper 49-16. *Pitchblende Occurrences between Beaverlodge and Hottah Lakes, N.W.T.*, by J. F. Henderson.
*Paper 49-17. *Goldfields and Martin Lake Map-areas, Sask.*, by A. M. Christie.
*Paper 49-18. *Snake Rapids, Sask.*, by G. E. P. Eastwood. (Map and descriptive notes.)
*Paper 49-19. *MacAlpine Channel Map-area, N.W.T.*, by M. Feniak.
*Paper 49-20. *Moody Lake, Man.*, by D. S. Robertson. (Map.)
*Paper 49-21. *Chipman, N.B.*, by J. E. Muller.
*Paper 49-22. *Nelson, B.C. (West Half)*, by H. W. Little. (Map.)
*Paper 49-23. *Southwest Dasserat, Témiscamingue County, Que.*, by C. H. Stockwell. (Map.)
*Paper 49-24. *Dezadeash Map-area, Yukon*, by E. D. Kindle.
*Paper 49-25. *Southeast Dasserat, Témiscamique County, Que.*, by C. H. Stockwell. (Map.)
*Paper 49-26. *Yellowknife, N.W.T.*, by J. F. Henderson and I. C. Brown. (Map.)
*Paper 49-27. *Pine Channel Area, Lake Athabaska District, Sask.*, by J. B. Mawdsley.
*Paper 50-1. *Elbow Lake, Man.* by D. S. Robertson. (Map.)
*Paper 50-6. *Ossian Township, Ont.*, by J. B. Currie.

French Translations

2486 Memoir 229. *Noranda District, Que.*, by M. E. Wilson.
2489 Memoir 231. *Bousquet-Joannès Area, Que.*, by H. C. Gunning.

Surveys and Mapping Branch

English Publications

Report No.

52 *Altitudes in Northern British Columbia*, by L. O. R. Dozois.
67 *Triangulation in Quebec North of Gulf of St. Lawrence*, by C. H. Ney.
76 *Geodetic Problems in Shoran*, by J. E. R. Ross.

Dominion Observatories

English Publications

Vol XI, No. 9. *Declination Results at the Canadian Stations North of Latitude 60 N, 1938-1947*, by R. G. Madill.
Vol. XI, No. 10. *An Investigation of the Applicability of Gravimetric and Magnetometric Methods of Geophysical Prospecting*, by M. J. S. Innes.
Vol. XIV, No. 4. *Bibliography of Seismology, July to December, 1948*, by W. J. Milne.
Vol. XV, No. 1. *Catalogue of 2,436 Stars from Observations with the Reversible Meridian Circle, made at the Dominion Observatory, Ottawa, during the Years 1911-1923*, by W. S. McClenahan.

*Mimeographed.

Reprints

Vol. 1, No. 4. *Gravity in the Interior of the Earth,* by R. M. Stewart.
Vol. 2, No. 2. *Canada's Time Service,* by M. M. Thomson.
Vol. 2, No. 3. *A Note on Four Complex Meteor Radar Echoes,* by Peter M. Millman and D. W. R. McKinley.
Vol. 2, No. 4. *Wave Lengths, Equivalent Widths and Line Profiles in the Spectrum of the Star H.D. 190073,* by C. S. Beals and Miriam S. Burland.
Vol. 2, No. 5. *Determination of the Elements of Meteor Paths from Radar Observations,* by D. W. R. McKinley and Peter M. Millman.

Publications

Vol. VII, No. 26. *The Intensities of Isotopic Carbon Bands in the Spectra of Twenty-one R Type Stars,* by Andrew McKellar.
Vol. VII, No. 27. *The Spectrographic Orbits and Dimensions of H.D. 171978,* by R. M. Petrie.
Vol. VII, Index.
Vol. VIII, No. 2. *New Radial Velocities of Nineteen Bright Members of the Ursa Major Cluster and the Space Motion of Nucleus Stars,* by R. M. Petrie.
Vol. VIII, No. 3. *The Spectrographic Orbit of H.D. 198784,* by T. S. Jacobsen and Robert P. Kraft.
Vol. VIII, No. 4. *The Spectrographic Orbits and Dimensions of the Eclipsing Binary H.D. 193611,* by Jean K. McDonald.
Vol. VIII, No. 5. *Line Intensities in Spectra of Advanced Type,* by A. Pannekoek.

Reprints

No. 9. *The Orbits and the Dimensions of the Components of the Spectroscopic Binary H.D. 43246,* by R. M. Petrie.
No. 10. *Wave-Length Standards for Radial-Velocity Determinations, II, the "A" Stars with High Dispersion,* by R. M. Petrie.
No. 11. *Wave-Length Standards for Radial-Velocity Determinations, III, the "A" Stars with Single-Prism Dispersion,* by R. M. Petrie.
No. 12. *Wave-Length Standards for Radial-Velocity Determinations, IV,* by Jean K. McDonald.
No. 13. *A new Projection Instrument for the Rapid Determination of Stellar Radial Velocities,* by R. M. Petrie and S. S. Girling.
No. 14. *Axial Rotation of the Brighter Stars in the Pleiades Cluster,* by Elsa Van Dien.
No. 15. *The Far Violet Region in the Spectra of the Cool Carbon Stars,* by Andrew McKellar.
No. 16. *Polyatomic Molecules in Late-type Stars,* by P. Swings and A. McKellar.
No. 17. *The Spectrum of Epsilon Aurigae, 1946-1948,* by K. O. Wright and Elsa Van Dien.