

DOMINION OF CANADA

REPORT

OF THE

DEPARTMENT OF MINES

FOR THE

FISCAL YEAR ENDING MARCH 31, 1931

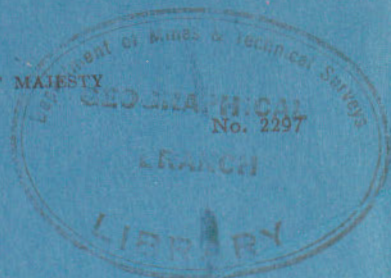


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W. A. GORDON,
Minister of Mines.

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OTTAWA

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CONTENTS

	Page
Department of Mines	1
Geological Survey	10
Geological Division	13
Topographical Division	17
Mineralogical Division	19
Palaeontological Division	21
Fluvialine Geology, Water Supply, and Harbours Division	21
Drafting and Reproducing Division	23
<p style="text-align: center;">To His Excellency Captain the Right Honourable the Earl of Bessborough, P.C., G.C.M.G., Governor General and Commander-in-Chief of the Dominion of Canada.</p>	
British Columbia	25
<p>MAY IT PLEASE YOUR EXCELLENCY:</p> <p>The undersigned has the honour to lay before Your Excellency, in compliance with 6-7 Edward VII, chapter 29, section 18, the report of the work of the Department of Mines, for the fiscal year ending March 31, 1931.</p>	
Mines Branch	33
Mineral Resources Division	39
Ore Dressing and Metallurgical Division	39
Fuels and Fuel Testing Division	39
Ceramics and Road Materials Division	39
Chemistry Division	39
Dominion of Canada Assay Office	39
Drafting Division	39
Distribution of Publications	39
Library	39

W. A. GORDON,
Minister of Mines.

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CONTENTS

	PAGE
Department of Mines.....	1
Geological Survey.....	10
Geological Division.....	13
Topographical Division.....	17
Mineralogical Division.....	19
Palæontological Division.....	21
Pleistocene Geology, Water Supply, and Borings Division.....	21
Draughting and Reproducing Division.....	23
Photographic Division.....	26
Geological Information and Distribution Division.....	27
Library.....	27
British Columbia Office.....	28
National Museum of Canada.....	29
Anthropological Division.....	30
Biological Division.....	31
Mines Branch.....	35
Mineral Resources Division.....	36
Ore Dressing and Metallurgical Division.....	38
Fuels and Fuel Testing Division.....	40
Ceramics and Road Materials Division.....	43
Chemistry Division.....	45
Dominion of Canada Assay Office.....	46
Draughting Division.....	47
Distribution of Publications.....	48
Library.....	48
Explosives Division.....	49
Editorial Division.....	52
Accounting Division.....	56
Index.....	59

DEPARTMENT OF MINES

REPORT
OF THE
DEPARTMENT OF MINES

FOR THE FISCAL YEAR ENDING MARCH 31, 1931

To the Honourable W. A. Gordon, K.C.,
Minister of Mines,
Ottawa.

SIR,—In accordance with the requirements of Parliament, I have the honour to submit the Annual Report of the Department of Mines for the year ending March 31, 1931.

The demand for information respecting the geology and mineral resources of the Dominion and for technical research and advice on these subjects, continues to tax the available facilities of the department in personnel and equipment. Recognition of the value of the services rendered in the past is shown in the increasing readiness of the mining industry throughout the country to submit its problems to the department, and to seek its co-operation in their solution.

During the twenty-four years since the department was created, its policy has been to extend, wherever and whenever possible, every legitimate assistance toward the greater development of the mining industry. The progress made by the industry during this period has fully justified the attitude originally adopted and since maintained, and Canada today has well-established mining and metallurgical industries with a capital investment of nearly a billion dollars, giving direct employment to nearly a hundred thousand men. In a period of industrial depression there is all the more need for the greatest possible technical contribution toward lower costs of prospecting, operation and production, improved methods of treatment, higher recoveries, better products, more efficient utilization, and the development of Canadian resources to replace imported products. These are among the more important objects of national interest with which the department is actively concerned.

In the following pages the year's activities of the various branches are reviewed in detail by the heads of each branch and division. Investigations of immediate economic interest make up the greater part of the work in hand, and in a number of cases research is being done, as time and circumstances permit, on subjects that are considered likely to have a bearing on Canadian industrial conditions. A feature of the work of the research divisions is the increasing interest shown by industrial and other organizations in various problems under investigation. More of these organizations are showing their interest in a most practical manner by actively co-operating with the department, and such assistance is welcomed and is mutually advantageous when it may lead to the solution of problems of economic importance.

Fifty-six parties headed by Geological Survey officers made geological and related topographical observations in various parts of the Dominion during the field season. These surveys are being directed particularly to mineral-bearing areas that have already attracted the attention of prospectors and others, and to areas of potential mineral interest. Results of field investigations are com-

piled as soon as possible and published in the form of maps and reports. Nine entirely new maps and fourteen reports on geological subjects were issued by the Geological Survey during the year. Reorganization of part of the work of this branch has resulted in the formation of a new division of Pleistocene geology, water supply, and borings, the need of which has in recent years become of increasing urgency. The survey of methods and apparatus employed in Canada in electrical prospecting operations was continued. Studies in anthropology and biology were carried on during the year by the National Museum of Canada.

Investigations in mineral technology, ore dressing and metallurgy, fuels and fuel testing, ceramics and road materials, and related subjects were continued by the Mines Branch. Technological methods and processes employed in the production, utilization, and marketing of minerals have for many years been carefully studied by this branch, and particular care is taken to keep operators and manufacturers informed of current developments and improvements in practice. Lower prices for mineral products have caused operators and manufacturers to give greater attention to these subjects, and the number of requests received for information and advice has increased accordingly. A considerably increased demand is observed for the reports of the Mines Branch, which contain fundamental technical data vital to the continued progress of the mineral industries. The number of publications sent out during the year exceeded that of the previous year by more than eleven thousand copies.

A new ore dressing and metallurgical laboratory building completed and taken over during the year affords greatly improved facilities for work in these fields, and enables the department to deal more effectively with the many problems surrounding the treatment of ores. Investigative work in these subjects increased 35 per cent in 1930-31 over the previous year. In the last six years the amount of this work has increased 262 per cent. In the new fuel research laboratories the installation of equipment is practically complete, with the exception of the briquetting and coal-cleaning installations. Routine and special investigational work, however, is proceeding in all sections, and progress is being made, in co-operation with Canadian coal and coking interests, towards the greater objective of these laboratories, the replacement by Canadian products of imported fuels. Colour control in the manufacture of brick and other problems of immediate importance to Canadian ceramic and clay-working industries were studied in the ceramic laboratories with promising results.

The more important investigations conducted by the department during the year are described in detail in the summary reports, special bulletins, maps, and memoirs published by the Geological Survey, the Mines Branch, and the National Museum. Continuing the practice followed in previous years much additional information of scientific, technical, and current interest was disseminated through the public and technical press, and by means of addresses by members of the staff. A selection of these papers and addresses is listed on pages 6 to 9. The winter series of lectures on natural resources and kindred topics, which for years has been a feature of the Museum educational activities in Ottawa, was continued in 1930-31. The fortnightly newsletter service inaugurated in 1923, covering current developments in the Canadian mining and metallurgical industries, was distributed through the High Commissioner's Office in London to a large list of newspapers and to mining, banking, and investment houses in the United Kingdom and on the Continent. The titles of the articles despatched during the year will be found following the list of papers and addresses mentioned above.

For their co-operation with the department during the year acknowledgment is due to many Dominion and provincial government departments, development branches of the Canadian Pacific and Canadian National rail-

ways, banks, chambers of commerce, and other organizations actively interested in the development of our natural resources. Close co-operation was also maintained with the Office of the High Commissioner in London, the Imperial Institute (London), the British Department of Scientific Research, the United States Bureau of Mines and Geological Survey, and with certain scientific and technical societies in the United States.

In addition to his departmental duties, the Deputy Minister served during the year as chairman of the Dominion Fuel Board, the principal activities of which are summarized below. He also served on the following official bodies: Council of the North West Territories; Advisory Committee on Mining Regulations; National Research Council and several of its associate committees; International Niagara Board; Turner Valley Waste Gas Committee; Bituminous Sands Administrative Committee; Canadian Committee of the World Power Conference; and Advisory Committee on Minerals of the Imperial Institute. As the representative of the Government of Canada the Deputy Minister attended the Third (Triennial) Empire Mining and Metallurgical Congress held in South Africa in March, April, and May, 1930. Before returning to Ottawa he led the Canadian delegation at the Third World Power Conference, Berlin, June 15-26, and attended the International Congress of Mines, Metallurgy, and Applied Geology, held in Liège, Belgium, June 22-28. In September the Deputy Minister proceeded with the Canadian delegation to the Imperial Conference at London, where he served as one of the Canadian representatives on the General Economic Committee, and in an advisory capacity to the Research Committee in its studies of recent developments in the use of geophysical prospecting methods, and of the proposed survey of the mineral resources of the Empire.

The continued buoyancy of the mining and metallurgical industries during the period covered by this report, considered in conjunction with the world tendency toward restricted operations and curtailment of production, indicates the growing stability and vigour of these industries and their ability to progress in the face of adverse economic conditions. The development of the mining industry in Canada has been steady and gradual, based largely on known resources and the ability of the market to absorb its output. Though all early estimates of the latter factor have been shattered by prevailing market conditions, the larger mining companies, by reason of the values in gold and other precious metals that enrich their ores, were able in the past year to produce record quantities of copper, lead, and zinc, notwithstanding the greatly reduced prices of these metals. Curtailment of production in these commodities may, therefore, be attributed to the exigencies of the trade, rather than to low price levels alone.

Production from base metal mines, the ores of which are not so enriched, fell off considerably, and in some cases it has been found necessary to discontinue mining and development operations until market conditions improve. A brighter picture, possibly the brightest in the entire industrial situation, is presented by the gold mining industry, the increased output of which offsets to some extent decreased activities in other lines of mineral production. For the year 1930 the total value of Canada's mineral output amounted to nearly \$280,000,000. This represents a decline of 10 per cent from the high record output of 1929, which was valued at nearly \$311,000,000. The decrease is attributed mainly to reduced activities in the mining of coal and other non-metallic minerals, the market for which depends to a large extent on local conditions. It is hoped, however, that measures adopted by the Government since the end of the fiscal year with respect to the transportation of coals to centres of consumption will aid materially in ameliorating existing conditions in the coal mining industry.

Compared with conditions under which the mining and metallurgical industries of most other countries are operating, the situation of the Canadian mining industry is good. Events of the past year have shown that base metal mining operations can be profitably carried on in Canada even in circumstances of unprecedented difficulty. In recent years the productive capacity of the Canadian mining industry has been extensively increased. Much has been done in the way of developing new deposits and increasing known ore reserves. Enormous sums have been invested in the erection of milling and metallurgical plants and in equipment for the treatment, smelting, and refining of mineral products. Although much exploratory and prospecting work has also been done, vast areas of potential mineral bearing lands remain unprospected. These various factors give the Canadian mining industry a distinctly favourable outlook, and place it in a position in which it will be able to take immediate advantage of any improvement in the general industrial situation.

Dominion Fuel Board

Eight meetings of the Dominion Fuel Board were held during the fiscal year. In addition, many sub-committee meetings were held to deal with the varied problems presented to the board.

The chairman attended various conferences at Montreal at which test movements of Canadian coal were discussed.

With the secretary he visited in August the new Ontario lignite field at Onakawana and saw at first hand the progress made in defining the area of the field. Market possibilities of the new field were also studied. Conferences were held in Ottawa during the year with operators from eastern and western Canada and with officials of the railroads to consider the possibility of extending the existing markets for Canadian fuels. Other conferences were held with a view to increasing the use of Canadian coals in the manufacture of coke in Canadian plants.

During the year the administrative work of the board has increased greatly. Order in Council of March 30, 1928 (P.C. 539), which deals with movements of Maritime Provinces coal to points in Quebec and Ontario, was in its third year of operation. The provisions relating to rail shipments inland of Maritime coal water-borne to St. Lawrence ports were administered by the board. During the fiscal year 601,855 tons of coal were accepted for movement. With respect to shipments wholly by rail under this Order in Council, the board reports the movement of 64,627 tons during the winter of 1929-30.

Four Orders in Council were passed during the year to provide assistance to the mines in the form of reduced freight charges on the shipment of western Canadian coals and briquettes to points in Manitoba where imported coals ordinarily can be sold at lower prices than Canadian coals. The administration of these Government measures was placed with the Dominion Fuel Board. From the summer of 1930, when these Orders in Council became effective, to the end of the fiscal year, the board accepted five hundred and thirty-one applications for the movement of 299,984 tons of coal and 7,791 tons of briquettes under the new terms.

Under all the Orders in Council the board granted five hundred and ninety-two acceptances during the fiscal year for the movement of 909,630 tons of fuel, involving \$452,095 in subventions. Actual movements were 457,191 tons, for which \$220,077.75 was paid in subventions.

The third seasonal movement of Alberta coal to Ontario under the test freight rate of \$6.75 a ton, authorized by P.C. 439 of March 16, 1928, amounted to 26,156 tons for the period December 1, 1929, to July 31, 1930.

The movement included in the twelve months covered by the fiscal year 1930-31 amounted to 19,104 tons. The board, in the year under review, assembled data to conduct a survey of the reports of Ontario dealers who handled the coal in order that full information might be obtained from them with regard to the prospects of developing a larger market in Ontario for this coal.

Administration of the Domestic Fuel Act (1927) included the final completion of an agreement with the Quebec Power Company and the inspection of the finished plant. A further application was received from the Nova Scotia Light and Power Company, Limited, with whom an agreement under the Act already exists, covering the second stage of construction of their by-product coking plant at Halifax. This application was accepted and arrangements were made by the board to carry out inspection of this addition to the works. Applications for the benefits of the Act were received from two other applicants, but in the opinion of the board the plants in question were not in the class of plants toward the construction of which assistance may be granted under the Act.

The Mineral Resources Division of the Department of Mines again conducted for the board the annual survey of fuels used for domestic heating. This survey now covers the Maritime Provinces, Quebec, Ontario, and Manitoba. It is proving of much value to the board and it is hoped that at an early date it may be possible to extend this survey to cover the other provinces.

During the year the staff of the board carried out a survey of industrial coal distribution in the area from the head of the Great Lakes to Saskatchewan. The secretary kept in close touch with the problems of the western operators through personal visits to the west.

Arrangements were made for a survey of fuel distribution in British Columbia under the auspices of the Provincial Government.

There has been a continued demand for the board's pamphlet on "Humidity in House Heating" and "Why You Should Insulate Your Home," many thousand copies being distributed. A further pamphlet on the subject of insulation is in course of preparation.

It is noteworthy that the number of inquiries for information continues to increase and that mine operators, trade and public organizations, and others look more and more to the board for such information as bears upon the economics of the fuel situation in the Dominion.

The board acknowledges with thanks the hearty co-operation shown by many Government Departments and by the coal interests and many public bodies and individuals throughout Canada.

Your obedient servant,

CHARLES CAMSELL,
Deputy Minister.

OTTAWA, ONT., September 25, 1931.

List of Papers and Addresses

NOTE: Lists of the papers prepared and addresses delivered during the year by members of the staffs of the Divisions of Anthropology and Biology are to be found in the Annual Report of the National Museum of Canada.

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(Distributed from the Office of the High Commissioner for Canada in London)

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- Fluorspar in Canada, by W. Malcolm.
- Gold Situation in Canada, by A. Buisson.
- Possibility of Revival of Phosphate Mining in Canada, by H. S. Spence.
- Field Research in Geology by Geophysical Methods, by W. Malcolm.
- Cadmium Situation in Canada, by A. Buisson.
- Field Work of Geological Survey, 1930, by W. H. Collins.
- Canadian Anhydrite and Its Possible Uses, by L. H. Cole.
- Valuable Service Rendered by Geological Survey, by W. Malcolm.
- The Nickel Situation in Canada, by A. Buisson.
- The Gold Prospects of Northern Manitoba, by J. F. Wright.
- The Oil-shale Situation in Canada, by A. A. Swinnerton.
- The Opemiska District, Quebec, by C. Tolman.
- Mining Note—Gypsum, by L. H. Cole.
- The Copper Situation in Canada, by A. Buisson.
- Oil Developments in Western Canada, by G. S. Hume.
- Mining Operations in Yukon Territory, by W. E. Cockfield.
- Diatomite, by V. L. Eardley-Wilmot.
- Lead and Zinc Situation in Canada, by A. Buisson.
- Field Work of the Geological Survey, 1930, by W. Malcolm.
- Gold Situation in Canada, by A. Buisson.
- Features of Great Slave Lake, by C. H. Stockwell.
- Whiting Substitute in Canada, by M. F. Goudge.
- West Coast of Hudson Bay, 1930, by L. J. Weeks.
- Petroleum and Natural Gas in Eastern Canada, by E. H. Wait.
- Prospects for Oil and Gas Production in Eastern Foothills of Alberta, by G. S. Hume.

GEOLOGICAL SURVEY

W. H. Collins, Director

CHANGES IN STAFF AND ORGANIZATION

The Geological Division of the Survey was strengthened during the year by the appointment of three assistant geologists: D. F. Kidd, on June 1, 1930; R. T. D. Wickenden and A. H. Lang on July 1, 1930; R. B. McConnell, who had been appointed on March 27, 1930, as assistant geologist, resigned on February 11, 1931.

With increasing density of population in southern Canada and corresponding increase in individual complexity the Pleistocene and Recent formations—those unconsolidated deposits of clay, sand, organic matter, etc., that overlie the glaciated bedrock formation of the country, which are popularly spoken of as soils—are assuming a growing importance. A large share of the materials required for our great program of road building comes from these deposits. They furnish much of the raw materials for manufacture of brick, tile, and other structural materials. They yield gold, platinum, and other metals from placer deposits, and fuel and other useful products from peat bogs. They are the basis of all agriculture, and are becoming more and more the subject of scientific survey and analyses from the agricultural standpoint. From these deposits is drawn much of the water supply needed for domestic and individual uses, and in places where population is dense, e.g., southwestern Ontario, or precipitation is scant, as in the southern parts of Alberta, Saskatchewan, and Manitoba, the amount and purity of the available supply are becoming of growing concern.

The Geological Survey has for many years paid more or less incidental attention to this branch of geology. The amount and importance of the work to be done has grown until it was finally decided in 1930 to establish a separate division for the investigation of Pleistocene geology and the closely related matters of underground water supply and borings. A nucleus for this division already existed in the Borings Division, which had been created in 1908 and placed in charge of Mr. E. D. Ingall. This division confined attention to the collection of samples and records of deep borings and to occasional investigations of water supply not distant from Ottawa. Investigation of placer deposits, peat bogs, and glacial geology continued to be a function of the Geological Division.

Important requests for the investigation of water supplies for Regina, Moose Jaw, and other places in the Great Plains region, as well as the steady increase of other problems in Pleistocene geology, led, in 1930, to the enlargement and transformation of the Borings Division. Mr. W. A. Johnston, who has for twenty-five years specialized in Pleistocene geology, was appointed acting head of this new division. R. T. D. Wickenden, before his recent appointment as Assistant Geologist, had specialized in the study of water supply and was assigned to the new division. Mr. D. C. Maddox, who had carried on the work of Mr. Ingall since retirement of the latter in 1929, remained in the division.

For lack of a shorter name that would accurately describe its functions the new division bears the appellation Pleistocene Geology, Water Supply, and Borings. Its main functions are: to collect and study samples and records of well borings and to provide information on this subject; to investigate and report upon underground water supply; to survey the Pleistocene and Recent formations throughout Canada in order to provide a good geological basis for agricultural surveys and other industrial purposes; to investigate the placer deposits, peat bogs, and other economic features of the Pleistocene and Recent formations.

EDUCATIONAL AND PUBLICITY WORK

Combination of the Division of Geological Information with the Director's office about two years ago has enabled more attention to be given to the educational possibilities of the great quantity and variety of scientific materials and information that the Geological Survey has accumulated in the course of its existence of ninety years. It can now afford the following services within the limits of its facilities:

(a) Photographs and Lantern Slides

A large collection of photographs of geological interest, including physiography, palaeontology, and mineralogy, has been accumulated during a period of over seventy years. Prints and lantern slides of these photographs are supplied at a nominal cost. No list of the photographs has been prepared yet, but selections are made by the staff of the Director's office to meet the requirements of individual applicants.

A fine collection of photographs of physiographic forms has been arranged and prints 10 inches by 12 inches are on file in the library. Prints, enlargements, and lantern slides are supplied to universities and high schools at a reasonable price. Sets of lantern slides of physiographic forms are also available for loan to high schools, one of the conditions of the loan being that the borrower pay express charges. The value of these slides in teaching physiography is evident by the demand for them.

(b) Collections of Minerals and Rocks

Three standard grades of collections of minerals and rocks are prepared by the Geological Survey for sale to high schools and universities. The collections are prepared by the Mineralogical Division and a report on the distribution of collections for the fiscal year ending March 31, 1931, is given in the report of the Mineralogical Division.

The chips resulting from trimming specimens for the special collections are used in preparing sets for the use of prospectors and for blow-pipe work in high schools and universities.

Individual specimens of certain minerals and rocks may also be obtained at prices depending upon the sizes of specimens required.

Copies of the price list of these collections and individual specimens may be obtained upon application to the Director.

(c) Motion Picture Films

The following motion picture films have been deposited with the Geological Survey for distribution in Canada in 1930 and 1931, through the courtesy of the United States Bureau of Mines: The Story of Sulphur; The Story of Gasoline; The Story of a Storage Battery; The Story of Heat Treatment of Steel; When a Man's a Miner; Through Oil Lands of Europe and Africa, Part 1; Through Oil Lands of Europe and Africa, Part 2; The Story of Dynamite; Twelve Points of Safety; Carbon Monoxide, the Unseen Danger.

The Ontario Motion Picture Bureau has also courteously deposited the following films with the Geological Survey for distribution in Canada outside Ontario: Graphite Mining; Gypsum Mining; Gold Production in Ontario; Prospecting for Gold; Gold Assaying; A Tale of Tale; Mining Nickel and Copper Ore; Refining Nickel; Harvesting the Earth's Crust (Trap); A Story of Stone (Dolomite).

The films are lent to mining and technical societies, boards of trade, service clubs, and educational institutions on condition that the borrower pay transportation charges and comply with other regulations governing the loan of the films.

These films depict mining processes, methods of treatment of minerals, the manufacture of mineral products, etc., and the numerous letters that have been received by the Geological Survey testifying to the educational value of the films and the consequent greater knowledge of mining in general indicate the fruitfulness of this undertaking.

(d) Relief Maps

The following relief maps, based on the study of map-areas by members of the staff, have been prepared by the Geological Survey for exhibition and study purposes:

Mount Albert Sheet, Quebec.
 Fort William and Port Arthur Sheet, Ontario.
 Mountain Park and Cadomin Sheets, Alberta.
 Blairmore Sheet, Alberta.
 Frank Landslide, Frank, Alberta.
 Turner Valley Map-area, Alberta.
 Fraser River Delta, B.C.
 Kokanee Glacier Park, B.C.

Models of these relief maps may be obtained by high schools and universities at reasonable prices, which vary with the costs of construction. The models are framed and are covered with glass to protect them.

A relief map model is one of the best aids in teaching geography and geology. Such a model is a reproduction, as near as scale will permit, of the actual surface lineaments of the earth or of its underground structure. The relation of culture to topography is shown, as well as the location of settled areas, the position of roads, railways, canals, and other artificial features. It also facilitates the study of engineering projects such as the location of dams, power plants, power lines, harbours, and numerous other industrial developments, as well as the study of drainage patterns, fault-line scarps, anticlines, synclines, dip slopes, cliffs, en échelon ridges, cuestas, and other physiographic features.

FIELD AND OFFICE WORK

The field work of the Geological Survey in 1930 was as diversified in character as usual, the number of field parties of all kinds being fifty-six. Each of the field operations in 1930 is referred to in the divisional reports that follow.

Reference was made in the annual report for 1927-28 to the work of putting into more convenient and systematic form the great volume of literature that the Geological Survey has published since its inception in 1842. On this work good progress is being made. The Economic Geology Series of reports on the commercially important minerals now consists of eight published reports and five others in various stages of preparation. Among these is a comprehensive report, in three parts, on gold in Canada. The regional geological maps, on a scale of 1 inch to 8 miles, have also increased to eight published sheets and five in course of preparation. The following reports in the Economic Geology Series have already been published:

- No. 1. "Geology and Economic Minerals of Canada," by G. A. Young.
- No. 2. "Talc Deposits of Canada," by M. E. Wilson.
- No. 3. "The Iron Ores of Canada—Volume I, British Columbia and Yukon," by G. A. Young and W. L. Uglow.
- No. 4. "Arsenic-bearing Deposits in Canada," by M. E. Hurst.
- No. 5. "Oil and Gas in Western Canada," by G. S. Hume.
- No. 6. "Fluorspar Deposits of Canada," by M. E. Wilson.
- No. 7. "Prospecting in Canada," by Officers of the Geological Survey, Ottawa.
- No. 8. "Zinc and Lead Deposits of Canada," by F. J. Alcock.

GEOLOGICAL DIVISION

G. A. Young, Chief Geologist, reports as follows:

Yukon

W. E. Cockfield reviewed mining developments and further investigated geological problems in Dawson, Mayo, and Whitehorse mineral areas. This was done in accordance with the plan, inaugurated last year, of presenting an annual review of mineral developments in Yukon. The review will appear in Summary Report 1930, Part A, and has been supplied, in advance of publication, to the Department of the Interior, which is charged with the administration of Yukon territory.

E. J. Lees, under supervision of W. E. Cockfield, continued topographical and geological mapping of Laberge quadrangle (latitude 61° to 62° , longitudes 134° to 136°), southern Yukon. This area lies along the eastern margin of the Coast Range batholith and, therefore, is geologically favourable for the occurrence of metalliferous deposits.

British Columbia

F. A. Kerr made a preliminary examination of mineral developments in Taku River area, where recent discoveries of sulphide deposits carrying values in zinc, copper, gold, and silver caused a considerable rush of prospectors. He also explored parts of the hitherto virtually unknown territory adjacent to the eastern margin of the Coast Range batholith between Taku and Stikine rivers. Reports on this work will appear in Summary Report 1930, Part A.

George Hanson continued the mapping and study of the geology and mineral resources of the Alice Arm section of Portland Canal mineral area. The geological work has been mainly confined to two map-areas bounded by latitudes $55^{\circ} 30'$ and $55^{\circ} 45'$ and longitudes 129° and 130° . Various complex types of mineral deposits bearing silver, lead, zinc, copper, or molybdenite are present. Field work was directed towards ascertaining the mode of origin of these deposits and their distribution in relation to the rock formations. A full report and a series of maps are in course of preparation.

H. C. Gunning continued the geological exploration, commenced in 1929, of the central and northern parts of Vancouver island. His work lay mainly in the country around Butte, Sproat, and Grand Central lakes where conditions are not unfavourable to the existence of mineral deposits and where a variety of discoveries have been made. An account of the work will appear in Summary Report 1930, Part A.

H. S. Bostock concluded geological mapping of four one-mile quadrangles in Hedley district, between latitudes 49° and $49^{\circ} 30'$ and longitudes $119^{\circ} 30'$ and $120^{\circ} 30'$. A full report and three one-mile map sheets are being prepared.

C. E. Cairnes continued the geological mapping of the Trinity quadrangle (latitudes $50^{\circ} 15'$ to $50^{\circ} 30'$, longitudes $118^{\circ} 30'$ to 119°). He also investigated mineral occurrences in the neighbourhood of Okanagan lake and made a detailed examination of Lightning Peak mineral area. Accounts of the various mineral deposits will be given in Summary Report 1930, Part A.

J. F. Walker made a geological survey of part of the valley of North Thompson river near Vavenby, for which urgent requests had been received from prospectors and others in the locality. A full report will appear in Summary Report 1930, Part A.

B. R. MacKay made a detailed geological investigation of the coal mining area at Corbin. A complete report on this work will appear in Summary Report 1930, Part A.

C. M. Sternberg collected vertebrate fossil remains for the National Museum in Peace River valley upstream from Hudson Hope. Several fairly complete skeletons of ancient reptiles and an unusually fine series of dinosaur tracks were obtained.

Alberta

G. S. Hume, working in the oil and gas region west of Calgary, completed the geological mapping of the Jumpingpound quadrangle (latitudes $51^{\circ} 15'$ to $51^{\circ} 30'$, longitudes $114^{\circ} 30'$ to 115°) and the Calgary southwest quadrangle (latitudes $50^{\circ} 45'$ to 51° , longitudes 114° to $114^{\circ} 30'$). A memoir dealing with the oil and gas possibilities of the southern foothills region is in course of preparation and a series of one-mile and half-mile geological sheets are in various stages of publication.

C. S. Evans geologically mapped the greater part of two quadrangles (latitudes 49° to $49^{\circ} 15'$, longitudes $111^{\circ} 30'$ to $112^{\circ} 30'$) in a region where oil and gas have been found on both sides of the International Boundary, and in which drilling exploration is being carried on for petroleum and natural gas. A report presenting the results of this work will appear in Summary Report 1930, Part B.

Saskatchewan

F. H. McLearn, assisted by L. S. Russell, continued the study and mapping of the geology of the southern part of the Regina 8-mile map-area (latitudes 49° to 52° , longitudes 102° to 109°). The work involves obtaining all available information regarding the mineral resources of the area, including the investigation of the significance of structures that might favour the accumulation of gas or oil. An account of some of the results obtained will appear in Summary Report 1930, Part B.

P. S. Warren, who co-operated with F. H. McLearn, concluded the study and mapping of the geology of the northern part of the Regina 8-mile map-area.

J. R. Marshall, with J. Satterly, completed the geological study and mapping of Pelican Narrows quadrangle (latitudes 55° to 56° , longitudes 102° to 104°). This area lies within the area of Precambrian rocks known as the Canadian Shield, to which so much attention is given by the mining public.

W. A. Johnston and R. T. D. Wickenden continued a systematic survey of the Pleistocene and Recent deposits (soils) in Regina 8-mile map-area (latitudes 49° to 52° , longitudes 102° to 109°). The purposes of this survey are to provide a good basis for agricultural soil surveys and for development of road materials, constructional materials, etc. In co-operation with the Dominion Department of Agriculture they surveyed the Pleistocene and Recent deposits in a block of about thirty townships in the southwestern part of Saskatchewan and neighbouring part of Alberta. They also investigated the underground water supply available for Moose Jaw. A full report upon the last-mentioned item will appear in the Summary Report 1930, Part B. Further field work is needed before reports on the other items can be made.

Manitoba

S. R. Kirk continued the study and mapping of the Winnipeg 8-mile map-area (latitudes 49° to 52° , longitudes 95° to 102°) with a view to obtaining all available information about the rock formations, structure, and mineral possibilities of the part of the map-area west of the edge of the Canadian Shield. Field work will be continued in 1931, following which a full report will be prepared and a geological map made of the solid rocks.

J. F. Wright examined mineral occurrences in The Pas region and explored geologically the territory intervening between the occurrences. Many mineral discoveries carrying values in gold, copper, lead, or zinc were investigated and will be fully reported upon in Summary Report 1930, Part B.

North West Territories

C. H. Stockwell continued a geographical and geological exploration of the eastern part of Great Slave lake. Attention was given principally to the 4-mile quadrangle between latitudes 62° and 63° , and longitudes 110° and 112° . The region is occupied by Precambrian rocks, the home elsewhere of important mineral deposits. Field work will be continued in 1931. A report and maps will not be prepared until field work has been further advanced.

L. J. Weeks and D. F. Kidd continued the geographical and geological exploration of a large area on the west coast of Hudson bay south of Rankin inlet. Two 4-mile quadrangles (latitudes 62° to 63° , longitudes 92° to 96°) are being mapped. Discoveries of gold and copper-nickel have been made within the district. Further field work is required before reports and maps can be prepared.

Ontario

T. L. Tanton completed the geographical and geological mapping of the Shebandowan quadrangle (latitudes $48^{\circ} 30'$ to $48^{\circ} 45'$, longitudes 90° to $90^{\circ} 30'$). Various types of mineral deposits occur within the map-area. Mr. Tanton also examined portions of Manitou map-area with a view to revising the geology in anticipation of the preparation of the Kenora 8-mile geological map. This map, which is one of a series of regional 8-mile sheets, will cover the country between the International Boundary and latitude 52° , and from longitude 90° west to Manitoba.

A. F. Matheson, under supervision by T. L. Tanton, continued geographical and geological mapping of the Michipicoten quadrangle (latitudes $47^{\circ} 45'$ to 48° , longitudes $84^{\circ} 30'$ to 85°). The map-area contains parts of a large area of "Keewatin" schists favourable for prospecting. Field work will be concluded in 1931.

H. M. Bannerman completed the geological and geographical survey of Rush Lake quadrangle (latitudes $47^{\circ} 45'$ to 48° , longitudes 82° to $82^{\circ} 30'$). This map-area is part of the Woman River district in which iron formations occur and discoveries of gold, lead, and zinc have been made. A final report and 1-mile geological sheet are being prepared.

W. H. Collins completed the geological mapping of Copper Cliff quadrangle (latitudes $46^{\circ} 15'$ to $46^{\circ} 30'$, longitudes 81° to $81^{\circ} 30'$). This is one of a series of four quadrangles that include the Sudbury copper-nickel mineral area. Field work will be continued in 1931.

T. T. Quirke completed the geological mapping of a quadrangle in Parry Sound district bounded by latitudes $45^{\circ} 15'$ and $45^{\circ} 30'$ and longitudes $79^{\circ} 30'$ and 80° . The map-area is part of a district containing a variety of non-metallic mineral deposits. It lies between the Huronian and Grenville geological sub-provinces and affords opportunities for correlating the geology of these two regions. Field work will be concluded in 1931, following which a final report will be prepared.

M. E. Wilson continued the geological mapping of the Perth quadrangle (latitudes $44^{\circ} 45'$ to 45° , longitudes 76° to $76^{\circ} 30'$). The area contains a variety of mineral deposits. This is part of an extended study of the geology of the Grenville geological sub-province in eastern Ontario, the results of which are being published in the form of Economic Geology Series reports, 1-mile geological sheets, and memoirs. Mr. Wilson also collaborated with L. Gilchrist and A. H. Miller in certain investigations of geophysical methods.

Miss A. E. Wilson commenced the geological mapping of the Ottawa quadrangle (latitudes $45^{\circ} 15'$ to $45^{\circ} 30'$, longitudes $75^{\circ} 30'$ to 76°).

Quebec

C. Tolman investigated discoveries of copper sulphides near Opemiska lake and geographically and geologically mapped part of the quadrangle (latitudes $49^{\circ} 45'$ to 50° , longitudes $74^{\circ} 30'$ to 75°) in which these discoveries lie. A report on the work of the season will appear in Summary Report 1930, Part C.

J. B. Mawdsley commenced geological mapping of the Chibougamau quadrangle (latitudes $49^{\circ} 45'$ to 50° , longitudes 74° to $74^{\circ} 30'$) in which mineral discoveries have been made. Further field work is required before a report and map can be prepared.

T. H. Clark completed the geological mapping of Sutton quadrangle (latitudes 45° to $45^{\circ} 15'$, longitudes $72^{\circ} 30'$ to 73°) and commenced similar work in Memphremagog quadrangle (latitudes 45° to $45^{\circ} 15'$, longitudes 72° to $72^{\circ} 30'$). This is part of an extended survey of the complex geology of southern Quebec. A series of three memoirs and three 1-mile geological maps are in course of preparation as the field work progresses.

H. C. Cooke commenced geological mapping of Thetford map-area (latitudes 46° to $46^{\circ} 15'$, longitudes 71° to $71^{\circ} 30'$). This map-area includes a large part of the asbestos and chromite-producing district, all of which it is planned to investigate closely. Some of the results obtained from the study in 1930 will be presented in Summary Report 1930, Part C.

E. Poitevin spent part of the season in Thetford Mines-Black Lake asbestos area in further study of the mineralogy of the serpentine-asbestos belt. His work was partly directed to a critical study of the chemical and physical properties of chromite, in co-operation with geophysical investigations by L. Gilchrist and A. H. Miller. (See below.)

G. W. Crickmay, under supervision of F. J. Alcock, concluded the study of the geology of that part of Matepedia valley lying within two quadrangles bounded by latitudes 48° and $48^{\circ} 30'$, and longitudes 67° and $67^{\circ} 30'$. The results of this investigation will be included in a memoir and series of maps by F. J. Alcock that deal with the region around Chaleur bay.

F. J. Alcock continued the geological mapping of that part of Quebec bordering the head of Chaleur bay. This investigation, which will be concluded in 1931, is mainly for the purpose of providing foundation for systematic mapping of New Brunswick and Gaspé.

A. Anrep examined a number of the larger peat bogs in southern Quebec that appear to be suitable for the manufacture of peat litter products.

C. H. Kindle, under supervision by E. M. Kindle, continued the geological mapping of the coastal part of Gaspé from Port Daniel to Percé. The work by Mr. Alcock, Mr. Kindle, and Mr. Crickmay is part of one larger study of Chaleur region, as explained above.

New Brunswick

F. J. Alcock continued the geological mapping of that part of New Brunswick bordering the head of Chaleur bay.

G. W. H. Norman commenced the geological mapping of Hillsborough quadrangle (latitudes $45^{\circ} 45'$ to 46° , longitudes $64^{\circ} 30'$ to 65°). The map-area includes important deposits of gypsum, oil-shale, and salt, and within it lies an important gas and oil field.

G. F. Flaherty, under supervision by Mr. Norman, commenced the geological mapping of the New Brunswick part of Chignecto quadrangle (latitudes $45^{\circ} 30'$ to $45^{\circ} 45'$, longitudes $64^{\circ} 30'$ to 65°).

Nova Scotia

W. A. Bell, assisted by E. A. Goranson, continued geological mapping of Sydney, Bras D'Or, and Glace Bay quadrangles within which lie the Sydney coal field and various mineral deposits.

E. R. Faribault continued geological mapping of the Sissiboo quadrangle (latitudes $44^{\circ} 15'$ to $44^{\circ} 30'$, longitudes $65^{\circ} 30'$ to 66°) and Church Point quadrangle (latitudes $44^{\circ} 15'$ to $44^{\circ} 30'$, longitudes 66° to $66^{\circ} 30'$). Mr. Faribault also investigated various recently made mineral discoveries in western Nova Scotia.

General

A. S. Eve and D. A. Keys continued the experimental investigation of electrical and magnetic geophysical methods of prospecting, in collaboration with a party under Dr. W. T. Lee of the United States Bureau of Mines. Part of the season was devoted to a study on the penetration of radio waves at the Mammoth cave, Kentucky, where unique natural conditions exist for experimentation. The latter half of the season was given to the application of electrical and magnetic methods of the Falconbridge nickel-copper mine, Sudbury, Ontario. Geophysical methods give promise of becoming an important accessory for discovery of mineral deposits in drift-covered areas and under other conditions where ordinary methods of prospecting are not applicable.

L. Gilchrist and A. H. Miller (Dominion Observatory) were also engaged in experimental application of other geophysical methods. Electrical, magnetic, and gravimetric (torsion balance) methods were used in locating portions of the Gloucester fault, near Ottawa, the Calabogie pyrite deposit, near Renfrew, and various problems in the asbestos-chromite field in southern Quebec.

Full reports on all the geophysical work have been prepared and will be published in a volume covering such work in 1930.

H. V. Ellsworth spent three weeks in the further study of radioactive and rare-element minerals in eastern Ontario. This is the conclusion of a systematic survey of these minerals throughout Canada. An Economic Geology Series report on the subject is about ready for publication.

TOPOGRAPHICAL DIVISION

W. H. Boyd, Chief Topographical Engineer, reports:

FIELD WORK

British Columbia

R. Bartlett mapped by photo-topography approximately 250 square miles of the Taku sheet, latitudes $58^{\circ} 30'$ to $39^{\circ} 00'$, longitudes $133^{\circ} 00'$ to $134^{\circ} 00'$. Map scale, 1 inch to 2 miles. Contour interval 250 feet. As a result of recent discoveries of sulphides carrying zinc, copper, gold, and silver this area is being actively prospected.

S. M. Steeves completed topographical mapping of the Salmo sheet, latitudes $49^{\circ} 00'$ to $49^{\circ} 15'$, longitudes $117^{\circ} 00'$ to $117^{\circ} 30'$. Map scale, 1 inch to 1 mile. Contour interval 100 feet. He also continued the topographical mapping of the east half of the Cranbrook sheet, latitudes $49^{\circ} 30'$ to $49^{\circ} 45'$, longitudes $115^{\circ} 30'$ to $116^{\circ} 00'$. Map scale, 1 inch to 1 mile. Contour interval 100 feet. Approximately 50 square miles of this sheet were completed during the season. Both areas were mapped by a combination of photo-topography and plane-table traverse methods.

Mining camps occur in both areas and the topographical maps are being prepared as a basis for geological and prospecting needs.

Alberta

W. H. Miller continued the topographical mapping of the Nordegg sheet, latitudes $52^{\circ} 15'$ to $52^{\circ} 30'$, longitudes $117^{\circ} 30'$ to $118^{\circ} 00'$. Map scale, 1 inch to 1 mile. Contour interval 100 feet. This sheet is being mapped by a combination of photo-topography and plane-table traverse methods. The area contains important coal fields.

J. W. Spence completed the topographical mapping of the Wildcat Hills sheet, latitudes $51^{\circ} 15'$ to $51^{\circ} 30'$, longitudes $114^{\circ} 30'$ to $115^{\circ} 00'$. Map scale, 1 inch to 1 mile. Contour interval 100 feet. This sheet has been mapped by the plane-table traverse method. The area is part of the same foothills region in which Turner Valley oil and gas field is situated.

J. A. Macdonald carried out by photo-topography and plane-table methods detailed topographical mapping of an area of 14.5 square miles that includes the coal mining area at Hillcrest. Map scale, 1 inch to 800 feet. Contour interval 25 feet.

A. C. T. Sheppard visited parties in British Columbia and Alberta for the purposes of inspection and advising on any matters relating to the work.

Ontario

A. G. Haultain established elevations throughout the Sudbury nickel basin as a basis for drawing controlled form lines on the base maps previously prepared for that area.

H. N. Spence carried on geographical surveys in Timagami area, latitudes $46^{\circ} 45'$ to $47^{\circ} 00'$, longitudes $79^{\circ} 30'$ to $80^{\circ} 00'$, and in Wanapitei area, latitudes $46^{\circ} 30'$ to $46^{\circ} 45'$, longitudes $80^{\circ} 30'$ to $81^{\circ} 00'$. Both map sheets are for publication at 1 inch to 1 mile, as a basis for geological work in these areas, which are of considerable interest to prospectors.

Quebec

J. V. Butterworth carried out control surveys for the detailed mapping of an area including the Thetford and Black Lake asbestos deposits. This area will be mapped on a scale of 1 inch to 800 feet.

A. C. Tuttle carried on geographical and geological control surveys in the Makamik sheet, latitudes $48^{\circ} 45'$ to $49^{\circ} 00'$, longitudes $78^{\circ} 30'$ to $79^{\circ} 00'$; the Desbouis sheet, latitudes $48^{\circ} 45'$ to $49^{\circ} 00'$, longitudes $78^{\circ} 00'$ to $78^{\circ} 30'$; and the Amos sheet, latitudes $48^{\circ} 30'$ to $48^{\circ} 45'$, longitudes $78^{\circ} 00'$ to $78^{\circ} 30'$. Map scale, 1 inch to 1 mile. These quadrangles are part of Rouyn mineral area.

New Brunswick

R. C. McDonald carried out the control surveys for that portion of the Chignecto sheet, latitude $45^{\circ} 30'$ to $45^{\circ} 45'$, longitudes $64^{\circ} 30'$ to $65^{\circ} 00'$, which lies in New Brunswick. He also carried out the control surveys for the St. Stephen sheet, latitudes $45^{\circ} 00'$ to $45^{\circ} 15'$, longitudes $67^{\circ} 00'$ to $67^{\circ} 30'$, and started the control surveys for the St. George sheet, latitudes $45^{\circ} 00'$ to $45^{\circ} 15'$, longitudes $66^{\circ} 30'$ to $67^{\circ} 00'$. The three sheets will show geographical features and will be on a scale of 1 inch to 1 mile.

J. V. Butterworth carried out the control surveys for the Campbellton sheet, latitudes $47^{\circ} 45'$ to $48^{\circ} 00'$, longitudes $66^{\circ} 30'$ to $67^{\circ} 00'$. Map scale, 1 inch to 1 mile.

The work in New Brunswick is part of a systematic topographical and geological survey of the province.

Nova Scotia

S. C. McLean carried out triangulation control for an area covering the Sydney and Glace Bay coal fields. This control and the detailed mapping that will be based on the control are part of a comprehensive investigation into these coal fields and their seaward extension. Map scales, 1 inch to 1,000 feet for a series of detailed sheets and 1 inch to $\frac{1}{2}$ mile for a general sheet covering the whole area.

K. G. Chipman was in charge of the mapping and other matters affecting the detailed mapping of the Sydney and Glace Bay coal fields.

OFFICE WORK

The control and computing section under S. C. McLean carried out all computing, adjusting, and checking for triangulation and traverse control in connexion with field work. This centralizing of the computations has proved of value in improving and speeding up the work of the division as well as in the standardization and availability of all control information.

D. A. Nichols continued his work in physiography and related subjects. Investigational work in the mapping of controlled form lines from vertical air photographs was carried on. Considerable progress was made in the preparation of a physiographic diagram of Canada, together with an improved grouping of the physiographic areas and their descriptions.

MINERALOGICAL DIVISION

Eugene Poitevin, Chief of the Division, reports:

The Division of Mineralogy has issued during the fiscal year 850 collections of minerals. To date the division has distributed more than 10,000,000 specimens of ores, minerals, and rocks to prospectors, mining syndicates, scientific institutions, and local and international expositions.

FIELD WORK

Eugene Poitevin spent about forty days in the field continuing his study of the mineralogical problems in Thetford Mines. He has also collected a large suite of chromite specimens, and assisted Professor Gilchrist and Mr. Miller in their geophysical studies in that camp.

H. V. Ellsworth spent three weeks in the field in the study of rare-element mineral occurrences in Parry Sound district and central Ontario, where he examined particularly uraninite occurrences.

LABORATORY WORK

The mineralogists of the division are called upon to identify and report upon a large number of minerals as to their commercial value, etc. At least five thousand specimens were examined and studied during the year.

E. Poitevin spent a considerable time in a detailed laboratory study of the chromite ores and their associated ultrabasic rocks.

H. V. Ellsworth made detailed investigations of various rare-element minerals, including uraninites from Parry Sound district and central Ontario and from southeastern Manitoba. He also made a large number of tests identifying rare-element minerals sent in by prospectors, and supplied information as to these occurrences. He also spent some time revising and bringing up to date an Economic Geology Series report on rare-element minerals.

During the year ended, R. J. C. Fabry, in addition to qualitative tests and routine chemical work, completed the analyses of the following rocks and minerals:

Five rocks of granitic type from Parry Sound district, submitted by T. T. Quirke.

The Dead Island syenite, the Dokis granite, the Bekanon batholith, the Dunlop porphyry, and a diorite from Beef Tea Creek outlet.

A massive ilmenite from Wolfe county, Que.

An altered pyroxene from Glasgow pit, Canadian Asbestos, Black lake, Que.

Knebellite from Bluebell mine, Kootenay lake, B.C.

Chromite from the Bennett-Martin claim, Ireland tp., Que.

Chromite from Caribou chrome pit, Que.

Stannite (partial) from Snowflake mine, Albert Canyon, B.C.

Three sea-oozes for E. M. Kindle, collected at the time of the Atlantic cable break off Newfoundland.

Test for vanadium in some boring samples.

MUSEUM WORK

During the year some of the exhibits in the National Museum have been improved and the collections have been increased by acquisition of some valuable specimens—mostly by exchange. A list of these is given in the Annual Report of the National Museum.

EDUCATIONAL COLLECTIONS

More than 36,000 mineral specimens have been distributed, during the year, as shown in the following table:

Province	Stand- ard	Grade 2	Grade 3	Grade 4	Special Grade 4	Mineral chips	Miscel- laneous	Prospectors	
								Minerals	Rocks
British Columbia.....	4	0	1	0	0	0	4	37	6
Alberta.....	0	0	0	0	0	0	0	11	2
Manitoba.....	2	0	1	0	0	0	2	5	0
Ontario.....	4	2	50	0	0	1	52	49	11
Quebec.....	2	0	3	50	500	1	9	13	7
New Brunswick.....	0	0	0	0	0	0	0	2	0
Nova Scotia.....	0	0	0	0	0	0	1	1	1
Foreign.....	0	0	0	0	0	0	10	3	3
	12	2	55	50	500	2	78	121	30

Total number distributed, 850 collections. The standard collection consists of 144 specimens of rocks and minerals in a good wooden cabinet, for which \$35 is charged. The Grade 2 collection is a smaller one of the same nature containing 48 specimens and costing \$12. Grade 3 collection comprises 40 specimens of rocks, minerals, and fossils, in a plain box, and is designed especially for the study of physiography and geology in the primary and secondary schools. Grade 4 collections are made up especially for the teaching of geology and mineralogy to prospectors, and vary in size and character. The 400 "Special Grade 4" collections mentioned in the table were prepared for the Quebec Department of Mines to their specifications.

PALÆONTOLOGICAL DIVISION

E. M. Kindle, Chief of Division, reports:

FIELD WORK

References to field work by F. H. McLearn and L. S. Russell, W. A. Bell, A. E. Wilson, C. H. Kindle, and C. M. Sternberg are given under the Geological Division.

OFFICE WORK

The division has supplied about the usual number of reports on fossils collected by members of the staff in the course of areal mapping in various parts of Canada. Reports on fossils have also been prepared for the Ontario Department of Mines and the Quebec Department of Mines.

E. M. Kindle has devoted a large share of his time to bringing together the data for a Bibliographic Index of North American Devonian fossils.

F. H. McLearn has continued his studies of Jurassic ammonites of Skidegate inlet and begun the study of Jurassic pelecypods from the same locality. His Jurassic studies of Skidegate inlet are now nearly completed. A preliminary study of some Lower Cretaceous ammonoids of Peace River district has been made and a report on field work in southern Saskatchewan prepared.

W. A. Bell has been occupied with the continuation of a report on the Pictou coal field. He has prepared reports on plant remains from Gaspé peninsula, Que., from the Pocahontas and Corbin coal areas, B.C., and from the Dunvegan formation, B.C.

A. E. Wilson continued work on the catalogue of type fossils, the Devonian section of which was completed. Considerable time was spent in reporting on the collections of Ordovician and Silurian fossils submitted by field officers. Work was begun on the report on the Palæozoic portion of the Thurso sheet.

L. S. Russell has prepared a card catalogue of the types of the Devonian fishes and identified collections of fishes from Campbellton, N.B., and Maguasha, Que. A report on fossil turtles was begun.

C. M. Sternberg has carried on preparator work on the dinosaur tracks from Peace river and continued other preparator work.

COLLECTIONS

Reference has been made in the Annual Report of the National Museum to collections received and to Museum exhibits.

PLEISTOCENE GEOLOGY, WATER SUPPLY, AND BORINGS
DIVISION

W. A. Johnston, Chief of the Division, reports:

The problem of obtaining adequate ground water supplies for cities, towns, and rural districts in the Prairie Provinces, in areas where surface water supplies are not available, has become of considerable importance during the past few years, for, owing to climatic and other conditions, large supplies of ground water are available in only a few places. In exceptionally dry years such as 1929 and 1930 there was a marked decrease in the supply of ground water and it is necessary to obtain supplies that will be sufficient during periods of drought in the future. Moreover, there are large areas in which it is difficult for farmers to obtain supplies of water, and if they are forced by soil drifting and by other factors to undertake mixed farming the problem of finding water for rural districts will also be of considerable importance. In order to meet the

demand for information regarding the possibility of obtaining ground water supplies in parts of southern Saskatchewan, a study was made in 1929 of the ground water resources of Regina and in 1930 of Moose Jaw and the surrounding districts. The report on the ground water resources of Regina by H. E. Simpson is published in *Summary Report 1929, Part B*, and of Moose Jaw by W. A. Johnston and R. T. D. Wickenden in *Summary Report 1930, Part B*. The main result of this work was to show that in the case of Regina additional supplies of water sufficient for a number of years can be obtained within 14 miles of the city, and that in the case of Moose Jaw, though the supply that can be obtained locally may be sufficient for only a few years, there is a large artesian basin about 45 miles northwest of the city from which large supplies of water can be obtained. In connexion with these ground water supply investigations the surface or Pleistocene deposits have been studied and mapped in sufficient detail to show the general character of the soils, occurrences of clays, sands, and gravels.

The work on ground water supplies and Pleistocene geology was combined in September, 1930, with that on borings, to form one division. Mr. R. T. D. Wickenden, a member of the division, has assisted in examination of well samples during the winter of 1930-31 and continued the work on foraminifera begun in 1928.

D. C. Maddox reports on borings samples received and examined, and office work, as follows:

During 1930 the work of the collection, examination, and storage of samples was continued.

The number of samples examined and reported on was 4,400, of these 256 came from New Brunswick, 44 from Quebec, 1,154 from Ontario, and 2,846 from the Prairie Provinces.

In addition to the routine work reports were made on the mechanical composition and heavy mineral content of five samples of Boissevain sandstone submitted by S. R. Kirk, and on seven samples dredged from the North Atlantic by one of the cable-laying ships, and submitted by E. M. Kindle. F. J. Fraser continued the work on samples of rocks collected in southern Saskatchewan by F. H. McLearn. About 200 such samples were examined, this work involving mechanical analysis and heavy mineral content. About 200 slides of heavy minerals obtained from well samples were made. Mr. Maddox spent some time in assisting A. E. Wilson in field work in Ottawa district, both in the examination of excavations and in the examination of areas of interest adjacent to some of the principal faults.

The chief items of interest in the individual provinces are given below:

Nova Scotia. A deep test for oil was drilled during the year near Scotsburn by the Imperial Oil Company. Samples covering depths of 1,920 feet were received. The well was abandoned at that depth and another one was started near Amherst.

New Brunswick. The New Brunswick Gas and Oilfields, Limited, was the only company drilling in the province for oil and gas. Logs and samples from two new wells and the deepening of four old wells were received.

Quebec. The only deep wells drilled in this area from which records were received were the Experimental Farm well at L'Assomption and a well drilled for water in Montreal. Renewed interest is being shown in the area between Montreal and Quebec city.

Ontario. In order to assist geologists who had done field work in Ottawa district in the determination of formation thicknesses, 671 samples available from twelve deep wells drilled in Carleton, Russell, Prescott, and Dundas counties were examined. Four hundred and eighty-three samples from three wells recently drilled for oil and gas in southwestern Ontario were also examined. Sixty-six samples from twenty shallow wells were examined.

Prairie Provinces. The interest shown in the oil and gas possibilities of this area in 1929 was continued during 1930. Turney valley was again the chief centre of operations, but the Red Coulee, Wainwright, and Ribstone fields also showed much activity, and numerous other tests were put down. The total number of samples received was 28,563, only 435 less than in 1929.

British Columbia. Drilling for oil and gas was continued in Sage Creek area and some other districts received attention, among them being Lulu island in Fraser Delta area, Cariboo area in which the Australian well was started, the town of Dorr, and Kelowna district.

The total number of samples received was 29,540, corresponding to a section about 56.7 miles long.

	Records	Samples
British Columbia, oil and gas.....	1	35
Alberta, oil and gas.....	173	28,208
Alberta, water.....	42	214
Saskatchewan, oil and gas.....	4	311
Saskatchewan, water.....	80	79
Manitoba, oil and gas.....	1	34
Manitoba, water.....	2	13
Ontario, oil and gas.....	256	162
Ontario, water.....	40	176
Quebec, water.....	1	76
New Brunswick, water.....	4	40
Nova Scotia, oil and gas.....	1	175
	349	29,540

For their valuable co-operation and for information supplied on well positions, drilling progress, analyses of water, oil and gas, well logs, etc., thanks are due to: Mr. C. C. Ross, Supervisory Mining Engineer, Department of the Interior; Colonel R. B. Harkness, Gas Commissioner for Ontario; Dr. J. A. L. Henderson, of the New Brunswick Gas and Oilfields Company, Moncton; Mr. John Bennett, of the Tulameen Coal Mines, Limited, Princeton, B.C.; Mr. John Ness, of the Imperial Oil Company; officials of the Provincial Health Departments; and many others.

DRAUGHTING AND REPRODUCING DIVISION

A. Dickison, Chief of the Draughting and Reproducing Division, reports:

Maps Published April 1, 1930, to March 31, 1931

Series A	Publication number	Title	Remarks
BRITISH COLUMBIA			
255A	2247	Quatsino-Nimpkish area, northern Vancouver island; scale, 1 inch to 2 miles.	Geology. For report by H. C. Gunning, Summary Report, part A, 1929.
256A	2248	Summit of Nickel Plate mountain (near Hedley), Similkameen district; scale, 1 inch to 500 feet.	Geology. For report by H. S. Bostock, Summary Report, part A, 1929.
—	2249	Figure 16. Isometric diagram of the underground workings of Nickel Plate mine (near Hedley).	Geology. For report by H. S. Bostock, Summary Report, part A, 1929.

Maps Published April 1, 1930, to March 31, 1931—Concluded

Series A	Publication number	Title	Remarks
ALBERTA			
257A	2252	Turner Valley sheet (west of fifth meridian); scale, 1 inch to 1 mile.	Geology.
258A	2253	Bragg Creek sheet, east half (west of fifth meridian); scale, 1 inch to 1 mile.	Geology.
ONTARIO			
238A	2204	Delamere sheet, Sudbury and Parry Sound districts; scale, 1 inch to 1 mile.	Geology. For memoir by T. T. Quirke.
QUEBEC			
242A	2212	Escuminac sheet, Bonaventure county; scale, 1 inch to 1 mile.	Geography.
NEW BRUNSWICK			
243A	2216	Hillsborough sheet, Albert and Westmorland counties; scale, 1 inch to 1 mile.	Topography.
NOVA SCOTIA			
241A	2211	Digby sheet, Digby and Annapolis counties; scale, 1 inch to 1 mile.	Geography.
253A	2228	Bridgetown sheet, Annapolis county; scale, 1 inch to 1 mile.	Geography.
OTHER WORK			
—	2232	Figure 2. Crest line of Horseshoe fall, 1927; scale, 1 : 2,000.	Topography. For memoir by W. H. Boyd.
—	2233	Figure 3. Crest line of American fall, 1927; scale, 1 : 2,000.	" "
—	2234	Figure 4. Diagrams illustrating Finsterwalder's method of plotting points.	" "
—	2235	Figure 5. Determination of ground plumb point, height of air station, and tilt; scale, 1 : 2,000.	" "
—	2236	Figure 6. Determination of ground plumb point, height of air station, and tilt; scale, 1 : 2,000.	" "
—	2237	Figure 7. Diagram showing photo plane projected vertically (plumb line projection) on to map plane.	" "
—	2238	Figure 8. Construction and proof of plumb line projection method of plotting points; scale, 1 : 2,000.	" "
—	2239	Figure 9. Diagram showing photo plane projected obliquely in the direction of tilt on to map plane.	" "
—	2240	Figure 10. Construction and proof of oblique projection method of plotting points; scale, 1 : 2,000.	" "
—	2241	Figure 11. Showing relation of vertically and obliquely projected photo triangles and points; scale, 1 : 2,000.	" "
—	2242	Figure 12. Crest line of Horseshoe fall, plotted by vertical and oblique projection methods; scale, 1 : 2,000.	" "
—	2243	Figure 13. Showing oblique projection method of plotting aerial photograph of lake shore; scale, 1 inch to $\frac{1}{2}$ mile.	" "

Maps in Hands of King's Printer, March 31, 1931

Series A	Publication number	Title	Remarks
		ALBERTA	
252A	2227	Jumpingpound sheet (west of fifth meridian); scale, 1 inch to 1 mile.	Topography.
		MANITOBA	
254A	2245	Winnipeg sheet; scale, 1 inch to 8 miles.....	Geology (surface deposits).
		NOVA SCOTIA	
260A	2256	Lake Ainslie sheet, Inverness county; scale, 1 inch to 1 mile.	Geography.
		GENERAL	
—	—	Canada and United States (with descriptonal chart); scale, 1 inch to 250 miles.	For National Museum use.

Other Map-Work in Varying Stages of Progress

	Title	Remarks
	CANADA	
1	Linguistic and tribal divisions of aborigines of Canada; scale, 1 inch to 197.3 miles.....	For National Museum.
	BRITISH COLUMBIA	
1	Corbin area, Kootenay district; scale, 1 inch to 1,000 feet.....	Geology. For report by B. R. MacKay, Summary Report, part A, 1930.
2	Slocan sheet, Kootenay district; scale, 1 inch to 1 mile..	Geology.
3	Sandon (Slocan and Ainsworth mining divisions), Kootenay district; scale, 1 inch to 4,000 feet.....	Geology.
4	Structure sections of the Slocan series; scale, 1 inch to 4,000 feet.....	Geology.
5	Stikine area, Cassiar district, 56° 30'-57° 00', 131° 00'-132° 00'; scale, 1 inch to 2 miles.....	Geology.
6	Stikine area, Cassiar district, 57° 00'-57° 30', 131° 00'-132° 00'; scale, 1 inch to 2 miles.....	Geology.
7	Stikine area, Cassiar district, 57° 30'-58° 00', 131° 00'-132° 00'; scale, 1 inch to 2 miles.....	Geology.
8	Topley sheet, Coast district; scale, 1 inch to 1 mile.....	Geology.
	ALBERTA	
1	Turner Valley sheet (southwest quarter), west of fifth meridian; scale, 1 inch to $\frac{1}{2}$ mile.....	Geology.
2	Turner Valley sheet (northwest quarter), west of fifth meridian; scale, 1 inch to $\frac{1}{2}$ mile.....	Geology.
3	Fish Creek sheet (southwest quarter), west of fifth meridian; scale, 1 inch to $\frac{1}{2}$ mile.....	Geology.
4	Bragg Creek sheet (southeast quarter), west of fifth meridian; scale, 1 inch to $\frac{1}{2}$ mile.....	Geology.
5	Bragg Creek sheet (northeast quarter), west of fifth meridian; scale, 1 inch to $\frac{1}{2}$ mile.....	Geology.
6	Cardinal River sheet (west of fifth meridian); scale, 1 inch to 1 mile.....	Geology.
7	Lovett sheet (west of fifth meridian); scale, 1 inch to 1 mile.....	Geology.
8	Thoreau Creek area (west of sixth meridian); scale, 1 inch to 1,000 feet.....	Geology.

Other Map-Work in Varying Stages of Progress—Concluded

	Title	Remarks
SASKATCHEWAN		
1	Regina sheet; scale, 1 inch to 8 miles.....	Geology.
MANITOBA		
1	Lac du Bonnet sheet (east of principal meridian); scale, 1 inch to 1 mile.....	Geology.
2	Oiseau sheet (east of principal meridian); scale, 1 inch to 1 mile.....	Geology.
3	Wadhope area (township 22, range 16), east of principal meridian; scale, 1 inch to 2,000 feet.....	Geology.
4	The Pas sheet; scale, 1 inch to 8 miles.....	Geology.
ONTARIO		
1	Thunder Bay silver area, Thunder Bay district; scale, 1 inch to 4 miles.....	Geology.
2	Espanola sheet, Sudbury district; scale, 1 inch to 1 mile.....	Geography.
3	Shebandowan sheet, Thunder Bay district; scale, 1 inch to 1 mile.....	Geology.
4	Kenora sheet; scale, 1 inch to 8 miles.....	Geology.
QUEBEC		
1	Rouyn-Harricana area, Abitibi and Témiscamingue counties; scale, 1 inch to 4 miles.....	Geology.
2	Duparquet sheet, Abitibi and Témiscamingue counties; scale, 1 inch to 1 mile.....	Geology.
NEW BRUNSWICK		
1	New Brunswick sheet; scale, 1 inch to 8 miles.....	Geology.
2	Moncton sheet, Westmorland and Albert counties; scale, 1 inch to 1 mile.....	Topography.
NOVA SCOTIA		
1	New Ross sheet, No. 86, Lunenburg, Hants, and Kings counties; scale, 1 inch to 1 mile.....	Geology.

In addition to the foregoing, two hundred and thirty-three map and other figure drawings were prepared for reproduction by zinc-cut process, for illustrating reports and memoirs of the Geological Survey and bulletins of the National Museum; other draughting and associated work necessary for staff and public use amounted to one hundred and eighty-five items. Duties in connexion with the Geographic Board of Canada were also attended to.

PHOTOGRAPHIC DIVISION

G. G. Clarke, Chief of the Division, reports:

The following work has been done in this division during the fiscal year:

Contact prints, 4 x 5 to 36 x 48.....	15,823
Bromide enlargements, 4 x 5 to 40 x 72.....	799
Exposures developed, 3½ x 4½ to 6½ x 8½.....	4,651
Dry plate negatives, 4 x 5 to 11 x 14.....	519
Wet plate negatives, 8 x 10 to 2½ x 30.....	180
Zinc plates, 11 x 14 to 24 x 36.....	19
Photostat copies, 7 x 11 to 11 x 14.....	185
Lantern slides, 3½ x 4.....	822
Photos and maps mounted.....	2,554
Total	25,552

GEOLOGICAL INFORMATION AND DISTRIBUTION DIVISION

Wyatt Malcolm, Chief of the Division, reports:

Articles were prepared during the year for publication in the British and Canadian press, and an article by P. J. Moran on Economic Geology of Canada, 1928, was published in the Canada Year Book. Numerous short articles were given to the daily press and scientific periodicals containing information regarding the publications issued from time to time by the Geological Survey and National Museum.

The publications of the Survey and Museum are distributed by this division. During the year 35,492 publications, exclusive of the French editions, were distributed. Of these 9,036 were sent to addresses on the regular mailing lists, and 26,456 were distributed in compliance with written and personal requests for named publications, or requests for general or specific information.

LIBRARY

Mrs. F. E. Forsey, Librarian, reports:

Additions to the Library during the year include:

Books purchased	657
Volumes received as gifts or exchanges.....	1,032
Pamphlets	498
Maps	503
Periodicals subscribed for	210
Periodicals and serial publications by gift and exchange (separate files)	540

Four hundred and ninety-nine volumes were bound and a considerable number of publications were encased in pamphlet binders.

During the year, 10,397 books, periodicals, and maps were loaned. An increase of 50 per cent is shown in inter-library loans.

The card catalogue was increased by 4,475 cards. Exchange relations were entered into with a considerable number of North American and foreign societies, institutions, and journals.

The installation of a new gallery on the north side of the Library provides for much-needed expansion and allows a re-organization of shelving space throughout the Library. The work of readjustment, which will take some months to complete, has already been undertaken.

Among notable acquisitions of the year were the following: Gandoger's *Flora Europa*, volumes 2-26, presented by M. O. Malte; *Conseil Permanent international pour l'exploration de la mer, Rapports et Procès Verbaux*, volumes 1, 2, 10, 11, 13, 14-16, 18-20, 1903-1914, by purchase, and volumes 41-65, 1927-1930, by exchange; *Linnean Society, Journal of the Proceedings, Botany*, volumes 17, 21, 22, 24-26, 29, 30, 33-40, 1878-1912; *Vienna Akademie der Wissenschaften, Denkschriften*, volumes 75, 82, 87-95, 98, 99, 1913-1924; Ledebour, C. F.: *Icones . . . plantarum florum Rossicam*, in five volumes, 1829-1834; *Svensk Botanisk Tidskrift*, volumes 1-23, 1907-1929; *Liverpool Marine Biology Committee, Memoirs*, volumes 1-29, 1899-1929; and a set of thirty-four Fascicules of Oeder's *Florae Danicae*.

BRITISH COLUMBIA OFFICE

W. E. Cockfield, Geologist in Charge, reports:

During the year 1930 the office was in charge of W. E. Cockfield, assisted by J. F. Walker, geologist, and A. J. C. Nettell, office engineer. During the year the office was visited by 3,645 people interested in mining and metallurgy; 325 inquiries were answered by mail and a large number by telephone; there were distributed 1,400 reports and 1,500 maps; a large number of rock and mineral specimens were examined and reported on. A number of lectures on subjects relating to geology and mining were given by the staff.

LIBRARY

Mrs. F. E. Forsey, Librarian, reports:

Additions to the library during the year include:

Books purchased	837
Volumes received as gifts or exchanges	1,002
Prints	428
Maps	403
Periodicals subscribed for	219
Periodicals and news publications (not subscribed for)	240

Four hundred and thirty-two volumes were bound and a considerable number of publications were received in duplicate. During the year 10,000 copies of periodicals and maps were distributed. The end of the year was marked by 1475 copies of "The Canadian Geologist" entered into with a considerable number of libraries and institutions. The installation of a new library building on the 11th floor for book-based operation and a new library building through the library. The library is now in a position to receive in duplicate all the publications of the Department of Mines. A number of new books were received from the international library exchange. The following list of books received during the year 1930 is given:

1. A. J. C. Nettell, "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

2. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

3. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

4. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

5. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

6. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

7. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

8. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

9. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

10. "The Geology of the Province of British Columbia," 1929, 17. 21 pp. 8vo. \$2.00.

NATIONAL MUSEUM OF CANADA

W. H. Collins, Acting Director

Satisfactory progress was made during the year 1930-31 in field, office, and exhibition work.

Anthropological investigations were carried on among the Indians living at Kitimat, British Columbia, around Lesser Slave lake, Alberta, in the vicinity of Abitibi lake, Quebec and Ontario, and on a number of Indian reserves in southern Ontario and Quebec. An archæological reconnaissance was made of Magdalen islands, and Indian village sites in New Brunswick and Ontario were excavated. Good progress was made in the preparation of reports on the results of these and earlier investigations. Valuable anthropological material was obtained for exhibition and study purposes. Some very fine new exhibits are being made in cases acquired a year ago and other exhibits are being re-arranged to advantage.

The Biological Division continued investigating the mammals of southeastern British Columbia and made collections of mammal material in Rocky Mountains and Jasper parks. Zoological work was carried on in Churchill area, northeastern Manitoba, and extensive collections, mainly of ornithological material, were made. The botanical survey of Wood Buffalo park, started in 1928, was completed, and a botanical survey of Nova Scotia was started to acquire material for a "Flora of the Maritime Provinces." Valuable additions were made to the herbarium and to the collections of zoological material. A number of very fine habitat groups were prepared and placed on exhibition.

For exhibition work along other than anthropological and biological lines the National Museum is greatly indebted to other government organizations, and the Acting Director here expresses his sincere appreciation of the time and energy so generously contributed during the year by members of the staff of the Geological Survey, and of the sympathetic co-operation of the Entomological Branch, Department of Agriculture. Accounts of the museum work in geology, mineralogy, and palæontology are given under these headings in the part of this volume that relates to the Geological Survey. The Acting Director is grateful also to other organizations and government departments for contributions of museum material, and would mention in particular the North West Territories Branch and the National Parks Branch, Department of the Interior, the Department of Indian Affairs, and the Hudson's Bay Company. He also wishes to express to many individuals and institutions, both Canadian and foreign, his most cordial appreciation for donations and exchanges and for assistance rendered in connexion with scientific investigations.

During the year the equipment of the exhibition halls was increased by five upright cases for the Palæontological hall, a large upright case for the Biological hall, a large wall case for a dinosaur mount, three table cases for geological and palæontological exhibits, and by a case specially designed to carry sixteen, small, standard, insect cases.

ANTHROPOLOGICAL DIVISION

D. Jenness, who had charge of the Anthropological Division during the greater part of the year, reports:

FIELD WORK

Five parties went to the field during the summer, as follows:

C. M. Barbeau spent from June to December in Ontario, Quebec, and New Brunswick studying the manual arts of the Indians on various reserves and the handicrafts of their French-Canadian neighbours who so greatly influenced them.

W. J. Wintemberg, in June, made an archaeological reconnaissance of the Magdalen islands, in the gulf of St. Lawrence, then excavated during the mid-summer months a pre-European Miemac site in eastern New Brunswick. Returning west, he excavated, during September and October, a pre-European Iroquoian site in southwestern Ontario. Both the New Brunswick and the Ontario sites yielded large numbers of interesting and valuable specimens which were transported to the National Museum for future study.

J. C. Boileau Grant, now Professor of Anatomy in the University of Toronto, continued his anthropometric survey and blood-grouping of the Canadian aborigines, examining this year the Indians and half-breeds around Lesser Slave lake. More than 200 individuals were examined.

I. A. Lopatin, of British Columbia University, made an ethnological study of the Kitimat Indians of Douglas channel, B.C., during the three midsummer months. He completed his report of this work in November.

J. T. MacPherson, of Toronto University, made a similar study, from early June to September, of the Indians on lake Abitibi, Quebec.

Harlan I. Smith, archæologist, was lent to the National Parks Branch of the Dominion Government to reorganize its museum at Banff. In the course of this work he began the labelling of nature walks within the Banff National park and made motion pictures of the animal life and of the Stoney Indians in the neighbourhood.

OFFICE WORK

Two reports from the division were published during the past year, viz., "Totem Poles of the Gitksan", by C. M. Barbeau, and "Anthropometry of the Chipewyan and Cree Indians of the Neighbourhood of Lake Athabaska", by J. C. Boileau Grant. Five reports were completed and submitted for publication, viz., "The Roebuck Village Site", by W. J. Wintemberg, "Anthropometry of the Beaver, Sekani, and Carrier Indians", by J. C. Boileau Grant; "Ethnology of the Great Bear Lake Indians", by C. B. Osgood; "Social Life and Religion of the Indians in Kitimat", by I. A. Lopatin; and "The Aborigines of Canada, Part I", by D. Jenness. Mr. Jenness has in hand the second part of "The Aborigines of Canada", for which he is assembling suitable illustrations. Mr. Barbeau has completed a report on "Tsimsyan Songs from Northern British Columbia"; Mr. Wintemberg has commenced the preparation of a report on his excavations at Lawson, in southwestern Ontario, and Mr. Smith is sorting and classifying the mass of information assembled in the archæological files.

Shortly before Christmas Mr. Jenness found that he could not continue to act as chief of the Anthropological Division and requested to be released from further administrative responsibilities. His reversion to ethnologist was, accordingly, effected in March.

The division provided several hundred anthropological specimens for an exhibit held in Montreal during August. It is estimated that half a million people viewed this exhibit. Several lesser loans were made.

Among the more prominent visitors who investigated some phase or other of the division's activities were Dr. Carl Guthe, Chairman of the Division of Anthropology and Psychology in the United States National Research Council, who came to examine the archaeological files; Dr. E. M. Box, of Toronto University, who received assistance in his study of dental diseases among the Eskimo; and Dr. C. H. M. Williams, of Toronto University, for whom some two hundred impressions in beeswax of Eskimo teeth were made.

MUSEUM WORK

Considerable progress was made during the year on the series of synoptic exhibits. Four of the large new cases have been permanently arranged, and temporary exhibits installed in the remainder. The archaeological series has been completely reorganized, and its former place in the west hall devoted to a number of exhibits specially designed to catch the public eye. Two large carved house-posts and their cross-beam, acquired in 1929, now render more striking and impressive the archway between the east and west halls; and the older labels are being gradually replaced by more legible labels in larger type. Mr. Leechman prepared for the Annual Report of the Museum a paper on "Technical Processes in the Preservation of Anthropological Museum Specimens" which should prove of value to private collectors and to workers in other museums.

Accessions to Museum

Ethnological..	223
Osteological..	2
Archæological..	9,648

The figures for the archaeological collections are approximate only. The most important accessions were two valuable wampum records of the Five Nations, an excellent collection of French archaeological material presented by the late Dr. H. M. Ami; and a very fine British Columbian grave monument secured through the co-operation of Dr. D. C. Scott, Deputy Superintendent-General of the Department of Indian Affairs.

BIOLOGICAL DIVISION

R. M. Anderson, Chief of the Division, reports:

FIELD WORK

R. M. Anderson attended the Twelfth Annual Meeting of the American Society of Mammalogists held at the American Museum of Natural History, New York, from May 21 to 24, 1930. He presented a paper on "The present Status of the Musk-ox" illustrated by slides and motion pictures. While at the American Museum of Natural History, he also examined a considerable number of specimens of Canadian mammals, particularly from British Columbia, comparing specimens brought from Ottawa.

For the summer, field work was planned and carried out in southwestern British Columbia, which aimed to bring to a conclusion the biological reconnaissance of the International Boundary region begun in 1927. H. M. Laing and I. McTaggart-Cowan were engaged on this work for part of the field season, some time being spent in co-operation with the Parks Branch, Department of the Interior, at Jasper and at Banff.

P. A. Taverner, ornithologist, conducted zoological investigations on the west coast of Hudson bay during the summer, assisted by B. C. Lloyd and Victor E. Gould. Considerable material was collected for both study and exhibition collections. Thanks are due to the Hudson's Bay Company and its officers and to the Department of Railways and Canals whose co-operation was of great assistance to the work.

Complete reports of field work done by the staff of the Biological Division are given in the Annual Report of the National Museum.

Clyde L. Patch, chief taxidermist and herpetologist, D. Blakely, taxidermist, Claude E. Johnson, artist, and Miss W. K. Bentley, museum assistant, did some field work in Ottawa district, collecting some local material to fill out the collections and obtaining accessories for habitat group work.

MUSEUM WORK

Progress has been made in collecting and preparing biological exhibits and installing them in the Museum halls, and a number of interesting new habitat groups have been finished.

Forty-six large mammal skins were tanned for the reserve series of the Museum, and 207 bird and small mammal skins were prepared for the study collections. A considerable amount of skeletal material of mammals and birds was cleaned and prepared. Two hundred and eighty-two mammals, birds, and amphibians were lent to educational institutions for use in art and nature study.

Considerable progress was made in the study and identification of the accumulated mammal collections, which this year reached the number of 11,125 catalogued specimens, an increase of 7,163 specimens of mammals since the end of 1920. At the end of 1912, the mammal collection numbered 1,804 specimens. In addition to the incoming accessions determined and catalogued, several consignments of specimens were identified for various Canadian institutions and collectors.

The Museum specialists are always glad to have the opportunity of examining such material from all parts of the country.

Mr. Taverner continued his studies in the bird collections, particularly the water birds, upland game birds, hawks, and owls. Mr. Patch attended to requests for information on reptiles and amphibians.

Dr. Arthur Gibson, Dominion Entomologist, supplied systematic collections of typical specimens of several important orders of insects, and a series of small life history and habitat groups of insects of economic importance in Canada.

PUBLICATIONS

R. M. Anderson continued work on a "Check List of Canadian Mammals," additional research having added about forty forms to the 1928 manuscript list, the number of recognized species and subspecies known in Canada being now given as 504. Parallel with this work, progress has been made on a more popular descriptive and illustrated book on the "Mammals of Canada," planned to appear ultimately as a museum bulletin in the Biological Series. The large number of specimens, together with extensive life history notes, which have been obtained by the field work of the past four years in British Columbia, are also being thoroughly studied as a basis of a systematic and distributional biological report on the mammals of southern British Columbia. He also continued work as general editor of scientific reports of the Canadian Arctic Expedition 1913-18, and some work was done at indexing volumes, but no new parts were issued during the current year.

C. L. Patch continued work on a manuscript report on "Reptiles and Amphibians" of Canada. C. E. Johnson has done the illustrations for this work.

Accessions

Accessions to the Zoological Collections:

Mammals received and catalogued.....	667
Birds received and catalogued.....	1,050
Amphibians and reptiles received and catalogued.....	129

The National Parks Branch, Department of the Interior, through the Commissioner, Mr. J. B. Harkin, has continued to send in many specimens of large game and predatory fur-bearing mammals from the various national parks. The Museum collection of skulls of large mammals in particular is frequently added to from animals which have to be killed or die from natural causes. The North West Territories and Yukon Branch of the Department of the Interior, through its Director, Mr. O. S. Finnie, has contributed many valuable specimens collected by its exploratory officers. The most important accession from the North West Territories Branch was the remainder of J. D. Soper's collection from Foxe basin, southwestern Baffin island, which he was unable to transport to the coast in time to ship out the previous year. Acknowledgment of valuable accessions from remote localities in northwest Canada is also due to Messrs. L. T. Burwash and A. E. Porsild of the same branch.

Two years ago, by arrangement with Mr. C. V. Sale, Governor of the Hudson's Bay Company, the Museum sent small outfits for collecting and preserving zoological material, to forty-five selected posts scattered through the north of Canada. These were distributed through the office of Chief Factor, Fur Trade Commissioner, and during the past year consignments were received from eight more posts (Fort Vermilion, Alberta; Fort Grahame, B.C.; Mistassini, Quebec; Woswonaby, Quebec; Chipewyan, Alberta; Davis inlet, Labrador; Simpson, Mackenzie district, and Fort Chimo, Quebec), totalling over 150 specimens of mammals, including many good skulls of the rarer, large, fur-bearing mammals.

NATIONAL HERBARIUM

M. O. Malte, Chief Botanist, attended the Fifth International Botanical Congress, held at Cambridge, England, August 16-23. He reports substantial progress in the matter of stabilizing international botanical nomenclature. Subcommittees representing most countries of the world were appointed to prepare amendments and additions to existing international botanical rules of nomenclature. While in Europe Mr. Malte visited the herbaria of the British Museum, the Kew Gardens, the Botanical Museum of Copenhagen, Denmark, and the Botanical Museums of Lund, Stockholm, and Upsala, Sweden, for the purpose of making investigations, mainly in connexion with the preparation of "The Flora of Arctic Canada."

H. M. Raup concluded a botanical survey of Wood Buffalo park, Alberta, begun in 1928. A full report, containing sections on exploratory history, topography and soils, geology and physiography, climate, a general description of the vegetation, and an annotated list of the flowering plants and ferns that are known to occur in the region, is under preparation.

Jacques Rousseau investigated the vegetation of Nova Scotia east of Halifax to collect data for a proposed "Flora of the Maritime Provinces." During the year Mr. Rousseau submitted a report on his botanical investigations in Matapedia valley, Quebec, carried out in 1929.

Botanical Accessions

Receipt of the following number of herbarium specimens is herewith gratefully acknowledged:

From Mr. E. A. Moxley.....	8
" Prof. M. Victorin.....	180
" Mr. H. M. Laing.....	183
" Dr. John Dearness.....	1
" Mr. H. Groh.....	1
" Mr. D. Leechman.....	1
" Provincial Museum, Victoria, B.C.....	2
" Dr. H. F. Lewis.....	1
" Mr. A. E. Porsild.....	9
" Mr. N. Criddle.....	7
Total	393

A total of 1,289 herbarium specimens were distributed.

MINES BRANCH

John McLeish, Director

The demand for information respecting Canada's mineral resources, and for investigational work respecting methods of treatment and of utilization continues to tax the available facilities of the Mines Branch in personnel and equipment.

The total number of employees at the end of March, 1931, was 197 (of whom 47 were temporary) and included: 68 administrative officers, engineers, and chemists; 13 technical clerks and draughtsmen; 27 clerks and stenographers; 24 laboratory assistants in several grades; and 65 mechanics, labourers, and messengers. During the summer months, the number of employees is increased through the temporary employment of a number of investigating engineers and student assistants in the laboratories.

The Mines Branch undertakes, through the Mineral Resources Division, the study of, and the collection of information regarding, the mining industry in all its phases, including: extent of resources; methods of mining; processes of recovering marketable products; the nature and character, chemical and physical, of the ores and minerals; intermediate and final market products; the uses to which products are put; prices; markets; marketing conditions; and other related economic facts.

In addition to the reports or monographs issued on the completion of investigations of industrial minerals, an annual review of the mineral industry is prepared covering, briefly, each metal and mineral product, and lists of mines, metallurgical plants, milling plants, etc., are kept up to date, and available in printed form.

Experimental test and research investigations, on both small and semi-commercial scales, are carried on in four main laboratory divisions. Studies and investigations are carried on respecting ore: ore dressing and metallurgy; the fuels, coal, peat, petroleum, gas, and oil-shales; clays, ceramic materials, refractory materials, structural materials, and the various rocks, sand, and gravels used for road building; all with a view to determining the character of products, testing products and processes, determining the most suitable processes to employ to secure results desired—whether in the production or in the utilization of mine products, the prevention of waste, or the protection of life.

In carrying out its investigations, the Mines Branch co-operates to the greatest possible extent with related organizations, provincial, federal, foreign, and private.

During the year, the Director, in addition to departmental administrative duties, served as a member of the Dominion Fuel Board; the Advisory Committee on Mining Regulations; Associate Committees of Natural Research Council on Helium, on Mining and Metallurgy, and on Coal Analysis and Classification; and the Government Advisory Committee on the Civil Service Superannuation Act. In September, he attended the annual western meeting of the Canadian Institute of Mining and Metallurgy at The Pas, Flinflon, and Sherridon; consulted with officials of the Mining Bureaus of the western provinces respecting the work of the Mines Branch; inspected the work of the Assay Office at Vancouver; and visited some of the principal mining centres in southern British Columbia.

The outstanding activities of the Mines Branch during the year are briefly outlined under its several divisions, as follows:

MINERAL RESOURCES DIVISION

Published reports completed by the division, and issued in printed form during the year, included: monographs on Artificial Abrasives, on the Gypsum Industry in Canada, on the Salt Industry in Canada, and a report on the Mining Laws of Canada. Information prepared and issued in mimeograph form included the Annual Review, "The Canadian Mineral Industry in 1930," comprising reviews on fifty-four subjects, and reports: "Notes on Beryllium and Beryl," "Waste Natural Gas in the Turner Valley." Twelve lists of Mines, Metallurgical Works, and Milling Plants were issued in printed form during the year.

The field investigations of technical officers of this division during the past season covered all sections of Canada except Yukon, and were extended into both the Pacific and Atlantic states of the United States. These investigations dealt with some eighteen different subjects, apart from studies of current progress in many phases of the Canadian mining industry; about nine special monographs or reports based on this field work are in process of preparation, in addition to a number of articles offered to the technical press for early publication.

The Chief of the Division, A. W. G. Wilson, devoted almost all year to the administrative duties of his office. Only a few days were spent in the field with other technical officers of the division; in September he made a trip through western Canada to the Pacific coast for the purpose of planning new work. About two weeks were devoted to a study of some practical problems having to do with the use of asbestos fibre for heat insulating purposes.

H. S. Spence continued his studies of the minerals of the pegmatite dykes that are the principal sources of feldspar in the provinces of Ontario and Quebec. Developments in the feldspar industry during the last year were studied, and most of the information required to complete the new edition of the report on feldspar is now in hand. Among the very rare minerals encountered during this investigation is an occurrence of thucholite and oil in a pegmatite dyke in Parry Sound district. The office work has included studies of the large amount of material collected during this and previous seasons' field work and a correlation of data on the occurrence of rare-element minerals throughout the world and a study of the use of such minerals or elements in industry. The study of the radium-bearing minerals from central Ontario and from Echo bay, Great Bear lake, also occupied a large part of Mr. Spence's time in the office. A bulletin on Possible Industrial Applications for Bentonite, including a review of recent patent literature, was issued during the year, and published in the annual report of this division.

L. H. Cole continued the study of anhydrite and anhydrite cements during the year, with the assistance of R. A. Rogers, of the Ore Dressing Division; the final report is in process of compilation. The principal problem undertaken by this officer was a survey of the industry engaged in the producing and working of granites and other related crystalline rocks, particular attention being paid to the technology of these building and ornamental stones and to current practices in quarrying, dressing, and utilizing these rocks. During the past season a preliminary survey was made of some of the more important producing localities in Ontario and Quebec.

S. C. Ells devoted most of the year to the construction of a new machine designed for preparing asphalt mixes for road surfacing. The machine is so constructed that it can be used either for preparing raw bituminous sands for road surfacing, or separated asphalts can be properly blended with additions and aggregates to produce various kinds of mixtures for road construction. After the machine was erected a few trial batches of asphalt mixes were

prepared and laid in Edmonton, chiefly for the purpose of discovering and correcting errors in design and construction. Under Mr. Ells' supervision, the Mines Branch quarry in the asphalt deposit on Clearwater river, near Waterways, Alberta, was in operation for nearly three months, supplying raw bituminous sands to the experimental separation plant erected near the quarry site by the Research Council of Alberta. In all, about 15,000 gallons of separated bitumen were produced at this plant during the past season. Most of this asphalt was used by the Highways Department of the province of Alberta in some experimental work on road surfacing.

M. F. Goudge continued his work on the systematic survey of the limestone resources of Canada. The general areal survey of the important occurrences of limestones in this country was completed in the previous year, and good progress has been made on the laboratory examinations of the very large assortment of samples that were collected during the two years. The field work of the past year was devoted principally to collecting further detailed information on the quarrying and fabrication of limestones and marbles for building and ornamental purposes. The possibility of producing whitening substitutes and rock wool in Canada is also being studied.

A. H. A. Robinson has been engaged upon the preparation of an exhaustive report on Lode Mining for Gold Ores in Canada. He also prepared a number of important articles for the technical press and special memoranda for the use of the executive staff.

V. L. Eardley-Wilmot was engaged in studying new developments in the diatomite industry, both in Canada and in the United States. A new edition of his report on diatomite is being prepared; many sections of the report will have to be re-written to bring the report up to date, so rapid have been the new developments in the utilization of this product. Current progress and new developments in the abrasive industries were also under investigation as opportunities offered.

Arthur Buisson, mineral technologist in charge of the Records Section of this division, spent about seven weeks visiting a number of the leading mining centres in northern Ontario, western Quebec, Manitoba, Alberta, and southern British Columbia. This work was in continuation of a practice initiated some years ago to procure for the records first-hand information about new developments and local conditions in the various districts of the country. Mr. Buisson has prepared for distribution to the press a number of short articles based on this field work. During the year a compendium of the various mining laws in operation in the provinces of Canada was compiled and issued under the title "Mining Laws of Canada." A survey of oil and chemical reagents used in milling plants in Canada was also made by correspondence, the data obtained being compiled in tabular form for office use.

C. H. Freeman has been engaged chiefly in a laboratory study of the large-scale samples of moulding sands secured during the previous season. In addition, a comparative study was made of fifteen samples of imported moulding sands, which are in general use by many foundries in eastern Canada. With the co-operation of the Ceramic Laboratories refractory tests on some of the native, and on some of the imported, moulding sands were made. During the summer seven additional samples of native sands from four new localities in Ontario were secured. The results of these examinations will be embodied in a report that is now in process of preparation for publication.

E. H. Wait was engaged in a study of current conditions in the natural gas and oil well industry in Ontario, Quebec, and New Brunswick. A short report on this work will be issued in the annual report of this division.

John Casey, statistician, conducted the fourth annual survey of fuels used for heating purposes in Canada during the year 1929. These surveys covered

the domestic fuel consumption in the Maritime Provinces, Quebec, Ontario, and Manitoba; bunkering coals consumed on the Atlantic coast, in the St. Lawrence basin, and in Manitoba; and the fuel oil consumption in all Canada. Though all the surveys were conducted by circular letters of inquiry, together with additional correspondence as required, it was found necessary to follow up written inquiries by personal visits to many distributors in the territory mentioned above. Statistical compilations on certain phases of the asbestos industry and other compilations required for use in current reports being issued by the Mines Branch were also carried out under Mr. Casey's direction.

ORE DRESSING AND METALLURGICAL DIVISION

W. B. Timm, Chief of the Division, reports about 35 per cent increase in the applications for investigative work on ore treatment as compared with the previous year. This increase was due to a greater demand from the mining industry for experimental test work. As this work is closely associated with the treatment of new ores from properties that have not reached the producing stage, as well as with improvements in ore treatment, the applications are steadily increasing.

The pyrometallurgical laboratory was equipped for investigations on iron and steel in order to provide the laboratory facilities for tests of iron ores and iron and steel products. It is hoped that similar assistance can be given to the iron and steel industry as is afforded the mineral industry in connexion with ore treatment.

Electric melting furnaces of the high-frequency induction and Herroult Arc type have been installed, as well as electric heat-treating furnaces and accessory equipment. The equipment includes a small cupola, metallizing furnace, roasting furnace, a briquetting machine, and a continuous Dwight and Lloyd sintering unit. Complete metallographic, physical, and mechanical testing equipment is also provided for the iron and steel investigations. Investigations were commenced on a study and examination of Canadian iron ores, having in view their utilization in Canadian industry.

During the year, a new ore dressing and metallurgical laboratory building was erected. This will provide much needed housing for the various laboratories, as well as office accommodation for the technical staff.

CO-OPERATIVE INVESTIGATIVE WORK

The co-operative arrangement with the Base Metal Extraction Company, Limited, is still existent. Due to the low price of base metals and the depression in the non-ferrous base metal industry, very little investigative work was carried on.

The Cassel Cyanide Company, a subsidiary of Canadian Industries, Limited, and the American Cyanamid Company, Niagara Falls, Ont., maintained each a research engineer in the laboratories, under Mines Branch supervision, each investigating the suitability of their various products, as compared with other similar products, for treating complex ores. These studies assisted materially the investigative work of the division.

Permission was granted the Ross-Playfair interests, of Montreal, to demonstrate on pilot-plant scale the Musso semi-direct steel process for the production of steel from iron ores. The demonstration plant of 4 to 6 tons capacity was installed by the Ross-Playfair interests, the Mines Branch making available their laboratory facilities and staff for its operation. Several tests made with the experimental plant failed to show the commercial value of the process in its present stage of development, the lack of success being due to the mechanical

inadequacies of the test plant. The work which has been carried out independently by the Mines Branch staff has indicated that sponge iron can be produced from iron ore and coal mixtures by the Musso method, provided the proper mechanical facilities can be worked out. Owing to disagreement between the Ross-Playfair interests and the inventor the investigation has been discontinued.

Advantage has been taken of the laboratory facilities by investigators from the industry and equipment firms to carry out tests in connexion with ore treatment problems.

These co-operative arrangements are evidence of the practical value of the service being rendered to the mining industry. With a limited staff it is not possible to take care of all requests for experimental test work. Co-operative work is invited and the use of the laboratory facilities is placed at the disposal of the mining industry.

FIELD STUDIES

The policy of allowing the officers to keep in contact with those engaged in the mining industry was continued. Laboratory investigations were followed up by assistance in operating plants.

W. B. Timm represented the Department of Mines at the Third (Triennial) Empire Mining and Metallurgical Congress, held in South Africa. On a congress tour through the Union and the Rhodesias, he visited the principal mining centres and gained much information on the mineral industry of British South Africa.

C. S. Parsons spent two months in the field. He followed up the laboratory investigations on Amulet copper-zinc ore by a visit to the Amulet concentrator. He also visited the Noranda concentrator and the Granada mill in Rouyn district, western Quebec. He spent about six weeks visiting concentrators, milling plants, and metallurgical works in British Columbia, Manitoba, and Ontario.

A. K. Anderson spent two months in northern Manitoba at the Flin Flon and Sherritt-Gordon mines. He investigated the ore treatment practice at the Flin Flon concentrator, and also visited the Sherritt-Gordon concentrator.

T. W. Hardy visited the iron and steel plants in southern Ontario, securing information regarding these industries and their problems in which the laboratory facilities of the Mines Branch could be of assistance.

LABORATORY INVESTIGATIONS

In the Ore Dressing Section for metallic ores, C. S. Parsons in charge, assisted by A. K. Anderson and J. S. Godard, conducted the following investigations:

Gold ore:

- (a) San Antonio mine, Bissett, Man.
- (b) Kirkland Lake gold mine, Kirkland lake, Ont.
- (c) Night Hawk Lake Mining Company, Night Hawk lake, Ont.
- (d) Casey Mountain Operating Syndicate, Summit lake, Ont.
- (e) Parkhill Gold Mines, Limited, Wawa, Ont.
- (f) English Brook area, Rice Lake district, Man.
- (g) Arrowhead Consolidated Mines, Joannes township, Rouyn, Que.
- (h) County Harbour mines, N.S.
- (i) Brookfield gold mines, N.S.
- (j) Tashota gold mines, Tashota, Ont.
- (k) Central Patricia gold mines, Savant lake, Ont.
- (l) O'Brien mine, Cadillac township, Amos, Que.
- (m) Beardmore gold mines, Jellicoe, Ont.
- (n) Argonaut mine, Larder lake, Ont.

Silver ore: Animikie Mines, Limited, Port Arthur, Ont.

Lead-zinc ore: Regal silver mines, Albert Canyon, B.C.

Lead-silver ore: Mallard Lake Gold Mines, Kirkland Lake, Ont.

Copper-nickel ore:

- (a) Denison copper mines, Worthington, Ont.
- (b) Sudbury offsets, Levack, Ont.
- (c) Falconbridge nickel mine, Garson, Ont.

Copper-zinc ore:

- (a) Amulet mine, Rouyn, Que.
- (b) Sherritt-Gordon mine, Sherridon, Man.

Copper-pyrite ore: Aldermac mine, Aldermac, Que.

Cobalt ore:

- (a) Aguanico cobalt mine, Cobalt, Ont.
- (b) Yorkshire cobalt mine, Cobalt, Ont.

Molybdenite ore: Dalhousie Mining Company, Alice Arm, B.C.

In the Ore Dressing Section for non-metallics, R. K. Carnochan in charge, assisted by R. A. Rogers, conducted the following investigations:

- (a) Lime from Howey gold mines, Red lake, Ont.
- (b) Mica from Blackburn Brothers, Ottawa, Ont.
- (c) Shale from St. Lawrence Brick Company, La Prairie, Que.
- (d) Gypsum from various Canadian occurrences.
- (e) Anhydrite from various Canadian occurrences.

In the Iron and Steel Section, T. W. Hardy in charge, assisted by R. J. Traill, W. R. McClelland, and W. S. Jenkins, conducted the following investigations:

- (a) Demonstration of the Musso semi-direct steel process.
- (b) Beneficiation and metallization tests on:
 - (1) Wabana hematite ore, Sydney, N.S.
 - (2) Bell hematite ore, Sault Ste. Marie, Ont.
 - (3) Helen siderite ore, Michipicoten, Ont.
 - (4) Pyrite sinter from Freeman flash roasting process, Three Rivers, Que.
- (c) Metallographic study of fractured exhaust valve for Aeronautical Division, Department of National Defence.
- (d) Examination of chilled shot, for cutting marble.
- (e) Examination of nickel cast iron.

H. C. Mabee, Chief Chemist, was in charge of the Chemical Section of the division.

FUELS AND FUEL TESTING DIVISION

B. F. Haanel, Chief of Division, reports a rapid increase in investigational and routine work. Since the completion of the installation of large-scale equipment, the staff of engineers and assistants has been continuously engaged on the carrying out of tests on British Columbia coals and northern Ontario lignite, to determine their value for steam raising when burned in the pulverized state, and in the case of British Columbia coals, for the manufacture of a domestic and metallurgical coke. As a result of the tests carried out in the coke oven on Michel coal, it has been demonstrated that this coal can be successfully used to replace the American coal now imported for the coke oven plant of the Winnipeg Electric Company. In all, ten commercial size samples of coal obtained from representative mines in British Columbia have been investigated in detail as to their value for steam raising in a pulverized fuel boiler and for coke manufacture in a high-temperature, by-product recovery coke oven.

A boiler equipped with special grates for burning lignite is now in course of erection for the purpose of ascertaining the value of such equipment for the burning of Ontario lignite. This equipment is temporary and will be removed when the investigation has been completed. At the conclusion of the coking tests on British Columbia coals, $3\frac{1}{2}$ tons of northern Ontario lignite was carbonized to provide carbonized material for the manufacture of briquettes.

Research work has been conducted in the small-scale pressure experimental hydrogenation laboratory on the bitumen recovered from Alberta tar sands and on natural gases.

The chemical and physical survey of the Phalen seam in Nova Scotia, as originally planned, has been completed. The peat manufacturing plant at Alfred, Ontario, was closed throughout the year. Permission, however, was granted for the shipment of a small quantity of peat humus and peat fines.

The technical staff of the division was changed considerably during the year. J. R. Kirkconnell was appointed as Engineer Grade II, G. P. Connell was transferred from the position of Assistant Chemist to Engineer Grade II, and the temporary Assistant Chemist position filled by R. J. Young was made permanent. T. E. Warren continued as special Research Engineer, and Professors E. A. Smith and G. B. Frost were employed as Research Engineers during the vacation period of their respective universities.

INVESTIGATIONS CONDUCTED BY THE CHIEF OF DIVISION AND TECHNICAL ENGINEERS

In addition to planning and directing the work of the division, Mr. Haanel attended the regular meetings of the Dominion Fuel Board, and the summer meeting of the Nova Scotia Advisory Board of Fuel Investigation in June. He held several conferences with officials of the Dominion Steel and Coal Corporation in regard to low-temperature carbonization, and also conferences with that company and the Montreal Coke and Manufacturing Company in connexion with the tests conducted in the plant of the Montreal Coke and Manufacturing Company on Nova Scotia coal. Mr. Haanel also had a meeting in Winnipeg with the Manager of the Gas Utility of the Winnipeg Electric Company, to make arrangements for the carrying out of a 1,000-ton test on Michel coal in the coke ovens of that company, and later spent two weeks in Winnipeg witnessing the test. Mr. Haanel also made a special trip to New York in April to inspect the marine coal pulverizing plant which had been erected by the Todd Shipyards Corporation at Brooklyn, New York. On this trip he also visited the Foster Wheeler Corporation to obtain information regarding the progress which they had made in the installation of their pulverized fuel equipment on a tug boat.

R. E. Gilmore, Superintendent of the Fuel Research Laboratories, reports increased activities in respect to both small and large-scale fuel testing investigations and research. As detailed below, the large-scale testing program comprised tests in the pulverized fuel fired boiler and the by-product coke oven installations. The Mashek roll briquetting press, a gasoline knock-testing engine, and a Pehrson rotary dryer with accessory oil burner and brick combustion chamber, constituted the new large-scale testing equipment installed. In addition to his regular supervising duties, Mr. Gilmore assisted in planning the work of the division and in the preparation of the annual "Investigations of Fuels and Fuel Testing." He paid special attention to the experimental work pertaining to the development of a new method for the laboratory assay of coals and other solid fuels for low-temperature carbonization, and also coal classification matters, in which connexion he attended meetings of both the American and Canadian coal classification committees held in Washington and Ottawa, respectively. His active interest in the work of the coals, oils and natural gas, and chemical laboratory sections, as well as the high-pressure hydrogenation laboratory, was continued.

E. S. Malloch and C. E. Baltzer, in addition to the regular routine duties of the Mechanical Engineering Section, conducted and made preliminary reports on a series of tests in the experimental pulverized fuel fired boiler installation on several Canadian coals. The objective of the tests was to obtain data concerning the use of these coals when burned in the pulverized state for the generation of steam and to correlate them one with another, as well as with a so-called "operating coal." A good grade of bituminous coal that will be available in large quantities over many years, and which can be universally accepted

as being a first class coal for this purpose, was chosen as the operating coal. A total of thirty-seven tests were made on eleven coals, of which ten were from British Columbia and one from Ontario. During the last quarter of the year, Mr. Baltzer was occupied with details in connexion with the installation of the Pehrson coal dryer, and of the proposed boiler unit which is to be installed for special steaming tests on northern Ontario lignite.

R. A. Strong, and E. J. Burrough, of the Carbonization Section, had charge of the 2-ton by-product coke oven installation during a series of tests on British Columbia and other coals. A total of ninety-four, twelve-hour test runs were made, the threefold purpose of which was: (1) to select a Canadian coal equal to or better than the imported coal now used in Winnipeg for the production of city gas and domestic coke; (2) to test blends of various British Columbia coals for the production of a coke suitable for metallurgical, as well as domestic fuel, purposes; (3) to indicate possible new blends for use in existing by-product coke ovens in northern British Columbia. Messrs. Strong and Burrough also witnessed and reported the results of the two series of tests on Canadian coals in commercial by-product coke ovens, comprised of the coking of 10,000 tons of Nova Scotia coal in the LaSalle plant of the Montreal Coke and Manufacturing Company, Montreal, during July and August, followed in December by a 1,000-ton test on Crownsnest Pass coal in the by-product coke ovens of the Winnipeg Electric Company. Mr. Strong made detailed plans for completing the large-scale experimental briquetting equipment, and Mr. Burrough paid special attention to the laboratory assay of coals and developed a scheme for their classification for use in the by-product coking industry.

A. A. Swinnerton and G. P. Connell continued work pertaining to the heat treatment and laboratory assay of oil-shales and bituminous sands. Mr. Swinnerton conducted further oil-shale sample-taking field work in Port Daniel area, Que., New Glasgow, N.S., and Moncton, N.B. Mr. Connell, in conjunction with the provincial mining inspectors, acted as Mines Branch sampler in respect to the taking of a series of samples from thirteen mines in southern Alberta for special coal classification work by the Research Council of Alberta, on which samples, namely, one from each mine, he also conducted low-temperature carbonization assay tests according to the new F-R-L method.

P. V. Rosewarne and H. McD. Chantler continued the field and laboratory work of the Oils and Natural Gas Section. Mr. Rosewarne conducted further examinations of natural gases from different parts of the country, and in particular from Turner Valley field, which gases were analysed for both hydrocarbon and helium content. The hearty co-operation of the officials of the office of the Supervisory Mining Engineer, Department of the Interior, and of the Institute of Technology, both in Calgary, as well as the co-operation of the operators in Turner Valley field, was gratefully accepted. Further naphtha and crude oil samples were obtained both from this and other fields, and analysed in Ottawa. In addition to attending to the laboratory examinations pertaining to the crude oil analysis survey work, Mr. Chantler paid considerable attention to a survey of the motor fuels and lubricating oils marketed in Alberta, as requested by the Committee on Inquiry into Fuel and Lubricating Oils of that province. Of special mention was a series of tests on lubricating oils in farm tractors, conducted in Government and other tractors in the neighbourhood of Ottawa. The annual gasoline survey was also continued.

J. H. H. Nicolls and C. B. Mohr were mostly occupied in the analytical work of the Solid Fuels Analyses Section: the former paid special attention to the recording and compiling of the results of examination of Canadian coals and other solid fuels, and the latter had immediate charge of the proximate analyses and calorific value work according to standard laboratory procedure. Mr. Nicolls continued his forms of sulphur and caking index studies, and prepared for the Canadian Coal Classification Committee a comprehensive arrangement,

according to area, of the coals of Canada. The compilation of the Analyses of Coals and Other Solid Fuels for inclusion in the annual Investigations of Fuels and Fuel Testing for the previous year was also made.

Research Engineers. Special research problems were investigated by three Research Engineers, viz: T. E. Warren throughout the whole year, and Professors E. A. Smith and G. B. Frost during their summer vacations. Dr. Warren paid special attention to the operation of the high-pressure hydrogenation equipment, in which he made a series of tests on Alberta bitumen for its direct conversion into motor fuels, on which tests a preliminary report, showing promising results, has been made. He also conducted some tests on the pyrolysis of high methane content natural gas from the Lanoraie (Quebec) field. Professors Smith and Frost were active with reference to co-operative research work on Canadian fuels between the Fuel Research Laboratories and their respective universities. Prof. Smith continued his low-temperature carbonization assay and peat alteration studies; Prof. Frost was engaged in some ash fusibility studies, with particular reference to Nova Scotia coals, which work was in addition to an investigation of the forms of sulphur in Turner Valley natural gas in relation to its corrosive action during refining.

Routine Chemical Laboratory Work. The routine chemical laboratory work was conducted in two sections as previously, namely, the Solid Fuels Analyses Section, and the Oils and Natural Gas Section.

R. J. Young, Assistant Chemist, was assigned particularly to gas analysis work pertaining to large-scale tests on coals in the pulverized fuel fired boiler and by-product coke oven. Mr. Young also conducted some special fusibility of ash tests on "Sydney" coal in admixture with imported by-product oven coals.

During the year a total of 1,957 samples of solid, liquid, and gaseous fuels were examined. Of these, 1,477, or approximately 75 per cent, pertained to investigations conducted within the division; the remaining 25 per cent originated outside the division. Of the total samples submitted from outside, 49 were from the Geological Survey, 91 from the Department of Pensions and National Health (formerly the Department of Soldiers' Civil Re-establishment), 127 from other Federal and Provincial Government departments; and 213 from public institutions, commercial firms, and private individuals. The following is a classification of the various kinds of fuels analysed:

Solid fuels: total samples examined		1,209
Coals (various kinds)	662	
Cokes and chars	348	
Peat and miscellaneous	199	
Liquid fuels: total samples examined		501
Gasoline and kerosene (motor fuels)	277	
Lubricating oils	195	
Crude oils	15	
Other petroleum, oils and miscellaneous	14	
Gases from coals, oil-shales, etc.		135
Oil-shales		42
Natural gas		70
Total		1,957

CERAMICS AND ROAD MATERIALS DIVISION

Howells Fr chet te, Chief of the Division, reports a year in which much progress has been made in research and investigational work. The advice of the members of the staff has been sought on a variety of technical matters connected with the ceramic resources, manufacturing problems, and the utilization of finished products. In three cases the consultation had to do with plants that had proved utter failures. Through lack of foresight, or lack of knowledge of

the raw materials available, they had been improperly designed and had failed to produce marketable ware. Advice was furnished as to the changes that should be made in order to correct the original faults and make successful operation possible. The division has also furnished other departments with information and advice on subjects concerning ceramics or road materials. Memoranda have been prepared in reply to many inquiries as to the Canadian resources of ceramic raw materials and industrial matters.

CERAMICS

The investigation conducted by L. P. Collin on the compounding of ceramic bodies for electrical heating devices has been completed. Bodies were developed that were found to possess certain necessary properties in a higher degree than any of the present commercial bodies with which they have been compared. The year's work on this investigation was devoted to increasing the strength in the unfired state and decreasing the shrinkage. The utilization of higher pressure in forming the shapes resulted in material improvement.

Mr. Collin also investigated colour development and colour control of brick. Experiments carried out in the laboratories and at an industrial plant in New Brunswick gave very satisfactory results in producing brick of colour and quality to compete with special high-grade face-brick now being imported. Experiments showed that a very good grey colour could be obtained with a clay occurring in Nova Scotia. Further work is under way to determine the possible economic use of this clay when mixed with clays of other localities for the production of grey brick. This is of particular importance in Ontario and Quebec, where there is a large importation of grey brick and where the local clays are unsuitable for its production.

Some preliminary work was carried out by Mr. Collin concerning the physical properties of Canadian brick.

J. F. McMahon completed a report on a laboratory study of clays and shales of Prince Edward Island for inclusion in a general report on the clay resources of that province, which is being prepared by Mr. Fréchette. The report covers the results of tests on the natural and the burned material of twenty representative samples. The results have been interpreted with reference to the suitability of the various materials for use in the manufacture of ceramic products.

Mr. McMahon has completed a study of some clays and shales of eastern Canada as to their suitability for the manufacture of roofing tile. A report on the subject is in course of preparation.

During the field season Mr. McMahon visited several clay plants located in the northeastern part of the United States, studying certain clay-winning practices not in vogue in Ontario or Quebec. The information obtained will be included in his report on the costs and methods of clay gathering in Ontario and Quebec.

Study of the Canadian refractory industry and raw materials has been continued by Mr. McMahon. A compilation of the available information is under way and preparations are being made for very full laboratory studies of refractory raw materials and products.

With a view to developing uses for waste dust and scrap from soapstone quarry operations, J. G. Phillips studied binders suitable for use in pressing soapstone powder into marketable shapes. Sodium silicate having been selected after preliminary tests as the most promising type of bonding agent, tests on the strength developed by various grades were made for the determination of the one most effective for the purpose. The conditions of processing to bring out the best results were also ascertained. Shapes were produced, having a transverse strength about equal to that of natural soapstone, using a reasonably low percentage of sodium silicate and a forming pressure within practical limits.

Various problems connected with the drying of brick and tile were studied by Mr. Phillips. Laboratory work in one case revealed that chemical treatment of the clay, similar to that devised for the Redcliff clays, would be effective in preventing the cracking of tile. It is understood that it will be given a trial in the plant at the opening of operations for 1931. In other cases recommendations were made for modifications in the drying practice or for changes in the plant equipment in order to overcome drying troubles.

During the year eighty-one samples of clays and shales, two samples of mineral pigment, one sample of feldspar, two samples of volcanic ash, and one sample of silica rock, all submitted by the general public, were tested and reported upon. In addition two hundred and seventy-five samples of clay from southern Saskatchewan, submitted by the Director of the Geological Survey, were tested for refractoriness. Determinations of strength were made on six samples of brick.

The research on the manufacture of high-grade refractories from Canadian magnesite continued throughout the year. This investigation is being conducted in co-operation with the National Research Council of Canada.

ROAD MATERIALS

In continuation of the work undertaken during 1929, R. H. Picher made a survey of the road gravel resources in that part of the province of Quebec lying south of St. Lawrence river and west of a line running from Levis to Waterloo. The survey consisted in investigating the character of the gravels and the approximate amount available in each deposit, sampling the more important deposits, and studying the wearing quality of the gravel where it is in actual service.

In addition to the testing of eighty-five samples gathered in the field, five samples from other sources were tested to determine their qualities as road material.

CHEMISTRY DIVISION

F. G. Wait, Chief of the Division, reports:

From April 1, 1930, to March 31, 1931, eleven hundred and eighty-seven specimens have been reported on.

The work of the different members of the chemical staff has been as follows:

H. A. Leverin made complete analyses of sixteen specimens of rock salt, and partial analyses of four other specimens, determining potash only, also partial analyses of some iron ores and of one supposed cassiterite. He spent several weeks in Europe investigating sponge iron processes and production in Germany and Sweden for the purpose of securing certain information required by officers of the Ore Dressing and Metallurgical Division who are engaged in a study of the application of these processes in Canada. He was also requested to secure such data as the limited time assigned would permit, on methods of manufacture and utilization of peat products other than fuel in Holland, Germany, and Sweden. His report on the first assignment was completed and that on the second still in course of preparation, at the end of the year.

E. A. Thompson made complete analyses of two limestones, four samples of hydrated lime, one rock specimen, one graphitic schist, one tantalite ore, two concentrates of Great Bear Lake uranium ore, two samples of Manitou Lake brine and of five waters. Two specimens were examined for mercury, one for titanium, one for manganese, one for zinc and lead, one for sulphur and copper. Fifteen samples of asbestos were examined for chlorine, fluorine, and iron. Dehydration curves were plotted on two samples of commercial asbestos.

Six specimens were analysed for vanadium, and also the methods of vanadium determinations were examined. He also made a large number of microscopic examinations and identifications of rocks and minerals, and of powdered coal and kaolin.

A. Sadler had charge of furnace assays. He made complete analyses of several uranium-bearing minerals. He tested thirty-five samples for radio-activity. He made partial analyses of eighty-two samples of silver-bearing ore. He investigated the commercial possibilities of the extraction of alumina from a mineral deposit located in British Columbia.

James Moran has reported on three hundred and fifty-two mine air samples from western Canada, including three important memoranda on special mining conditions in British Columbia. Investigation has been continued during the year on the efficiency of oxygen and carbon monoxide reagents with single gases and complex mixtures, using the specially designed apparatus. Another special apparatus designed for exhaustive gas analysis has not yet been set up. From January 28, he was detailed to assist the city and the Investigating Committee in their investigations of the causes of the Ottawa sewer explosion. To date, some seventy-five samples of gas and liquid have been subjected to exhaustive investigation, and eleven reports submitted thereon to the city and the Investigating Committee. Considerable independent research has been necessary to successfully carry on this work, and the investigation is still in progress. Miscellaneous work, such as mercury distillation, and recovery of the precious metals from the residues for the Ore Dressing Division indicate other lines of activity.

C. L. O'Brien during the past year made the following analyses:

- 407 limestones and dolomites for the Mineral Resources Division.
- 5 limestones for various individuals.
- 6 clays for the Ceramic Division.
- 24 diatomaceous earths for the Mineral Resources Division.
- 60 samples of mine air from western Canada coal mines.
- 1 kaolin and 1 volcanic ash for individuals.

S. R. M. Badger made partial analyses on limestone samples as follows:

- 623 for sulphur.
- 955 for iron.
- 470 for phosphorus.

DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.

G. N. Ford, Manager of the Dominion of Canada Assay Office, reports:

The net value of gold bullion deposited at the Assay Office for the calendar year ending December 31, 1930, was \$2,030,897.84, as compared with \$1,032,128.51 for the year 1929, an increase of \$998,769.33.

Deposits from British Columbia sources during the year amounted to \$1,278,657.35, showing an increase over the previous year of \$425,248.23, chiefly due to increased deposits from the following: the Consolidated Mining and Smelting Company of Canada, Limited, Trail; the Pioneer Gold Mines of B.C., Limited, in Lillooet mining division, and the Reno Gold Mines, Limited, in the Sheep Creek camp, Nelson mining division. There was also an increase in the production of placer gold in 1930 over the preceding year.

A comparison of the value of deposits from Yukon territory shows an increase for 1930 over 1929 of \$573,628.17, the figures being \$694,448.94 as against \$120,825.77. This increase is principally due to the marketing at this office last season of gold bullion from Dawson, Yukon territory, the bullion from this source having been during 1929 diverted to the United States, in order that the producers might benefit by the premium on United States funds then prevailing. Deposits from all other sources amounted to \$57,791.55 as compared with \$57,893.62 during 1929.

Renewed interest is being taken in gold mining in British Columbia and the Yukon and it is hoped that production will materially increase in the near future.

The purchase and disposal of the gold bullion deposits during the year 1929 required a total of 1,638 meltings and 1,638 assays, quadruplicate assays being made in each instance. This includes the melting into large bars of the smaller deposits after purchase and of the assaying of same before shipment.

The aggregate weight of all deposits before melting was 133,439.62 troy ounces and after melting 119,678.93 troy ounces, included in which were sixty-three deposits containing a large proportion of lead requiring to be cupelled. The total weight of these deposits before melting was 31,063.38 troy ounces and after melting and cupelling 18,865.94 troy ounces, showing a loss by melting and cupellation of 39.266 per cent. The average loss in melting all other bullion deposited, viz., 102,376.24 troy ounces before melting and 100,812.99 troy ounces after melting, was 1.527 per cent.

The loss in weight by assaying (base and parted silver) was 32.72 troy ounces, making the weight of bullion after melting and assaying 119,646.21 troy ounces, the average fineness of same being 0.821 gold and 0.128½ silver.

The net value of the gold and silver contained in deposits was \$2,030,897.84, and was received from the following sources:

Bars, nuggets, dust, and amalgam	Number of deposits	Before melting and assaying (troy ounces)	After melting and assaying (troy ounces)	Net value
				\$ cts.
British Columbia.....	538	83,903.22	71,157.44	1,278,657 35
Yukon territory.....	290	41,949.03	41,569.75	694,448 94
Dental and jewellery scrap.....	746	7,587.37	6,919.02	57,791 55
	1,574	133,439.62	119,646.21	2,030,897 84

DRAUGHTING DIVISION

H. E. Baine, Chief Draughtsman, reports:

The following work was performed by the Draughting Division during the fiscal year ending March 31, 1931.

Map showing the distribution of limestone suitable for agricultural purposes in southern Quebec; scale, 4 miles to 1 inch. Original and three copies were made and coloured for exhibition purposes.

Preparing coloured drawing in perspective of present Mines Branch buildings, Booth street.

Preparing coloured drawing in perspective of proposed general plan of expansion, Mines Branch, Booth street.

Preparing drawing of proposed Mechanical building, Booth street.

Preparing four drawings of Ore Testing Laboratory, Booth street.

Preparing three large plans showing buildings, etc., on Booth Street property, for the Director.

Four hundred and twenty-four page maps, drawings, charts, and flow-sheets were prepared during the year.

Two thousand one hundred and fourteen negatives and prints were made from the photostat machine.

Four hundred and sixty-six negatives, black and white and blue prints were made from the blue-print machine.

Two hundred and sixty-seven halftone and zinc blocks were sent out, received, and filed during the year.

DISTRIBUTION OF PUBLICATIONS

During the fiscal year ending March 31, 1931, the distribution of Mines Branch reports, bulletins, memorandum series, press bulletins, maps, list of mine operators, etc., amounted to 51,635 copies.

LIBRARY

Mrs. O. P. R. Ogilvie, Librarian, reports:

Accessions to the Library, 1930

Books (by purchase)	336
Books (by gift)	63
Books (by transfer from other Government libraries)	100
Books (complete unbound volumes)	307
Books added to the circulating division of the Library.....	136
Canadian Government documents (by exchange and gift)	1,775
British and Foreign Government documents (by exchange and gift)....	1,431
Scientific societies bulletins, proceedings, and transactions (by gift and exchange)	1,289
Trades catalogues (by gift)	384

Periodicals subscribed for, 224; periodicals and serials presented to the library, 379.

One hundred and ninety books have been bound during the year.

Special attention has been directed to extending the biographical reference files, Canadian, British, American, and foreign.

Notable progress has been made in the number of bibliographical subject-cards added to the catalogue.

DRAUGHTING DIVISION

H. E. Baine, Chief Draughtsman, reports:

The following work was performed by the Draughting Division during the fiscal year ending March 31, 1931.

Maps showing the distribution of limestone suitable for agricultural purposes in southern Quebec, scale 1 mile to 1 inch. Original and three copies were made and colored for exhibition purposes.

Tramway colored drawing in perspective of present Mines Branch building, Booth street.

Present colored drawing in perspective of proposed general plan of extension, Mines Branch, Booth street.

Proposed drawing of proposed Mechanical building, Booth street.

Proposed plan of extension of the Tramway, Booth street.

Proposed drawing showing building, etc., on Booth street, etc., for the tramway.

Plans, etc., and twenty-four page-manual drawings of shaft and hoistways were prepared during the year.

Two thousand one hundred and fourteen high-class and sixteen low-class line drawings were made.

Four thousand six hundred and sixty-six negatives, black and white, were made for the year.

EXPLOSIVES DIVISION

Lt.-Col. G. Ogilvie, Chief Inspector of Explosives

Factories

The factories under licence and in operation remained the same as in the previous year except that the factory of the T. W. Hand Firework Company, Limited, was moved from Hamilton to Dixie, Ontario, where that company took over, also, and operated, the plant of the Dominion Fireworks Manufacturing Company.

At the close of the year there were thus in operation eleven factories: three engaged in the manufacture of commercial high explosives (with also black powders and propellents); three fireworks factories, one producing small arm ammunition and detonators, and one each for safety fuse, fulminate of mercury, and toy pistol caps.

Inspectors of the division made thirty-six visits of inspection to the factories. The regulations and terms of licences were well observed in the explosives factories. In the fireworks factories, where the dangers are not always so obvious to the employees, demands, in some cases, for a closer supervision and higher standard of maintenance, met with adequate response from the management.

There are two accidents to record involving loss of life. One at the Beloeil factory of the Canadian Industries, Limited, on April 8, occurred when the mixer of the "Tally Mix" was being charged with nitroglycerine. The operator was killed instantly and another employee, outside the building, died from injuries received. This accident has been discussed in the annual report of the division for 1930. The other fatal accident occurred on March 23, 1931, at the Brownsburg factory of the Canadian Industries, Limited. The evidence showed that the victim had been occupied at the bench in the building in which the composition for detonators is mixed, but whether he was actually weighing the one-pound charges, transferring them to their dogskin bags, or, possibly having completed that operation, was wiping spilt grains from the bench, has not been definitely established. The design of the balance was such as to preclude the possibility of particles of composition reaching the working parts; static electricity was fully guarded against; and the probability is that by some inadvertent action the operator initiated explosion by friction. The procedure followed adhered closely to general and accepted practice, but, since the accident, a process has been evolved whereby the composition is weighed in a wet state, and the direct handling of dry composition is avoided.

At the same factory a foreman suffered the loss of an eye as a result of the explosion of a detonator in the conduct of a laboratory operation; another was slightly injured by explosion when testing detonators. Two sustained minor injuries: one from the explosion of two detonators in the capping operation, and the other, slightly burned about the hands, from the "flashing" of primers which he was shaking, behind a glass shield, on to a transfer plate.

Accidents not involving injury to personnel but considerable property loss, were an explosion in the black powder corning mill, which in turn caused an explosion in the glaze mill, at Beloeil, on February 10, 1931, and one in the corning mill of the factory at James Island, B.C., on February 18, 1931. These accidents afford further examples of the efficacy of the automatic arrangements introduced a few years ago for the operation of corning mills, so as to dispense with the presence of operators when the mill is actually running.

Magazines

There were 329 magazines under licence on March 31, 1930, and 224 licences were issued for temporary magazines during the year, showing an increase, in all, over the previous year, of 32.

Cases were reported of five magazines having been forcibly entered and explosives stolen to the amount of 750 pounds, of which 350 pounds were ultimately recovered. A few instances were also noted of unsuccessful attempts having been made. Approximately 1,500 pounds of explosives distributed over eleven magazines were found, on inspection, to be in unserviceable condition and destroyed.

Prosecutions

A contractor, holder of a temporary magazine licence, was convicted and fined for breach of the terms of licence, having been found, on inspection, to have failed to place the magazine at that distance from a railway which was specified in the licence. Five persons were convicted on charges of contravention of the regulations relating to the proper keeping of small quantities of explosives in detached stores or receptacles. Fines were imposed. A teamster was convicted and fined for violation of the regulations governing conveyance, he having left a truck containing explosives unattended in a public place.

Importations

Five hundred and fifty-five permits and 42 special permits for the importation of explosives were issued during the year. With the co-operation of the Department of National Revenue, the checking of consignments being imported is readily effected. In the case of Chinese fireworks, however, this work calls for constant vigilance on the part of customs officials even at points in the interior to which shipments are sometimes made in bond, and also entails considerable intercommunication between officers of the Royal Canadian Mounted Police commanding districts, in expediting the examination of samples at Vancouver and Ottawa and notification of results. The last report noted a very marked reduction in the rejections. This year, unfortunately, these have increased, although not to the amount formerly experienced.

In connexion with the importation of nitroglycerine to the oil fields in Alberta and Ontario, a very valuable service is rendered by the Royal Canadian Mounted Police, who at the points of entry, Coutts, Alberta, and Sombra, Ontario, inspect the trucks and arrange for the supervision of their routing, and of the conduct of persons in charge to delivery at point of use. In Alberta they act in co-operation also with the Petroleum Engineer of the Department of Interior, a deputy inspector of explosives.

Authorization of Explosives

Four new explosives were added to the authorized list and fifteen new varieties of fireworks. Applications in respect to nine other varieties were refused.

Accidents

A commentary on the accidents in the use of explosives is given in the annual report of the Explosives Division, together with a summary of the accidents arranged according to probable causes, and whether occurring in mines and quarries or elsewhere.

The outstanding accident of the year was the Brockville disaster by which thirty lives were lost and eleven men injured. In addition to this there was a loss of twenty-nine lives and fifty-two injured in accidents elsewhere than in mines and quarries during the year 1930, the corresponding figures for 1929 being thirty and sixty-one. The casualties due to explosives accidents in mines and

quarries, which were thirty killed and seventy-four injured in 1929, were, in 1930, eighteen killed and fifty-one injured. The difference between the losses in mines and elsewhere is the more striking when it is remembered that about 70 per cent of the consumption of explosives is in mines and quarries, and is indicative of the value of the regulation of operations in mines. It has also been observed that most of the other accidents recorded do not occur in the operations of the large consumers of explosives, but, more usually, in connexion with those of small work parties and private users.

Playing with detonators, and other explosives, accounted for three deaths and fifty-four persons injured, the figures for 1929 being two and fifty-one. Accidents of a miscellaneous character, not directly associated with the use of explosives, were responsible for one death and injury to sixteen persons. One man was injured in a mine while conveying explosives.

General

The inspections of magazines made by inspectors of the division have been supplemented by those made by deputy inspectors of the Royal Canadian Mounted Police, and in the case of the inspections of hardware and other stores where small quantities of explosives are kept, also where small arm ammunition is sold, the work of the police patrols predominates—by these about 2,400 visits being made during the year, and about 600 by inspectors. Only by the excellent service so rendered is it possible to reach these widely distributed stores. The effectiveness of the instruction and guidance given is observable on the visits made by inspectors and in but few cases, as recorded above, has it been necessary to have recourse to prosecution to enforce the regulations.

These patrols also give valuable aid in tracing small work parties, and in endeavouring to instil in all the importance of keeping explosives in safe custody. Notwithstanding this, small quantities of explosives, lost or neglected, are frequently found, and but seldom under circumstances that enable the owners to be identified with certainty. Such explosives, when found, are destroyed or put in safe keeping and endeavour made, whenever occasion offers, to caution children against playing with any explosives they may find.

EDITORIAL DIVISION

F. Nicolas, *Editor-in-Chief*

During the fiscal year thirty-five separate English publications were issued by the department, consisting of annual reports, memoirs, bulletins, and pamphlets; there were issued, also, twelve lists of mine operators and mines. Nine reports were published in French.

At the end of the fiscal year there were in the hands of the King's Printer five English reports of the Geological Survey, two English reports of the National Museum, five English reports and two French translations of the Mines Branch, and one English report and one French translation of the Explosives Division. Several reports, also, were being edited preparatory to dispatch for printing, and several French translations are now in course of preparation.

The following list includes the publications issued by the various branches of the department during the fiscal year, under the supervision of the Editor-in-Chief; and the French publications distributed¹ during that period:

DEPARTMENT OF MINES

English Publications

Report
No.

2260 *Report of the Department of Mines for the Fiscal Year ending March 31, 1930*: 61 pages; 3,000 copies; published March 4, 1931.

French Translations

2276 *Rapport du Ministère des Mines pour l'année financière se terminant au 31 mars, 1930*: 65 pages; 1,250 copies; published March 31, 1931.

GEOLOGICAL SURVEY

English Publications

List of Publications of the Geological Survey and the National Museum of Canada: 17 pages; 1,000 copies; published September 26, 1930.

2159 *Economic Geology Series No. 7. Prospecting in Canada*—by officers of the Geological Survey: 288 pages; 23 plates; 25 figures; 2,500 copies; published October 23, 1930.

2178 *Index to Palæontology (Geological Publications 1917-26)*—by F. J. Nicolas: 482 pages; 1,500 copies; published September 26, 1930.

2207 *Memoir 160. The Disappearance of the Huronian*—by W. H. Collins and T. T. Quirke: 129 pages; 7 plates; 4 figures; 2 maps; 2,000 copies; published May 7, 1930.

2209 *Memoir 161. Lardeau Map-area, B.C.*—by J. F. Walker, M. F. Bancroft, and H. C. Gunning: 142 pages; 8 plates; 7 figures; 1 map; 2,500 copies; published May 22, 1930.

2210 *Economic Geology Series No. 6. Fluorspar Deposits of Canada*—by M. E. Wilson: 97 pages; 4 plates; 14 figures; 2,500 copies; published April 12, 1930.

2218 *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1928, Part C*: 115 pages; 1 plate; 3 figures; 3,000 copies; published June 16, 1930.

2229 *Economic Geology Series No. 8. Zinc and Lead Deposits of Canada*—by F. J. Alcock: 406 pages; 8 plates; 34 figures; 1 map; 3,000 copies; published December 26, 1930.

¹The distribution of English publications was made as usual by the branches that prepared them.

- 2230 *Memoir 162. Peat Bogs in Southeastern Canada*—by Vaino Auer: 32 pages; 1 figure; 3 maps; 2,000 copies; published May 6, 1930.
- 2244 *Memoir 163. Geology of Southern Alberta and Southwestern Saskatchewan*—by M. Y. Williams and W. S. Dyer: 160 pages; 5 plates; 4 figures; 4,000 copies; published November 24, 1930.
- 2246 *Memoir 164. The Niagara Falls Survey of 1927*—by W. H. Boyd: 20 pages; 5 plates; 13 figures; 2,000 copies; published August 6, 1930.
- 2250 *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1929, Part C*: 50 pages; 1 figure; 3,000 copies; published November 13, 1930.
- 2251 *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1929, Part A*: 319 pages; 4 plates; 21 figures; 2 maps; 3,000 copies; published December 4, 1930.
- 2255 *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1929, Part B*: 202 pages; 9 figures; 3,000 copies; published February 20, 1931.
- Separate: *Highwood-Jumpingpound Anticline with Notes on Turner Valley, New Black Diamond, and Priddis Valley Structure, Alta.*—by G. S. Hume: 24 pages; 1,000 copies; published June 11, 1930.

French Translations

- 2257 *Rapport sommaire de la Commission géologique, Ministère des Mines, pour l'année civile 1928, Partie C (extraits)*: 74 pages; 1 plate; 2 figures; 1,250 copies; published March 31, 1931.
- 2258 *Rapport sommaire de la Commission géologique, Ministère des Mines, pour l'année civile 1929, Partie C (extraits)*: 17 pages; 1 figure; 1,250 copies; published March 11, 1931.

NATIONAL MUSEUM OF CANADA

English Publications

- Bulletin 60. Anthropological Series 11. *Sacred Stories of the Sweet Grass Cree*—by L. Bloomfield: 346 pages; 1,000 copies; published June 24, 1930.
- Bulletin 61. Anthropological Series 12. *Totem Poles of the Gitksan, Upper Skeena River, B.C.*—by Marius Barbeau: 275 pages; 33 plates; 1 figure; 1,500 copies; published June 19, 1930.
- Bulletin 63. Geological Series 51. *Contributions to Canadian Palæontology*: 112 pages; 23 plates; 8 figures; 1,000 copies; published April 17, 1930.
- Bulletin 64. Anthropological Series 14. *Anthropometry of the Chipeurwan and Cree Indians of the Neighbourhood of Lake Athabaska*—by J. C. Boileau Grant: 59 pages; 5 plates; 3 figures; 1,000 copies; published October 8, 1930.
- Bulletin 67. *Annual Report for 1929*: 158 pages; 17 plates; 2 figures; 2,500 copies; published March 31, 1931.

French Translations

- Bulletin 56. *Rapport annuel 1927 (extraits)*: 38 pages; 1,250 copies; published October 9, 1930.
- Bulletin 62. *Rapport annuel 1928 (extraits)*: 23 pages; 1,250 copies; published October 9, 1930.
- Bulletin 66. *Etudes floristiques sur la région de Matapédia, Québec; Notes sur la flore de Saint-Urbain, comté de Charlevoix, Québec*—by Jacques Rousseau: 30 pages; 2 plates; 3 figures; 2,000 copies; published March 31, 1931.
- Bulletin 67. *Rapport annuel 1929 (extraits)*: 29 pages; 1,250 copies; published March 31, 1931.

MINES BRANCH

English Publications

Report
No.

- 610 *Investigations of Mineral Resources and the Mining Industry, 1928*: 57 pages; 2 plates; 5 figures; 4,000 copies; published June 13, 1930.
- 624 *Catalogue of Mines Branch Publications*: 29 pages; 2,000 copies; published April 24, 1930.

- 699 *Abrasives, Part IV. Artificial Abrasives*—by V. L. Eardley-Wilmot: 144 pages; 19 plates; 14 figures; 4,000 copies; published April 3, 1930.
- 711 *Investigations in Ore Dressing and Metallurgy, 1928*: 166 pages; 8 figures; 4,000 copies; published June 23, 1930.
- 712 *Investigations of Fuels and Fuel Testing, 1928*: 71 pages; 2 plates; 4 figures; 4,000 copies; published October 28, 1930.
- 713 *Mining Laws of Canada* (Revised edition): 96 pages; 4,000 copies; published March 12, 1931.
- 714 *Gypsum Industry in Canada*—by L. H. Cole: 164 pages; 20 plates; 23 figures; 1 map; 4,000 copies; published September 19, 1930.
- 716 *The Salt Industry of Canada*—by L. H. Cole: 116 pages; 15 plates; 31 figures; 2 maps; 4,000 copies; published December 11, 1930.
- 719 *Investigations of Mineral Resources and the Mining Industry, 1929*: 69 pages; 5 plates; 7 figures; 4,000 copies; published March 19, 1931.
- Separate: *Bituminous Sands of Northern Alberta*—by S. C. Ells: 42 pages; 3 plates; 4 figures; 500 copies; published January 13, 1931.
- Gasoline Survey for 1929* (Advance Section of *Investigations in Fuels and Fuel Testing, 1929*): 22 pages; 2 plates; 1 figure; 500 copies; published March 13, 1931.

Lists of Mines and Mine Operators in Canada:

- Cement Mills: 500 copies; published April 15, 1930.
- Metallurgical Works: 1,000 copies; published June 9, 1930.
- Talc and Soapstone: 1,000 copies; published June 14, 1930.
- Milling Plants: 1,000 copies; published June 26, 1930.
- Natural Gas and Petroleum Wells: 1,500 copies; published July 26, 1930.
- Asbestos: 1,000 copies; published July 26, 1930.
- Silver-Lead-Zinc: 1,000 copies; published August 1, 1930.
- Copper, Copper-Lead-Zinc, etc.: 1,000 copies; published August 4, 1930.
- Lime Kilns: 1,000 copies; published August 4, 1930.
- Salt Wells and Mines: 1,000 copies; published August 7, 1930.
- Quartz (Silica) Mines: 1,000 copies; published August 11, 1930.
- Gold: 1,000 copies; published September 4, 1930.

French Translations

Report
No.

- 674 *Les Abrasifs, Partie I: Abrasifs siliceux*—by V. L. Eardley Wilmot: 128 pages; 14 plates; 8 figures; 1,250 copies; published March 31, 1931.

DOMINION FUEL BOARD

English Publications

- Pamphlet: *Fuels Distributed for Domestic Heating (1928)*: 12 pages; 15,000 copies; published April 30, 1930.

EXPLOSIVES DIVISION

English Publications

Report
No.

- 27 *Annual Report of the Explosives Division for the Calendar year 1929*: 16 pages; 2,000 copies; published June 13, 1930.
- Pamphlet: *Handling of Explosives* (Reprint): 12 pages; 5,000 copies, published March 16, 1931.

French Translations

- 28 *Rapport annuel de la Division des Explosifs pour l'année civile 1929*: 17 pages; 1,000 copies; published September 25, 1930.

ACCOUNTING DIVISION

ACCOUNTANT'S STATEMENT

E. A. Sawyer

The funds available for the work and the expenditure of the Department of Mines for the fiscal year ending March 31, 1931, were:

	Grant		Expenditure		Grant not used	
	\$	cts.	\$	cts.	\$	cts.
CIVIL GOVERNMENT—						
Salaries—						
Department.....	77,955	00	69,605	79	8,349	21
Mines Branch.....	242,215	00	212,774	84	29,440	16
Geological Survey.....	343,540	00	318,872	44	24,667	56
	663,710	00	601,253	07	62,456	93
Contingencies.....	12,000	00	11,831	55	168	45
DEPARTMENT—						
Explosives Division.....	12,000	00	10,058	79	1,941	21
MINES BRANCH—						
For investigation of mineral resources, etc.....	300,000	00				
Salaries and wages.....			159,425	09		
Ceramics and Road Materials Division.....			3,851	81		
Fuels and Fuel Testing Division.....			34,607	51		
Ore Dressing and Metallurgical Division.....			60,021	23		
Mineral Resources Division.....			22,942	40		
Dominion Fuel Board.....			16,621	40		
			297,469	44		
Less advances 1929-30 accounted for 1930-31.....			4,441	63		
			293,027	81	6,972	19
For publications, English and French, etc.....	50,000	00				
Salaries and wages.....			12,738	90		
Publication of reports, maps, etc.....			20,105	16		
Printing, stationery, typewriters, etc.....			6,600	55		
Library.....			4,129	34		
Chemical Division.....			2,778	78		
Miscellaneous.....			1,866	80		
Advertising.....			1,697	28		
			49,916	81	83	19
To compensate J. H. Fortune for quarters.....	400	00	400	00		
To provide for assistance in coking tests, etc.....	10,000	00	10,000	00		
For maintenance of peat plant at Alfred, Ont.....	2,450	00	2,357	44	92	56
DOMINION OF CANADA ASSAY OFFICE—						
For maintenance of Assay Office, Vancouver.....	25,000	00				
Salaries.....			20,146	94		
Assayers supplies.....			2,147	06		
Miscellaneous.....			765	72		
Typewriters, repairs, and stationery.....			590	92		
Premium on bonds.....			436	83		
Electric burglar alarm service.....			360	00		
			24,447	47		
Less assaying and refining platinum.....			31	00		
			24,416	47		
Add adjustments 1929-30—\$0.04 less 1930-31 \$0.02.....			0	02		
			24,416	49	583	51

ACCOUNTANT'S STATEMENT—Continued

	Grant		Expenditure		Grant not used	
	\$	cts.	\$	cts.	\$	cts.
GEOLOGICAL SURVEY—						
For explorations, surveys, and investigations, etc.....	230,000	00				
Explorations, surveys, and investigations.....			167,562	20		
Salaries and wages.....			33,372	56		
Equipment and supplies.....			15,301	16		
Miscellaneous.....			3,744	81		
Photographic work.....			943	77		
			220,924	50		
Adjustments—						
Less advanced L. J. Weeks 1929-30; accounted for 1930-31.....	\$1,381	30				
Add paid C. B. Osgood 1930-31; accounted for 1929-30.....	912	60	468	70		
			220,455	80		
For publication of English and French editions, etc.....	90,600	00			9,544	20
Printing reports, etc.....			48,588	68		
Salaries and wages.....			23,356	40		
Publication of maps, etc.....			18,647	24		
			90,592	32		7 68
For maintenance of offices and museum, etc.....	65,000	00				
Salaries and wages.....			27,610	33		
Stationery, printing, typewriters, etc.....			13,092	37		
Library.....			7,710	93		
Instruments and repairs.....			5,213	14		
Photographic Division.....			2,514	52		
Miscellaneous.....			2,381	91		
Mineralogical Division.....			2,012	37		
Advertising.....			1,697	27		
Lectures and motion pictures.....			1,188	47		
Postage.....			806	19		
Mechanical Division.....			219	32		
			64,446	87		553 13
For museum equipment.....	15,000	00				
New equipment.....			8,737	08		
Salaries and wages.....			5,490	10		
Maintenance.....			641	41		
			14,868	59		131 41
For purchase of specimens.....	3,000	00	2,583	08		416 92
MISCELLANEOUS—						
To provide for payments to railways, etc.....	551,985	41	513,662	49	38,322	92
Grant to Imperial Institute.....	12,849	00	12,848	00	1	00
Grant to Canadian Institute of Mining and Metallurgy..	3,000	00	3,000	00		
MISCELLANEOUS (Statutes)—						
Domestic Fuel Act (1927) payments.....			6,202	61		
Miscellaneous gratuities.....			1,585	60		

Summary

Civil Government salaries.....	663,710	00	601,253	07	62,456	93
Civil Government contingencies.....	12,000	00	11,831	55	168	45
Department.....	12,000	00	10,058	79	1,941	21
Mines Branch.....	362,850	00	355,702	06	7,147	94
Dominion of Canada Assay Office.....	25,000	00	24,416	49	583	51
Geological Survey.....	403,600	00	392,946	66	10,653	34
Miscellaneous.....	567,834	41	529,510	49	38,323	92
Miscellaneous (Statutes).....	7,788	21	7,788	21		
	2,054,782	62	1,933,507	32	121,275	30

INDEX

	PAGE		PAGE
Accidents due to explosives.....	49-51	Collins, W. H.....	10, 15, 29
Accounting division.....	56	Connell, G. P.....	41, 42
Addresses and papers published, list of.	6-9	Cooke, H. C.....	16
Alberta, borings.....	23	Crickmay, G. W.....	16
Field work.....	14, 18	Deputy Minister. <i>See</i> Camsell, Charles	
Alcock, F. J.....	16	Dickison, A.....	23
American Cyanamid Company.....	38	Director's report. <i>See</i> Camsell, Charles	
Ami, H. M.....	31	Collins, W. H.	
Anderson, A. K.....	39	McLeish, J.	
Anderson, R. M.....	31	Distribution division.....	27, 48
Anrep, A.....	16	Dominion Fuel Board.....	4, 5
Anthracite. <i>See</i> Dominion Fuel Board		Draughting division	
Anthropological division.....	30	Geological Survey.....	23-26
Archæology.....	30	Mines Branch.....	47
Assay office, Vancouver, B.C.....	46, 56	Eardley-Wilmot, V. L.....	37
Badger, S. R. M.....	46	Economic Geology Series.....	12
Baine, H. E.....	47	Editorial division.....	52
Baltzer, C. E.....	41	Educational work.....	11, 12, 20
Bannerman, H. M.....	15	Ells, S. C.....	36
Barbeau, C. M.....	30	Ellsworth, H. V.....	17, 19
Bartlett, R.....	17	Ethnology.....	30
Base Metal Extraction Company.....	38	Evans, C. S.....	14
Bell, W. A.....	17, 21	Eve, A. S.....	17
Bennett, John.....	23	Expenditure. <i>See</i> Accounting division	
Bentley, W. K.....	32	Explosives division.....	49
Biological division.....	31	Fabry, R. J. C.....	20
Bitumen plant, near Waterways, Alta..	37	Faribault, E. R.....	17
Blakely, D.....	32	Field work.....	1, 12
Borings division. <i>See</i> Pleistocene		Archæology.....	30
Geology		Biology.....	31
Bostock, H. S.....	13	Ceramics.....	44
Boyd, W. H.....	17	Ethnology.....	30
Box, E. M.....	31	Geology.....	13-17
British Columbia, borings.....	23	Mineralogy.....	19
Field work.....	13, 17	Mines Branch.....	36, 39
Gold.....	46, 47	Palæontology.....	21
Office.....	28	Topography.....	17-19
Buisson, Arthur.....	37	Finnie, O. S.....	33
Burrough, E. J.....	42	Flaherty, G. F.....	16
Burwash, L. T.....	33	Ford, G. N.....	46
Butterworth, J. V.....	18	Forsey, Mrs. F. E.....	27
Cairnes, C. E.....	13	Fossils. <i>See</i> Palæontological division	
Camsell, Charles.....	1-5	Fraser, F. J.....	22
Canada, mineral production.....	3	Fréchette, H.....	43
Carnochan, R. K.....	40	Freeman, C. H.....	37
Casey, J. M.....	37	French publications.....	52, 55
Cassel Cyanide Company.....	38	Frost, G. B.....	41, 43
Ceramics division.....	43	Fuel Board. <i>See</i> Dominion Fuel Board	
Chantler, H. McD.....	42	Fuel Testing division.....	40
Chemistry division.....	45	Gas, natural. <i>See</i> Pleistocene Geology	
Chipman, K. G.....	19	division	
Clark, T. H.....	16	Geological division.....	13
Clarke, G. G.....	26	Geological Information and Distribution	
Clay. <i>See</i> Ceramics		division.....	27
Coal. <i>See</i> Dominion Fuel Board		Geological Survey, accounts.....	56-58
Cockfield, W. E.....	13, 28	Reports.....	10-28
Cole, L. H.....	36		
Collin, L. P.....	44		

	PAGE		PAGE
Gibson, Arthur.....	32	Mawdsley, J. B.....	16
Gilchrist, L.....	17	Miller, A. H.....	17
Gilmore, R. E.....	41	Miller, W. H.....	18
Godard, J. S.....	39	Mineral collections.....	11, 20
Goranson, E. A.....	17	Mineralogical division.....	19
Goudge, M. F.....	37	Mineral Resources division.....	36
Gould, Victor E.....	32	Mines Branch, accounts.....	56
Grant, J. C. Boileau.....	30	Bitumen plant near Waterways, Alta.	37
Gunning, H. C.....	13	Reports.....	35-46
Guthe, Carl.....	31	demands for.....	2
Haanel, B. F.....	40	Mohr, C. B.....	42
Hanson, G.....	13	Moose Jaw, Sask., water supply.....	22
Hardy, T. W.....	39	Moran, J.....	46
Harkin, J. B.....	33	Motion Picture films.....	11
Harkness, R. B.....	23	Musso steel process.....	38
Haultain, A. G.....	18	National Museum of Canada.....	29-34
Henderson, J. A. L.....	23	Ness, John.....	23
Hudson's Bay Company.....	33	Nettell, A. J. C.....	28
Hume, G. S.....	14	New Brunswick, borings.....	22, 23
Indians. <i>See</i> Anthropological division		Field work.....	16, 18
Jenkins, W. S.....	40	Nichols, D. A.....	19
Jenness, D.....	30	Nicolas, F.....	52
Johnson, Claude E.....	32, 33	Nicolls, J. H. H.....	42
Johnston, W. A.....	10, 14, 21	Norman, G. W. H.....	16
Kerr, F. A.....	13	North West Territories, field work....	15
Keys, D. A.....	17	Nova Scotia, borings.....	22, 23
Kidd, D. F.....	10, 15	Field work.....	17, 19
Kindle, C. H.....	16	O'Brien, C. L.....	46
Kindle, E. M.....	16, 21	Ogilvie, Lt.-Col. G.....	49
Kirk, S. R.....	14, 22	Ogilvie, Mrs. O. P. R.....	48
Kirkconnell, J. R.....	41	Ontario, borings.....	22, 23
Laing, H. M.....	31	Field work.....	15, 18
Lang, A. H.....	10	Ore Dressing division.....	38
Lantern slides.....		Palaeontological division.....	21
Lees, E. J.....	13	Papers and addresses published, list of.	6-9
Leverin, H. A.....	45	Parsons, C. S.....	39
Library, Geological Survey.....		Patch, C. L.....	32, 33
Mines Branch.....		Phillips, J. G.....	44
Lloyd, B. C.....	32	Photographic division.....	26
Lopatin, I. A.....	30	Photographs, educational.....	11
Mabee, H. C.....	40	Picher, R. H.....	45
McClelland, W. R.....	40	Pleistocene Geology, Water Supply, and	
McConnell, R. B.....	10	Borings Division.....	10, 21-23
Macdonald, J. A.....	18	Poitevin, Eugene.....	16, 19
McDonald, R. C.....	18	Porsild, A. E.....	33
MacKay, B. R.....	13	Prairie Provinces, borings.....	23
McLean, S. C.....	19	Publications, list of.....	6-9, 52-55
McLearn, F. H.....	14, 21	Publicity work.....	11
McLeish, J.....	35	Quebec, field work.....	16, 18
McMahon, J. F.....	44	Borings.....	22, 23
MacPherson, J. T.....	30	Quirke, T. T.....	15
Maddox, D. C.....	10, 22	Baup, H. M.....	33
Malcolm, Wyatt.....	27	Regina, Sask., water supply.....	22
Malloch, E. S.....	41	Relief maps, educational.....	12
Malte, M. O.....	33	Road Materials division.....	43
Manitoba field work.....	14	Robinson, A. H. A.....	37
Maps. <i>See</i> Draughting divisions		Rogers, R. A.....	36, 40
Topographical division		Rosewarne, P. V.....	42
Marshall, J. R.....	14	Ross, C. C.....	23
Matheson, A. F.....	15	Rousseau, J.....	33
		Russell, L. S.....	21

	PAGE		PAGE
Sadler, A.....	46	Trail, R. J.....	40
Salaries. <i>See</i> Accounting division		Tuttle, A. C.....	18
Sale, C. V.....	33		
Saskatchewan, field work.....	14	Vancouver, Assay office.....	46, 47
Satterly, J.....	14		
Sawyer, E. A.....	56	Wait, E. H.....	37
Scott, D. C.....	31	Wait, F. G.....	45
Sheppard, A. C. T.....	18	Walker, J. F.....	13, 28
Smith, E. A.....	41, 43	Warren, P. S.....	14
Smith, Harlan I.....	30	Warren, T. E.....	41, 43
Soper, J. D.....	33	Water supply. <i>See</i> Pleistocene Geology	
Spence, H. N.....	18	division	
Spence, H. S.....	36	Weeks, L. J.....	15
Spence, J. W.....	18	Wickenden, R. T. D.....	10, 14, 22
Steeves, S. M.....	17	Williams, C. H. M.....	31
Sternberg, C. M.....	14, 21	Wilmot, V. L. <i>See</i> Eardley-Wilmot, V. L.	
Stockwell, C. H.....	15	Wilson, A. E.....	15, 21
Strong, R. A.....	42	Wilson, A. W. G.....	36
Swinnerton, A. A.....	42	Wilson, M. E.....	15
		Wintenberg, W. J.....	30
Tanton, T. L.....	15	Wright, J. F.....	14
Taverner, P. A.....	32		
Thompson, E. A.....	45	Young, G. A.....	13
Timm, W. B.....	38, 39	Young, R. J.....	41, 43
Tolman, C.....	16	Yukon, field work.....	13
Topographical division.....	17	Gold.....	46, 47

