ANNUAL REPORT 1953

FISCAL YEAR ENDED MARCH 31

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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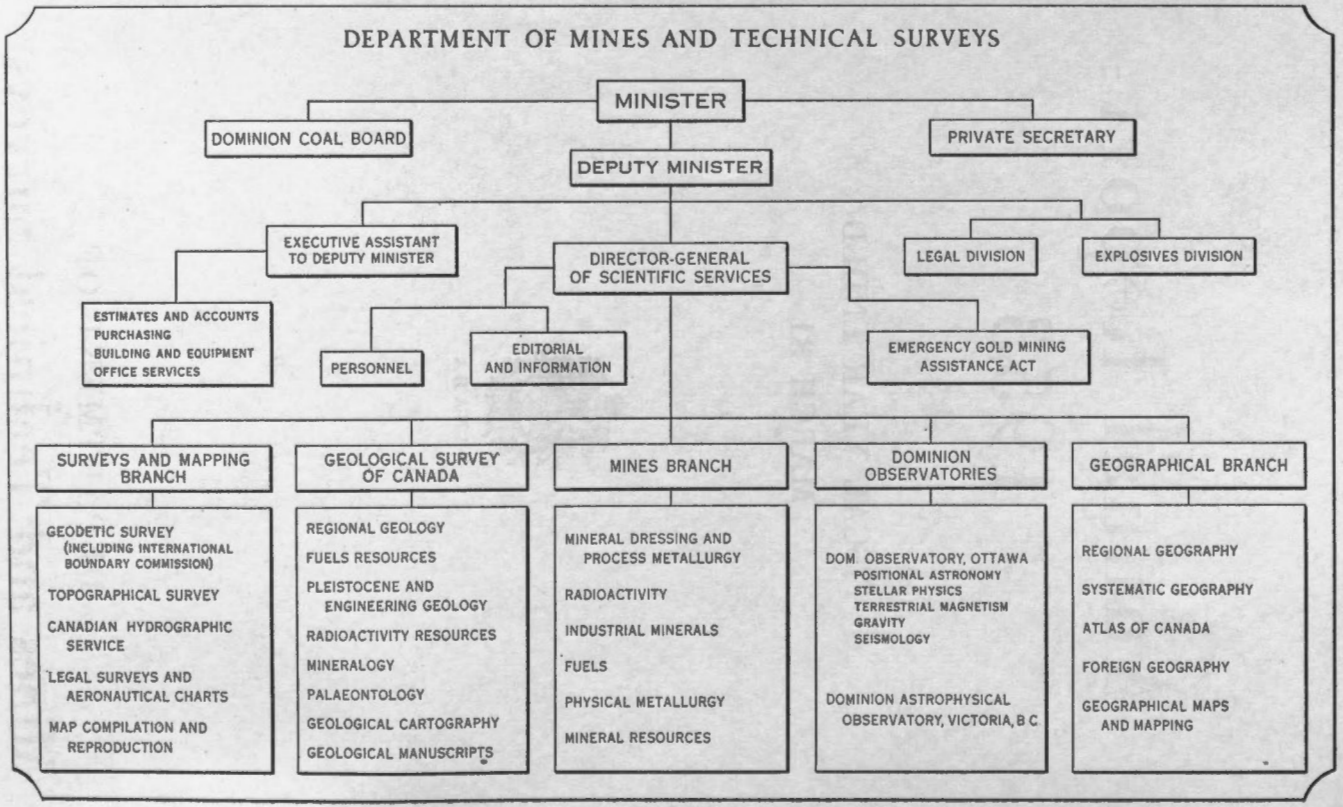
Mines and Technical Surveys

OTTAWA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FOREIGN GEOGRAPHY
GEOGRAPHICAL MAPS AND MAPPING

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

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to lay before Your Excellency the Annual Report of the Department of Mines and Technical Surveys for the fiscal year ended March 31, 1953.

Respectfully submitted,

GEORGE PRUDHAM,
Minister of Mines and Technical Surveys.

The Honourable George Prudham,
Minister of Mines and Technical Surveys,
Ottawa.

SIR:

I have the honour to submit the Annual Report of the Department of Mines and Technical Surveys, covering the fiscal year ended March 31, 1953.

Your obedient servant,

MARC BOYER,
Deputy Minister.

REPORT OF THE DEPARTMENT OF MINES AND TECHNICAL SURVEYS FOR THE FISCAL YEAR 1952-53

The outline accounts of the more important developments in the mineral industry and of the principal activities of the Department, given in this section of the report are followed by more detailed accounts of activities by branches.

Marked headway by the mineral industry can again be reported, tangible evidence of the improvement being the increase in the value of mineral production from $1,245,483,595 in 1951 to a record $1,285,332,353 in 1952. Particularly significant was the increase in the value of crude petroleum to $143,038,212, an amount approximately $27,000,000 greater than in 1951 and only $10,207,801 less than gold which has long been the chief single contributor to the value of Canada's mineral output. Thus from a position well down the list just prior to the discovery of the Leduc field in February 1947, crude petroleum has risen to near the top, and in fact may gain first position in 1953. Following the establishment of five successive records in as many years, the value of metal output declined 2·4 per cent in 1952 to $727,904,366. Among the main contributing factors in the decline were the lower prices of lead and zinc and the lower average price for gold. The fuels reached a record value of $263,582,319 and the value of the industrial minerals increased from $267,040,000 to a record $293,845,668. Asbestos and cement were each up about $7,000,000 compared with 1951, the largest gains next to that for crude petroleum.

High on the list of interesting developments in the industry in 1952 was the announcement near the close of the year of the discovery by the M. J. Boylen interests of Toronto of large base metal deposits in the Bathurst area of New Brunswick. The province's production of metals in the past was negligible but the whole outlook has been changed as a result of the discoveries. Of outstanding importance also were the disclosures by Fenimore Iron Mines Limited and by the Cyrus Eaton interests of Cleveland of huge iron-bearing deposits west of Ungava Bay. The Fenimore material, which can be mined by open-pit methods, is being tested to see if it will produce a suitable grade of concentrate. The Cyrus Eaton deposits are immediately to the north, and in both cases the deposits are close to tidewater.

Expenditures for crude oil exploration and development in 1952 reached an estimated $300,000,000, a new record. The regions under exploration extend across the Prairies and northward into northeastern British Columbia and into that part of the Northwest Territories lying south and west of Great Slave Lake. Daily crude oil production in Alberta in 1952 ranged from a low of 87,226 barrels during the week ended March 3 to a high of 217,513 barrels during the week ended June 16. Several discoveries were made in the Province, the most important being in the Bonnie Glen-Pigeon Lake district about 50 miles southwest of Edmonton. Several new oil fields were discovered in Saskatchewan also, one of the most important being in the Forget area 60 miles southwest of Wapella. By the close of the fiscal year 3,892 oil wells in Alberta were producing or capable of producing, the number producing in Saskatchewan being 358. In all, exploration for oil in western Canada in 1952 raised the reserves in that region to an estimated 1·8 billion barrels from about 1·5 billions at the end of 1951.

The programs involving capital outlays of hundreds of millions of dollars for new refinery construction, extensions to existing plants, and pipeline construction, undertaken by the oil industry as an outcome of the Leduc and other discoveries, are now nearing completion and thus the problem of market outlet facilities for the crude oil has been mainly solved. The Trans-Mountain pipeline to the Vancouver and neighbouring United States areas is expected to be ready for operation in the autumn of 1953 and construction of the Superior, Wisconsin to Sarnia, Ontario, extension to the Interprovincial pipeline is proceeding.

Completion of the various programs will provide market outlet facilities for a daily crude oil output of 600,000 barrels, an amount considerably more than double the peak rate of production during the current fiscal year. Accordingly, much of the interest is now concerned with the matter of disclosing sufficient supplies of oil to feed the greatly enlarged outlets that are becoming available. In this connection it should be noted that there were signs of a lessening of oil exploration activities toward the close of the fiscal year. However, this is not considered to have any particular adverse significance and appears to be largely a matter of awaiting the availability of adequate market outlet facilities for natural gas, the reserves of which have been increasing rapidly, particularly in Alberta and in parts of British Columbia and Saskatchewan. Much of the gas occurs in close physical association with the oil and would be largely wasted if crude oil production were unduly increased.

The two proposed outlets of chief interest are the Westcoast Transmission pipeline that would carry gas from the Peace River sections of Alberta and British Columbia to the Vancouver and northwestern United States areas, and a pipeline that would bring gas into Ontario and Quebec from fields in western Canada. Actually these and other proposed outlets await policy or legislative decisions, and thus by the end of the fiscal year the whole matter remained uncertain.

The production of coal at 17,579,002 tons was 5·4 per cent lower than in 1951 but the value of the output at $111,026,149 was about the same. Imports of 25,088,450 tons valued at $152,538,874 compared with imports of 26,971,562 tons valued at $170,151,246 in 1951.

In Saskatchewan uranium has been vying with oil and gas for a forefront position in mineral developments. An important feature of the fiscal year was the great amount of work done by Eldorado Mining and Refining, Limited in preparing its Ace mine in the Beaverlodge area north of Lake Athabasca for production, another being the large amount of work done by private companies in the same area. Actually, the Ace property was brought into production shortly after the close of the fiscal year. The company has about 200 claims in the Beaverlodge region, most of these in a large block extending about 9 miles along the St. Louis fault, the most important structure control of mineralization in the district.

At the end of 1952 an estimated 645 radioactive properties or unstaked occurrences were known in Canada. By far the greater part of these contain uranium rather than thorium. Some properties contain many individual occurrences the total of which is estimated to be more than 3,000.

The Canadian potential for the production of the non-ferrous base metals, and particularly of nickel, was further enhanced during the fiscal year. The International Nickel Company of Canada Limited and Falconbridge Nickel Mines Limited have been carrying out expansion programs that presage a considerable increase in production of the metal in the years ahead. International Nickel has expended about $150,000,000 since the war on an expansion program, which includes the mining of low grade ore at its

Creighton mine, the erecting of a 12,000-ton concentrator at that mine, the introduction of flash smelting of copper concentrates at the company's Copper Cliff plant, and extensive underground development in the various mines. The production of 13,000,000 tons of ore in 1952 was the highest in the company's history.

An eventual production rate of 60,000,000 pounds of nickel a year is the objective of Falconbridge Nickel Mines in its expansion program. The company in 1952 produced about 28,000,000 pounds and expects to increase this to 35,000,000 in 1954. Much of the expansion arises from arrangements the company has made to furnish the United States Defence Procurement Agency with supplies of nickel, copper, and cobalt over a period of years.

Early in 1954 Sherritt Gordon Mines Limited expects to bring its nickel-copper deposits at Lynn Lake in northern Manitoba into operation. Production will be in the neighbourhood of 17,000,000 pounds of nickel and 9,000,000 pounds of copper a year.

The world supply of nickel continued to be light in 1952 and the metal remained under allocation by the International Materials Conference.

World demand for copper also remained strong throughout 1952 and the allocation control established in 1951 by the International Materials Conference remained in effect. However, the value of the Canadian output at $146,679,040 was lower than in 1951 as the increase in the average price was insufficient to offset the 4·4 per cent decrease in the tonnage output. Close to half the output came from Ontario, about 27 per cent from Quebec, followed by Saskatchewan and British Columbia, with lesser amounts from Manitoba, Newfoundland and Nova Scotia. Canada was the fourth largest producer of copper in 1952, the first three being United States, Chile, and Northern Rhodesia. As an exporter Canada was third and as a consumer fifth.

The aforementioned developments in the Sudbury and Lynn Lake area have of course a bearing on the copper as well as the nickel outlook. Other than these, however, there were few developments of unusual interest in connection with copper in 1952. In the interior of the Gaspé peninsula, Gaspé Copper Mines Limited, a subsidiary of Noranda Mines Limited has been preparing its large copper deposit for production. The company laid out a modern townsite in 1952 and made plans for a plant to treat 6,500 tons of ore daily and for a smelter to produce 125 tons of copper anodes daily. Production from the property is expected to commence in 1955.

Two other copper properties in Quebec, both in the Chibougamau area, are preparing for production. One of these, Opemiska Copper Mines (Quebec) Limited has a 400-ton mill under construction and the other, Campbell Chibougamau Mines Limited, plans to erect a 1,700-ton mill which is expected to enter into production in 1955. The company has arranged a contract with the United States Defence Materials Procurement Agency for the sale of 63,200,000 pounds of copper over a 2-year period after production commences.

The substantial increases in the tonnage outputs of lead and zinc over 1951 failed by a considerable margin to offset the steady decline in the prices of the two metals. Thus the combined value of output at $184,504,306 was $9,487,483 lower than in 1951. The price of lead decreased from 18·80 cents a pound at the commencement of the fiscal year to 13·25 at the end, and that of zinc from 19·30 to 11 cents. The decline in prices led to the closing of several marginal producers, mainly in British Columbia, principal source of Canadian lead and zinc. The situation in that province was further aggravated by a power shortage which forced The Consolidated Mining and Smelting Company of Canada Limited to curtail its treatment of custom ores.

The strength of the Canadian dollar in terms of United States currency was accountable for the $8,626,857 decrease in the value of gold output to $153,246,016 in 1952 despite an increase in the volume of output compared with 1951. The average price of $34.27 an ounce in 1952 compares with an average of $36.85 in 1951. Seven gold mines ceased operations in 1952 but the loss in production was offset by increases in the output of some of the larger mines such as Lamaque in western Quebec and Giant Yellowknife in Northwest Territories. The cost-aid provided by the Federal Government through the Emergency Gold Mining Assistance Act was partly offset by the decrease in the Mint buying price of gold, and as a result the Government introduced amending legislation in Parliament early in 1953 to provide for increased rates of assistance.

Reference has been made to some of the important iron ore developments. Shipments of the ore in 1952 totalled 4,707,008 long tons, the chief contributors being the Wabana deposits in Newfoundland with 1,476,678 tons, the Steep Rocks deposits in Ontario with 1,274,354 tons and the Helen mine in that province with 1,148,761 tons. British Columbia, which until 1951 had little iron ore production, recorded an output of approximately 804,000 tons in 1952, all in the form of magnetite concentrates from the Quinsam Lake and Texada Island deposits.

Present indications are that 1953 will witness the end of the open-pit operations at the Errington mine of Steep Rock Iron Mines Limited. These operations have supplied all the output from the Steep Rock deposits to date but preparations for the changeover to entirely underground operations at the Errington are nearing completion. Meantime the company is preparing its Hogarth mine for production, which will be by open-pit operation. Incomplete exploration of another deposit, the "G" zone, which lies between the Hogarth and Errington mines, has tentatively outlined an orebody 3,500 feet long with an apparent width of 125 feet.

No drilling was carried out on the "C" zone, under lease to Inland Steel Company, in 1952.

The long range outlook is for a greatly increased production from the Steep Rock deposits, perhaps as high as 15,000,000 long tons or more a year within 10 to 15 years. Present plans call for a production of 1,500,000 tons of hematite in 1953, 3,000,000 in 1955 and 3,500,000 in 1956, all of which output will come from the Errington and Hogarth orebodies.

Demand for the industrial minerals continued strong. Shipments of asbestos, the chief mineral of the group, reached a record value of $89,254,913, although the tonnage shipped was slightly less than in 1951, the record tonnage year, owing to the decreased demand for short fibres. Canadian production was about 66 per cent of the world total in 1952, with producers in Quebec accounting for about 97 per cent of Canada's output. Shipments from deposits in northern Ontario, which were brought into production just a few years ago, amounted to 23,096 tons in 1952. First shipments of fibre recovered from the talus slope of Cassiar Asbestos Corporation's McDame Mountain deposits in northern British Columbia were expected in 1953. Underground development by the company has indicated the presence of substantial quantities of fibre of excellent spinning quality.

The expansion in the cement industry was still outdistanced by the steadily increasing demand despite an increase in output of more than 1,500,000 barrels over 1951. Value of output in 1952 was $48,059,470 compared with $40,446,288 in 1951. The rapidly growing concrete products industry now takes about one-fifth of the total output of cement. The products are turned out in 431 plants in Canada, of which close to 85 per cent are in Ontario and Quebec.

Elemental sulphur was produced in Canada for the first time since 1943, in which year The Consolidated Mining and Smelting Company of Canada Limited ceased its recovery from smelter gases. The sulphur is being produced at the rate of about 20,000 tons a year and is recovered from 'sour' natural gas in the Jumpingpound and Turner Valley fields of Alberta by Shell Oil Company of Canada and Royalite Oil Company, respectively.

Late in 1952 Noranda Mines Limited announced plans for the construction at Welland, Ontario, of a sulphur recovery plant that will use pyrites as a raw material. Present plans call for bringing the plant into operation in 1954, the annual output to be 18,000 tons of elemental sulphur and 36,000 tons of sulphur dioxide.

The sulphur shortage that existed in the free world from the middle of 1950 through 1951 seemed to be nearing an end by the close of the fiscal year. By then United States domestic restrictions on the distribution and use of sulphur had been lifted and consumers throughout the world were able to obtain their full requirements. This improvement was brought about by several factors, among which was the discovery a few years ago, and the later development of, further large deposits in the Louisiana-Texas region.

ACTIVITIES OF THE DEPARTMENT

Following the practice of the 2 previous years, the Department issued, toward the close of the fiscal year, a summarized account of its principal activities in 1952. Entitled "Summary of Activities 1952", it was distributed to members of the House of Commons, Senators, Canadian Government Trade Commissioners, prospecting and mining associations throughout the country and to mining periodicals and the press services.

The Department carried out extensive programs of topographical and geological mapping during the fiscal year, mainly on those areas of immediate mineral interest throughout the country.

In its research and investigative work on ores and minerals it gave special attention to uranium, titanium, coal, and certain of the industrial minerals.

To keep pace with the demands on its mapping services it has made increasing use of the shoran electronic method of distance measurement in its geodetic field work and of helicopters and conventional aircraft in its topographical mapping. Its use of helicopters in 1952 for the reconnaissance survey of a 57,000 square mile section of Northwest Territories was the first use made of such aircraft for geological mapping in Canada. Known as "Operation Keewatin", the project covered an area underlain by rocks of the Canadian Shield and lying west of Hudson Bay and north of the Prairie Provinces.

New areas under exploration and development received precedence in the mapping program. Establishment of mapping control over 131,000 square miles during the past fiscal year included, for instance, such areas as the Bathurst district in New Brunswick in which important base metal finds were made recently, the Goldfields area in northern Saskatchewan in the heart of exploratory activity for uranium, and the area south of Great Slave Lake in Northwest Territories where interesting base metal discoveries have been made, and the economic possibilities of known deposits are being appraised.

Altogether the Department placed 84 geodetic, topographic and legal surveys parties and 77 geological parties in the field in 1952. Its geological program was highlighted by the aforementioned Operation Keewatin. The

project was most successful in that an area twenty times greater than that ordinarily covered by conventional means was mapped at approximately the same cost per square mile. About 14,000 square miles, or 25 per cent of the area is considered to be good prospecting country, a high percentage in comparison with other known Precambrian areas. The Department expects to make a preliminary report on the results of the work available to prospectors well before the close of the 1953 field season.

The Department again took advantage of the transportation opportunities afforded by other Federal Government departments on missions to the Arctic to continue its geological reconnaissance of the Arctic islands. This work has so far been concentrated mainly on southern Baffin Island where rock formations are similar to those of the southern and eastern parts of the Canadian Shield in Ontario and Quebec, and on Cornwallis Island where beds of lignite coal up to 5 feet thick and petroleum residues have been found.

In its research and related work on the processing of ores and minerals the Department was successful in working out treatment methods that will help pave the way for the active development of various complex and low grade deposits and in providing information that it is hoped will lead to the solving of baffling problems in ore treatment. Among the most interesting projects is the research on the efficiency of grinding at higher temperatures. Mill operators have been showing a keen interest in the project in view of the encouraging results to date.

As a part of its work on industrial minerals the Department has been testing construction material from rock deposits in the vicinity of the St. Lawrence River in order to select those best suited for obtaining concrete aggregate for the proposed seaway and hydro-electric developments. Samples of rock and gravel have been obtained from all deposits within economic trucking distance of the sites of the proposed dams and locks. They are being tested by alternate freezing and thawing concrete specimens made with these aggregates.

Coal continued to receive chief attention in the fuel research projects. The coal industry faces increasing competition from oil and natural gas but has few facilities of its own to conduct the research that is necessary for a maintenance of market outlets.

At the request of the Department of National Defence the work in physical metallurgy was focused on the immediate and pressing problems of production and improvement of prototype weapons, the development of new alloys, and the improvement of existing alloys. A primary aim of such work is the development of metals and alloys that can withstand the high temperatures as experienced in jet engines and of light-weight corrosion-resistant metals for aircraft and airborne equipment.

As part of a co-operative program of meteor photography with United States, the Department installed, at its recently established observatories at Meanook and Newbrook, Alberta, two astronomical cameras of extreme speed and capable of photographing a large area of the sky at one time. The basic purpose of the program, which is sponsored in part by the defence services of Canada and United States, is the study of the characteristics of the upper atmosphere relative to the use of high speed military projectiles.

Geographical surveys carried out at Wager Bay on the west coast of Hudson Bay and at Resolute Bay and Alert in the northern Arctic islands yielded much valuable information on land forms, ice conditions and plant and wild life in these areas.

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

SUMMARY OF REVENUES AND EXPENDITURES FOR THE FISCAL YEAR 1952-53

	Revenue	Ordinary Expenditures
Minister of Mines and Technical Surveys		$ 12,000.00
Departmental Administration	$ 51.24	405,663.00
Explosives Act Administration	5,299.90	80,065.64
Surveys and Mapping Branch	108,684.62	5,609,559.04
Geological Survey of Canada	14,700.88	1,798,700.13
Mines Branch	53,234.85	2,460,976.75
Dominion Observatories	2,214.82	589,222.87
Geographical Branch	659.74	223,053.74
General:—		
To provide for payments under the Emergency Gold Mining Assistance Act		11,146,981.90
Payments to Royal Canadian Air Force and Commercial Companies for Air Photography, and to defray the expenses of the Interdepartmental Committee on Air Surveys		844,224.87
Gratuities to families of deceased employees		2,266.66
Exchequer Court Awards		2,500.00
Total of General		11,995,973.43
	$184,846.05	$23,175,214.60

EXPLOSIVES DIVISION

Commencing with the years 1944 to 1951 inclusive, which are combined into one report, the Division has resumed the publication of separate annual reports on the administration of the Explosives Act. Its report for the calendar year 1952 will provide considerable more detailed information on the activities than is given below.

The Explosives Act, 1946, is administered by the Division and regulates the manufacture, testing, sale, storage, and importation of explosives. Under its authority explosives factories, magazines, and registered premises for storage of explosives are licensed and regularly inspected. In addition, small stocks of explosives kept for private use and ammunition for resale are subject to regulations and inspection.

Within the Act comes the investigation of accidents in which explosives are involved and the collection and compilation of data pertaining to explosives. Accidents are classified according to attributed causes so that attention may be directed to good practice designed to avert them.

Members of the Royal Canadian Mounted Police serve as deputy inspectors of explosives.

FACTORIES

Nineteen explosives factories were licensed during the year, and the following explosives were manufactured: commercial blasting explosives, military explosives, small arms ammunition, detonators, track torpedoes, and blasting accessories; also safety fuse, primacord, fuse lighters, igniter cord, military and commercial fireworks, and toy pistol caps.

Inspectors of the Division made 34 inspections of licensed factories.

A new factory near Calgary, Alberta, began production of commercial blasting explosives in April 1952. Many mechanical devices new to explosives factories have been installed, which will reduce manual labour to the minimum. For the manufacture of nitroglycerine the "Biazzi" process is used. It is new to this country but has been used in Europe for a number of years. In addition to its advantages in operation over the older process, it has an excellent record of freedom from accident.

Production of commercial explosives in 1952 was 122,246,510 pounds, a new record and an increase of 14,907,006 pounds over 1951, the former peak year.

MAGAZINES—REGISTERED AND UNLICENSED PREMISES

There were 410 permanent and 914 temporary magazine licences in force at the end of 1952 compared with 389 permanent and 819 temporary magazine licences at the end of 1951. Registered premises increased from 74 to 82. Over 3,000 unlicensed premises, including dealers selling small arms ammunition, were visited by inspectors or deputy inspectors.

IMPORTS

Seven hundred and twenty explosives importation permits and 17 special permits were issued to manufacturers and users of explosives in 1952 compared with 540 permits and 14 special permits issued in 1951.

ACCIDENTS

Two fatal accidents in factories in 1952 marred an otherwise excellent record. On June 26 at the plant of Canadian Industries Limited, Brownsburg, Quebec, one man was seriously injured in an explosion of priming composition and later died. On December 29 at the T. W. Hand Fireworks plant, Cooksville, Ontario, a flash fire occurred in a small shop where coloured stars were being loaded into display fireworks. Two employees died from burns.

Eleven persons received minor injuries in other accidents in factories.

Accidents in the use of explosives in 1952 resulted in 26 deaths and caused injury to 84 persons. Accidents classed as "miscellaneous", not directly associated with use, but with playing or tampering with explosives, caused the deaths of 16 persons and injury to 40.

The number of accidents has not increased in proportion to the increase in the production of commercial explosives, but many casualties are still caused by carelessness or neglect. Often the victims of these accidents are children or innocent bystanders. Thus a duty rests on all users to keep explosives safely and to observe the regulations, which are designed to prevent accidents.

LABORATORY

The testing and analysis of explosives, required in the administration of the Explosives Act and for research, is carried out at the Explosives Laboratory, Montreal Road, Ottawa. The laboratory has been maintained jointly by the Department of Mines and Technical Surveys and the National Research Council under an agreement. The Council's interest in explosives has declined and as a result it has requested release of the buildings for other uses. Consequently, a new explosives laboratory is in course of construction on the River Road south of Uplands airport near Ottawa. Construction was started in December 1952 and is expected to be completed in May 1953.

The 581 samples received during 1952 for chemical and physical examination are classified as follows:

Blasting explosives, etc.	41
Fireworks, including Chinese firecrackers and toy pistol caps	532
Miscellaneous	8

Investigation of the hazards attending the storage, handling, and shipment of ammonium nitrate was continued. Studies were made of the energies and pressures developed during decomposition of ammonium nitrate, pure, and when mixed with other ingredients.

PROSECUTIONS

Eleven cases were prosecuted for violations of the Explosives Act and Regulations and ten convictions were obtained and fines imposed. The offences were: improper storage, conveyance by trailer, infraction of terms of licence, and smoking in prohibited areas. A charge of improper storage was dismissed on a technicality.

DESTRUCTION OF EXPLOSIVES

The Division is responsible under direction of the Minister for the destruction or disposal of abandoned or deteriorated commercial explosives. In all, 74,984 pounds of blasting explosives, 10,158 detonators, 11,212 feet of safety fuse, and about 100 pounds of rejected fireworks were destroyed in 1952.

SURVEYS AND MAPPING BRANCH

W. H. Miller, Director

The extensive programs of field work carried out by the Branch reflect for the most part the increasing needs for maps and charts resulting from the steady expansion of the Canadian economy and more particularly from the rapid growth of the mineral industry. Mineral resources development, and in fact industrial development as a whole, has been proceeding at such a rate in recent years that the Branch has found it difficult to do more than keep abreast of the urgent needs for its services, and only then by the use of the latest techniques in field mapping, of modern photogrammetrical plotting equipment, and of new and improved methods in reproduction. Shoran trilateration for geodetic control and the radar altimeter for vertical control are becoming increasingly dependable from the viewpoint of accuracy, and permit of much speedier coverage of territory than the long-established methods. Coupled with the increasing use of the helicopter for transport, they are among the most useful tools available to the Branch in keeping abreast of the demands on its services.

The Branch lost the services of R. J. Fraser, who from January 1948 until his retirement on superannuation, effective March 31, 1953, was head of the Canadian Hydrographic Service. Mr. Fraser entered the Civil Service in 1908 and over the years became widely known as a hydrographer of exceptional ability. He was succeeded as Dominion Hydrographer by F. C. G. Smith.

GEODETIC SURVEY

The Geodetic Survey provides the horizontal and vertical control essential for all mapping in Canada. During 1952 it completed 485 miles of primary and second-order triangulation, 140 miles of triangulation reconnaissance, 609,000 square miles of shoran trilateration, 1,079 miles of precise levelling, 3 precise azimuths, and 19 astronomical determinations of position.

The Division had 20 parties in the field compared with 18 in the previous year, the distribution in the 2 years being as follows:

	1952	1951
Yukon	0	1
Northwest Territories	3*	3
British Columbia	3	5
Alberta	2	0
Saskatchewan and Manitoba	0	1
Ontario	4	1
Quebec	2	4
Nova Scotia	2	1
Newfoundland	4	2
	20	18

* During the latter part of the field season these parties worked in an area east of the 70th meridian of west longitude between the Gulf of St. Lawrence and the 56th parallel of latitude.

SHORAN

In co-operation with the R.C.A.F., the National Research Council, and the Meteorological Office of the Department of Transport, the shoran network of trilateration extending from the vicinity of the 49th Parallel of latitude in Manitoba northward and northwesterly to the Arctic coast, was extended from the Fort Reliance-Coppermine area in Northwest Territories eastward to the

western limits of Hudson Strait, a distance of 1,000 miles. When weather conditions in the Hudson Strait area became unsuitable for work, trilateration was continued in the area east of the 70th meridian of west longitude lying between the Gulf of St. Lawrence and the 56th parallel of latitude.

In all, the axial length of the 1952 extension of the shoran network amounted to 1,400 miles. The area covered by the net, which involves 76 measured lines, is 609,000 square miles. In addition, 13 stations were reconnoitred and prepared for occupation during the 1953 field season. The average and maximum lengths of line are 239 and 363 miles respectively.

The stations of the shoran network comprise the necessary control for the aerial mapping of Canada's vast northern regions. Certain inherent advantages of the method, such as the use of triangle sides of over 200 miles in length, make it possible to project survey control into remote areas in a relatively short time. Improvements in the design of radionic equipment during the past 2 years has given assurance of increased accuracy in the distance measurements.

TRIANGULATION

Primary and secondary triangulation nets were extended in British Columbia, Alberta, Ontario, Quebec, Nova Scotia and Newfoundland.

Two parties operated in the area adjacent to the Alaska Highway between Fort St. John and Muncho Lake, British Columbia. This section of work constitutes a vital link in the 2,400-mile circuit extending from Whitehorse through Dawson Creek, Edmonton, Jasper, Prince Rupert, and thence through the Alaskan triangulation of the United States Coast and Geodetic Survey, northerly to Whitehorse. About 150 miles of the Whitehorse-Dawson Creek section remain to be done and the Division expects to complete this gap in 1953.

A reconnaissance and station-preparation party covered about 140 miles between Dawson Creek and Edmonton on the projection of the foregoing loop.

The Alaska Highway net, it should be noted, provides control for surveys and mapping along the British Columbia-Yukon boundary, and also control for the survey of the Highway itself and the adjacent areas. In addition, it has provided necessary control or "anchor" stations for the central Canada shoran net.

In Ontario, triangulation was continued in the Lake Superior-Lake Nipigon area. This work constitutes a link in the extension of the main arc which will ultimately join the geodetic triangulation of Eastern Canada with that of Western Canada. At present, the only geodetic connection between surveys in the two regions is through the triangulation network of the United States Coast and Geodetic Survey. The Canadian arc provides control for surveys in the region north of Lake Superior, and for the general mapping and charting of the region.

A party operating in the Quebec-Labrador iron ore region extended an easterly offshoot of the north-south arc serving the Knob Lake area. This network straddles the Hamilton River valley and provides control for mapping in an active mineral area.

In eastern Quebec, a party extended an arc of triangulation northward from the Havre St. Pierre area a distance of 30 miles into the Tio Lake titanium ore region.

In Nova Scotia a party established control in the Sydney and Springhill areas to serve the requirements of underground surveys of Dominion Steel and Coal Corporation.

Along the south coast of Newfoundland a second-order triangulation arc was advanced from Hermitage Bay westward about 60 miles to provide control for mapping and charting in this area.

Precise Levelling

After several years of operations with both double and single levelling parties, the use of the double party has been discontinued.

In 1952, one single party operated in British Columbia, one in Alberta, one in Quebec and one in Nova Scotia. The season's work resulted in the addition of 1,079 miles of new levelling to the Canadian levelling network, and the establishment of 513 bench marks.

The inspection of bench marks in Manitoba and Saskatchewan, begun in 1951, was completed.

In British Columbia, lines of levels between Cambie Creek and Hope, and between Osoyoos and Bridesville, and the southerly 50 miles of the line from Lake Louise to Jasper were completed.

In Alberta, the line between Altawan and Sterling and the easterly 83 miles of the line between Red Deer and Brazeau were completed.

In Ontario, about 60 miles of levels were run eastward from Ottawa to Plantagenet in connection with the extension of the Ottawa photogrammetric test range. In this work elevations were determined for 139 Topographical Survey bench marks, 172 natural features, and 15 bench marks of the Geodetic Survey.

For use in the proposed St. Lawrence seaway and power development project the Geodetic Survey was asked to establish additional vertical control adjacent to the St. Lawrence River between Kingston and Cornwall. By the end of the fiscal year, it had verified the elevations of 18 old bench marks, established 12 new bench marks and completed 17 miles of double levelling. It expects to complete the preliminary phase of its work by the middle of May 1953. Similar work will be required later, south of the St. Lawrence River in United States, and negotiations are now under way to obtain authority to do this section of the levelling operation.

In Quebec, lines of levels were completed between: Ste. Anne de la Perade and La Croche; Mattawa and Timiskaming; Belleterre and Laforce; and Arntfield and Belleterre.

In Nova Scotia, the 115-mile line between Middleton and Yarmouth and the 206-mile line between Halifax and Mulgrave were completed. In addition, tidal bench marks at Sheet Harbour, Guysborough, and Mulgrave in Nova Scotia, and a tidal bench mark on Partridge Island at Saint John, New Brunswick, were connected to the geodetic levelling datum.

Levelling in Canadian Net

The table below shows the total mileage of levelling in the Canadian net at the end of March 31, 1953:

Region	Precise	Secondary	Public Works	Total
Yukon	1,333·0	26·0	.....	1,359·0
British Columbia	5,712·0	52·0	.....	5,764·0
Northwest Territories	93·0	.....	.....	93·0
Alberta	4,495·0	3,799·0	.....	8,294·0
Saskatchewan	4,203·0	5,098·0	.....	9,301·0
Manitoba	2,963·0	467·7	113·0	3,543·7
Ontario	7,324·0	1,376·0	2,012·0	10,695·0
Quebec	4,801·0	1,428·8	1,750·0	7,979·8
New Brunswick	1,106·0	.....	403·0	1,509·0
Nova Scotia	1,023·7	.....	309·0	1,332·7
Prince Edward Island	284·0	.....	.....	284·0
Newfoundland	834·8	.....	.....	834·8
Minnesota, U.S.A.	89·0	.....	.....	89·0
Vermont	6·0	.....	.....	6·0
New York State	15·0	.....	.....	15·0
	34,282·5	12,247·5	4,587·0	51,117·0

Comparative Table of Levelling by Provinces
Fiscal years 1952-53 and 1951-52

Region	Number of parties		Mileage		Bench marks established	
	1952–53	1951–52	1952–53	1951–52	1952–53	1951–52
Yukon	.....	1 D	.....	285	.....	143
British Columbia	1 S	.....	88	.....	32	.....
Alberta	1 S	.....	309	19	142	9
Ontario	1 S	.....	69	.....	27	.....
	1*	.....	.....	.....	.....	.....
Quebec	1 S	1 D	292	255	145	109
Nova Scotia	1 S	.....	321	.....	167	.....
Newfoundland	.....	1 D	.....	234	.....	114
Totals	6	3	1,079	793	513	375

NOTE: 1 D and 1 S signifies one double and one single party, respectively.
* Multiple party on St. Lawrence seaway and power development project.

GEODETIC ASTRONOMY AND BASE LINES

Geodetic astronomy is used for mapping control, for the establishment of inter-provincial boundary lines, and for the control of accumulative errors of "twist" in triangulation nets.

During 1952, two engineers were engaged on astronomical work for the British Columbia-Northwest Territories and the Alberta-Northwest Territories Boundary Commissions. Using airplane and dog-team transportation they established two precise stations adjacent to the 60th parallel of latitude north of Fort Nelson, British Columbia. Earlier in the fiscal year they established two stations on the same parallel between Fort Smith and the northeast corner of Alberta, using pontoon-equipped planes for transportation. The astronomical stations serve as control points for the demarcation of boundary lines defined by law as the 60th parallel of latitude.

One Laplace azimuth station for the control of "twist" was established at Pinion triangulation station near the south coast of Newfoundland, and two more at Schreiber and MacKenzie in Ontario in connection with the triangulation net north of Lake Superior. In each of the areas a base line was measured on the ground with invar tapes to provide control in length of the triangulation system.

In connection with the selection of shoran stations, eleven astronomical fixations of second-order accuracy were made in Baffin Island and in the area south of Hudson Strait.

MATHEMATICAL ADJUSTMENTS AND COMPUTATIONS

The following major adjustments were made during the fiscal year:

Triangulation Nets

Primary net in northern British Columbia extending from Prince George to Dawson Creek.

Primary net along the Alaska Highway between McNaughton Lake and Lower Post.

In Labrador, three secondary nets; one extends from Knob Lake to Fort McKenzie, the second from Fort McKenzie to Ungava Bay, and the third is a smaller net in the iron-ore area in the vicinity of Wabush Lake. Another secondary net, observed by the Topographical Survey in the Dyke Lake area, was adjusted.

Two secondary nets in Nova Scotia, one in the vicinity of Sydney, and the other in the vicinity of Springhill.

A secondary net, along the southeast coast of Newfoundland. This net includes the French islands of St. Pierre and Miquelon.

Shoran Nets

The adjustment as a unit of all shoran work completed in 1952, 1951 and part of 1950. This project is nearing completion.

A preliminary adjustment was started of the 25-line net that was measured during 1952 in Quebec and Labrador. The adjustment is being made to determine, with a high order of accuracy, the lengths and azimuths of three of the northerly lines of the net which will be used as base lines in the 1953 operations for the extension of the net northward across Hudson Strait to Baffin Island.

Levelling Nets

All precise levelling of the Geodetic Survey except the work north of Edmonton and along the route of the Alaska Highway was adjusted as a unit, holding fixed the elevations of the tidal bench marks at Halifax, Yarmouth, Father Point, Churchill, Point Atkinson near Vancouver, and Prince Rupert.

INTERNATIONAL BOUNDARY COMMISSION

The Commission functions by virtue of the treaty of 1925 between Canada and the United States, which provides for the maintenance of an effective boundary line between the two countries and between Canada and Alaska. Expenditures for the maintenance of the boundary are shared equally by the two countries, but each country pays the salaries and travelling expenses of its own Commissioner and his assistants. The present Canadian Commissioner, J. E. R. Ross, Dominion Geodesist, replaced J. Leslie Rannie who retired as International Boundary Commissioner and Dominion Geodesist on December 18, 1951.

CONFERENCE OF THE COMMISSIONERS

At their first meeting of 1952, held in Washington April 7 to 10, the Commissioners reviewed the entire boundary situation between the two countries and agreed: that a Canadian party should work on the Quebec-Vermont boundary westward from Halls Stream; that a similar Canadian party should work on the British Columbia-Washington boundary between Kettle and Similkameen Rivers; that the United States party, which discontinued work on the Quebec-Maine Highlands boundary in 1951, should resume operations on that section; and that a United States party should complete the unfinished maintenance operations on the New Brunswick-Maine boundary on the North Line and Saint John River sections. Owing to the amount of monument repairs and triangulation required on Saint John River, it was agreed that a Canadian engineer should accompany the last-mentioned United States party.

The Commissioners further agreed that, on completion of the work on Saint John River in 1952, an appendix to the Commissioners' report covering the section of the boundary from the source of St. Croix River to the confluence of Saint John and St. Francis Rivers should be prepared containing the geographic positions on the 1927 North American datum and the descriptions of all boundary markers and triangulation stations in that area.

The two Commissioners inspected maintenance work in progress on the eastern section of the boundary late in July, noting in particular the amount of monument repairs and replacements necessary on Saint John River. Later they inspected work being done in the vicinity of Grand Fork, B.C. and vista conditions in the vicinities of Huntingdon and Point Roberts on the Pacific

coast where an experiment in vegetation control by chemical means had been undertaken earlier in the summer. They also inspected the new 90-foot range tower at Point Roberts and noted that the other five range towers in that area require scraping and repainting.

On the Saint John River section of the New Brunswick-Maine boundary, where a Canadian engineer with the United States party working in that area was engaged chiefly in triangulation, 62 monuments were repaired and 34 were moved to more suitable sites.

On the Quebec-Vermont boundary, 47½ miles of line were inspected eastward from Halls Stream to Bear Mountain; near Glen Sutton, 37½ miles of vista were recleared, and 129 monuments were inspected, only one of which required repairs.

On the British Columbia-Washington boundary, 70 miles of line were inspected from Kettle River to Similkameen River, 36 miles of which required repairs. The metal shafts of 60 monuments were scraped and painted with aluminium paint to preserve the metal and for ease in finding the monuments.

THE TONGASS PASSAGE-MOUNT ST. ELIAS REPORT

The report of the International Boundary Commission on the establishment of the boundary between Canada and the United States from Tongass Passage to Mount St. Elias (the Alaska "Panhandle" boundary) was tabled in the House of Commons and Senate on December 10, 1952. A limited edition of the report was printed for distribution to federal and provincial libraries and to government offices, and to the more important reference, university and public libraries through Canada. A limited number of copies are available to the public at a cost of $7.50 for cloth-covered copies and of $3.50 for those with paper covers. The report is illustrated and contains: the description and definition of the boundary from the Point B of the Award to Mount St. Elias and other relevant data; texts of the various boundary treaties, conventions, etc.; historical information and maps; narratives of field operations; and 24 triangulation sketches in an envelope at the back of the report. A series of 13 topographical maps of the boundary area is available for government or other agencies and for private individuals who may require them. Signed original copies of the report have been sent to the Prime Minister, the Department of External Affairs and the Dominion Archives, and copies bearing facsimile signatures have been sent to the Library of Parliament and to a few interested federal agencies.

The joint report of the Commissioners for 1951 was completed. It contains statements on all the inspections made, on the monuments, reference monuments and range marks repaired, relocated, rebuilt, moved and established during the year, and on the mileage and location of vistas re-opened, and has plats and tables certified and signed by the Commissioners, giving the locations and geodetic positions of the above-mentioned boundary markers. The report for 1952 is being prepared.

An appendix to the report on the re-establishment of the International Boundary from the source of St. Croix River to St. Lawrence River, published in 1925, is being prepared. It will contain a summary of all the maintenance work done under the provisions of Article IV of the Treaty of 1925 on the North Line and Saint John River sections of the boundary, and a revised description and definition of the boundary, with the geographic positions of all the boundary points and reference monuments changed from the old North American to the 1927 North American geodetic datum. The appendix is being prepared because of the inconvenience of making piecemeal conversions from the old to the new datum, and of the great number of boundary monuments and reference monuments established and re-established since the Treaty of 1925 went into effect. Appendices to other sections of the boundary line dealt with in the original report will be prepared as occasion permits.

TOPOGRAPHICAL SURVEY

The Division placed 37 parties in the field in 1952 and these, together with the 22 parties provided by Army Survey Establishment, covered areas in various parts of Canada totalling 273,000 square miles in ground surveys for control of mapping from aerial photographs. Included in the 142,000 square miles covered by the Army Survey Establishment parties was a project in the Northwest Territories for horizontal control by shoran-controlled photography in which an area of 43,000 square miles was covered.

The helicopter was again used to excellent advantage in field transport. Thus a party in the inland part of Newfoundland equipped with two helicopters and a conventional aircraft completed vertical and horizontal control, for one inch to one mile mapping, over 20,850 square miles of the most difficult-of-access parts of the island. Considering the nature of the terrain, the amount of work accomplished in one season, and the relatively low cost of the operation, it is one of the most outstanding airborne mapping projects so far undertaken anywhere. It brings to completion in two years the mapping control for the island.

Another helicopter-equipped party working in northern Yukon, completed vertical and horizontal control, for use in reconnaissance mapping, over about 17,000 square miles of remote and difficult terrain where use of other methods would have been practically impossible. Because of the crash-landing and loss of one of the helicopters less work was accomplished than had been planned.

Use of helicopters also made it possible to put in vertical control on about 77 map sheets in Quebec and Ontario during October and November when, due to poor weather conditions in Yukon and Newfoundland, it was necessary to discontinue helicopter operations in those regions.

The Division continued to add to its photogrammetry equipment, the chief additions during the year being a Wild A-7 autograph and two Kelsh plotters.

A new method of assembling the multiplex plots came into use during the year. By this method the plots are reduced photographically to manuscript scale and printed on a sensitized plastic-type material which is then mounted on the projection sheet. This has resulted in a remarkable saving of time and provides a completely accurate reproduction of the original material.

To meet the demands for advance information on new mapping about 12,000 prints of such material were distributed to federal and provincial authorities and to other interested parties, notably those engaged in oil developments in Western Canada.

FIELD SURVEYS

The field projects are summarized below:

Province or territory	Number of parties	Type of work	Publication scale	Area (square miles)
Northwest Territories....	1	Special investigation.....	.....	
	1	Triangulation, Mackenzie River	.....	200 (linear miles)
	1	Topographical control.....	1:50,000	1,070
	1	Planimetric control.....	.....	580
	1	Barometric elevations, District of Keewatin.....	.....	.....

Province or territory	Number of parties	Type of work	Publication scale	Area (square (miles)
Yukon	1	Photo-topographical (helicopter)	1:250,000	16,750
	3	Photo-topographical	1:250,000	9,310
British Columbia	4	Photo-topographical	1:250,000	24,900
	7	Photo-topographical	1:50,000	6,540
	1	Winter traverse (areas east of Nelson)	.....	350 (linear miles)
Saskatchewan	2	Planimetric control	1:50,000	2,430
Saskatchewan and Manitoba	1	Vertical control	1:50,000	2,490
Manitoba	1	Planimetric control	1:50,000	2,240
Ontario	.....	Field interpretation	1:50,000	2 (map sheets)
Ontario and Quebec	1	Vertical control (helicopter)	1:50,000	17,090
Quebec	1	Vertical control (helicopter)	1:50,000	15,530
	2	Topographical	1:50,000	5,860
	1	Special topographical	1" = 1,000'	290
	1	Levelling	.....	260 (linear miles)
New Brunswick	3	Topographical	1:50,000	1,850
		Field interpretation	1:50,000	29 (map sheets)
Nova Scotia	1	Topographical	1:50,000	770
		Field interpretation	1:50,000	9 (map sheets)
Newfoundland	1	Topographical (helicopter)	1:50,000	20,850
	1	Topographical and field Interpretation	1:50,000	1,540
			1:50,000	2 (map sheets)
		Army Survey Establishment		
Northwest Territories	2	Topographical	1:250,000	9,940
	1	Photo-topographical (helicopter)	1:250,000	12,420
	1	Shoran-controlled photography	1:250,000	43,000
	1	Vertical control (helicopter)	1:250,000	43,530
	.....	Vertical control (helicopter)	1:50,000	1,080
Yukon	4	Photo-topographical	1:50,000	3,420
British Columbia	2	Topographical	1:50,000	2,080
	5	Photo-topographical	1:50,000	3,660
	1	Photo-topographical	1:250,000	10,600
Alberta	2	Photo-topographical	1:50,000	1,800
	.....	Vertical control (helicopter)	1:250,000	2,570
Ontario	1	Horizontal control	1:50,000	5,040
	2	Revision and additional vertical control	1:50,000	3,360

Topographical detail was plotted on sheets for areas totalling approximately 27,400 square miles.

A winter party, provided by Army Survey Establishment, established basic level control between Great Slave and Great Bear Lakes and from Great Bear Lake to the Mackenzie River.

AIR SURVEY

The following mapping was completed:

Province or Territory	Number of map-sheets	Scale of publication	Area (square miles)
1. Planimetric			
Yukon	¼	1:250,000	1,155
British Columbia	1	1:250,000	5,966
Saskatchewan	38	1:50,000	12,645
Manitoba	6	1:50,000	2,340
	1	1:250,000	4,873
Quebec	1	1:50,000	400
Labrador	1	1:250,000	5,536
Miscellaneous Planimetric Projects, as follows, undertaken for Canadian Hydrographic Service (coastal areas); Geological Survey of Canada (preliminary mapping); Legal Surveys and Aeronautical Charts Division and Department of Resources and Development (special projects):			
Northwest Territories	16	1″ = ½ mile	3,461
	11	1″ = 2 miles	31,102
British Columbia	1	1″ = 1 mile	192
	2	1″ = 2 miles	949
Alberta	1	1″ = ½ mile	360
Manitoba	1	1:250,000	5,703
Quebec	2	1″ = ½ mile	700
Nova Scotia	1	1″ = ½ mile	5
Total, planimetric mapping	.....	.....	75,387
2. Topographic			
British Columbia	1½	1:50,000	540
Quebec	15	1:50,000	4,773
Quebec and Labrador	4	1:50,000	1,373
Nova Scotia	9	1:50,000	1,376
Newfoundland	33	1:50,000	8,318

Province or Territory	Number of map-sheets	Scale of publication	Area (square miles)
Miscellaneous Topographic Projects, as follows, undertaken for Canadian Hydrographic Service, Legal Surveys and Aeronautical Charts Division, Geological Survey of Canada and Department of Resources and Development:			
British Columbia	7	1" = ½ mile	75
Saskatchewan	9	1:10,000	287
Quebec	9	1" = 1,000'	367
New Brunswick	2	1" = 1,000'	80
Newfoundland	1	1:50,000	200
Total, topographic mapping			17,389
3. Mosaics			
Northwest Territories	6		3,639
British Columbia	1		306
Saskatchewan and Alberta	1		300
Ontario	1		1,800
Ontario and Quebec	4		9,337
Quebec	7		5,426
New Brunswick	2		6,180
Newfoundland	2		1,225
Total, mosaics	24		28,213

COMPUTATIONS AND CONTROL

A comprehensive card system of filing map-control information was initiated, and a large volume of such data was supplied on request to other federal and provincial government agencies and to a number of private companies engaged in the development of natural resources.

MAP INSPECTION AND EDITING

A senior field officer was assigned to supervise the last-minute check and inspection of all topographic detail appearing on map manuscripts. This final check by experienced and competent personnel is of great assistance in improving the quality of the maps.

Map Sheets forwarded for Reproduction

Province or Territory	1:50,000	1:250,000	Total	Area (square miles)
Newfoundland	18	1	19	11,331
Quebec-Newfoundland	6	.....	6	2,060
Nova Scotia	25	.....	25	8,637
New Brunswick	6	.....	6	2,473
Quebec	12	.....	12	4,000
Ontario	2	.....	2	525
Manitoba	4	.....	4	1,431
Saskatchewan	6	.....	6	2,000
Alberta	5	.....	5	1,246
British Columbia	2	3	5	18,145
Northwest Territories	.....	2	2	8,269
Yukon Territory	.....	1	1	3,986
	86	7	93	64,103

Map Sheets Inked or Traced for Advance Information Prints

Newfoundland	14
Quebec-Newfoundland	12
Nova Scotia	18
New Brunswick	8
Quebec	15
Manitoba	7
Saskatchewan	39
Alberta	1
British Columbia	4
Northwest Territories	2
Yukon Territory	1

Three hundred and eight projections were drawn to various scales and 180 manuscripts were mounted on metal.

Numerous index maps, charts, and special drawings were prepared.

NATIONAL AIR PHOTOGRAPHIC LIBRARY

During the fiscal year, 58,431 new prints were added to the collection, bringing the total now on file to 2,370,811. Those added during the year are of areas totalling 376,000 square miles, of which 236,000 square miles were covered by vertical photography, (including 192,000 covered by photographs taken at over 30,000 feet above sea-level), and 140,000 square miles by trimetrogon photography.

Purchases of prints by various agencies, organizations and individuals during the year totalled 452,586 compared with 411,807 in the previous fiscal year. Index maps were supplied in practically every case.

Copies of a new air photo coverage map of Canada, compiled during the year, are available on request.

CANADIAN BOARD ON GEOGRAPHICAL NAMES

The Board adopted names for 100 maps, 13 hydrographic charts and 21 provincial maps, and considered many new names, name changes, and other related matters.

The first volume (Southwestern Ontario) of a new Gazetteer of Canada series was published and the second volume (British Columbia) is in press.

Seven provincial members or their representatives attended the January, 1953 meeting of the Board, at which several items of particular interest to the provinces were discussed. A member representing Newfoundland was appointed in March 1953.

The present membership of the Board is:

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

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

CANADIAN HYDROGRAPHIC SERVICE

Seven ships, two of them chartered, and one launch were engaged in charting the coastal waters, and two launches in the charting of inland waters. The Service, in addition, had two hydrographers on the Department of Transport vessel *C. D. Howe*, in the eastern Arctic. The season's work on coastal waters will result in the publication of 29 new charts, including 2 provisional charts, and the work on inland waters, in the publication of 3 new charts.

Much of the charting was in connection with new mineral and other industrial developments, an illustration being the reconnaissance sounding of Leaf Bay and Leaf Lake on the west side of Ungava Bay where large deposits of iron-bearing minerals have been disclosed.

Safety of shipping is the principal reason for charting, but there is also a considerable call for hydrographic surveys for defence and scientific purposes. Among the latter requirements are accurate bathymetric charts for oceanographic and fishery studies. In this connection modern charts of Newfoundland waters are needed. A comprehensive system of chart coverage for the coastal waters of that province has been formulated and a start has been made on the hydrographic survey of its seaboard.

HYDROGRAPHY

Gulf of St. Lawrence, Atlantic Coast, and Arctic Waters

At the request of the Federal Department of Public Works the *Cartier* made a thorough examination of the channel leading into Richibucto on the east coast of New Brunswick. It completed the charting of Havre St. Pierre and approaches in eastern Quebec required by shipping in connection with the titanium ore developments at Allard Lake. As a result of the work a new chart "Havre St. Pierre and Approaches" will be published. The ship made a reconnaissance survey of waterfront changes at Seven Islands, the tide-water terminus for the Quebec-Labrador iron ore project, and did charting operations in the approaches to Gaspe.

Summary of season's work:

Ship sounding	1061 linear nautical miles
Boat sounding	504 " " "
Shoals examined	14
Oceanographical stations occupied	7

The *Kapuskasing* in its principal operation charted George Bay on the north coast of Nova Scotia. It also examined a reported deep between the Magdalen Islands and Prince Edward Island; calibrated Yarmouth and Canso radio direction-finding stations in Nova Scotia, and examined a reported shoal area off Seal Island, Nova Scotia. As a result of the work three new nautical charts will be published: "George Bay", "Pomquet and Tracadie Harbours" and "Plans of Harbours; Port Hood, Mabou Harbour and Havre Bouche".

Summary of season's work:

Ship sounding	1649 linear nautical miles
Boat sounding	1977 " " "
Shoals examined	279

The *Fort Frances*, assisted by the launch *Dawson*, carried out detailed charting on the west side of Placentia Bay, Newfoundland. Oceanographical observations were taken on the ship's course between Halifax, N.S., and Burin,

Nfld. As a result of the work three new navigation charts will be published: "Cape St. Mary to Little Placentia Bay and Long Island", "Burin Harbours" and "Pays Cove to Terrenceville".

Summary of season's work:

Ship sounding	1564 linear nautical miles
Boat sounding	2485 " " "
Coastlining	151 " " "
Oceanographical stations occupied	18
Shoals examined	314

The hydrographic ship *Acadia* charted the approaches to St. John's and Conception Bay, Newfoundland. Its main task of the season, however, was the detailed charting of a critical 37-mile section of Lake Melville, Hamilton Inlet, on the shipping route to Goose Bay.

The season's activities will result in the publication of three new charts: "Spaniard's Bay to Colliers Bay", "Ticoralak Island to Carrington Island" and "Carrington Island to Etagaulet Bay".

Summary of season's work:

Ship sounding	1452 linear nautical miles
Boat sounding	1825 " " "
Shoals examined	83
Oceanographical stations occupied	27

The survey of Hopedale and approaches on the coast of Labrador, which was started in 1950, was extended by the chartered vessel *Theron*. An area of 52 square miles, largely original charting, was sounded.

The ship's main operation of the season, however, was the charting of Spurrell Harbour and the entrance to Chesterfield Inlet on the west coast of Hudson Bay. It spent a day at Cape Dorset on the southwest side of Baffin Island where some reconnaissance sounding was done.

As a result of the season's work two new charts will be published: "Spurrell Harbour and Entrance to Chesterfield Inlet" and "Hopedale Harbour and Approaches".

Summary of season's work:

Ship sounding	899 linear nautical miles
Boat sounding	1,173 " " "
Coastlining	69 " " "
Shoals examined	14
Oceanographical stations occupied	29

The chartered vessel *Algerine* charted the approaches to the Koksoak River that flows into the southern part of the Ungava Bay and carried out a reconnaissance sounding of Leaf Bay and Leaf Lake on the west side of Ungava Bay. The work is of importance in connection with recent discoveries of iron ore in the region. Preliminary hydrographic data in regard to Diana Bay was also obtained. As a result of the season's operations the following charts will be published: "Approaches to Koksoak River" and "Koksoak River Mouth". Provisional charts "Leaf Bay and Approaches" and "Diana Bay" will be issued also.

Summary of season's work:

Ship sounding	960 linear nautical miles
Boat sounding	1,322 " " "
Shoals examined	17
Oceanographical stations occupied	21

Two hydrographers were again placed on the Department of Transport vessel *C. D. Howe*. Much valuable hydrographic information was obtained at thirteen ports of call in the Eastern Arctic and ship soundings over much of the vessel's track were recorded for chart use.

Hydrographic work accomplished:

Ship sounding	7,237 linear nautical miles
Boat sounding	214 " " "

Pacific Coast

The *Wm. J. Stewart* made a complete survey of the Douglas Channel-Gardner Canal area in connection with the Kemano power development and the proposed aluminium shipping port of Kitimat. The survey of Queen Charlotte Strait on the northeast side of Vancouver Island, and of the western end of Johnstone Strait between Vancouver Island and the mainland was continued. A section of Dean Channel was also surveyed.

Summary of season's work:

Ship sounding	247 linear nautical miles
Boat sounding	2,182 " " "
Coastlining	486 " " "
Shoals examined	578
Oceanographical stations occupied	52

The smaller vessel *Parry* conducted charting operations in the eastern part of Johnstone Strait.

Summary of season's work:

Boat sounding	879 linear nautical miles
Coastlining	159 " " "
Shoals examined	207

As a result of the year's operations on the west coast 5 new charts were completed and 8 others were in process of compilation.

The *Marabell*, the 136-foot ex-minesweeper acquired in 1952 was being converted for hydrographic surveying requirements.

Inland Waters

The launch *Bayfield* completed the survey of the Canadian shipping channels in the western end of Lake Erie, from Southeast Shoal to the Detroit River. The season's work will result in the publication of a new chart "Pelee Passage to Detroit River".

Summary of season's work:

Boat sounding	520 linear nautical miles
Shoals examined	19
Wrecks located	4

The launch *Boulton* conducted survey operations in the Bay of Quinte, Lake Ontario, between Upper Gap and Picton Bay, the greater part of which had not been charted since 1893. The work is required in connection with the proposed construction of a large iron-ore loading dock at Picton Bay. As a result of the survey a large-scale chart "Picton Bay" will be published and considerable information was obtained for a second new chart "Upper Gap to Telegraph Narrows".

Summary of season's work:

Boat sounding	529 linear nautical miles
Coastlining	48 " " "
Shoals examined	7

CHART PRODUCTION

Chart output exceeded that of any previous year. Production was as follows:

Standard charts (first editions)	8
New editions of existing charts	23
Reprints	15
Arctic charts	21
Special charts (plotting, instructional etc.)	48

PRECISE WATER LEVELS

The Division maintains self-registering water-level gauges at 46 permanent stations located strategically along the 1,400 miles of the St. Lawrence-Great Lakes waterway from Quebec to Port Arthur. The fluctuating water-level records are analysed and the results are incorporated into water-level bulletins, graphs and reports for the use of all services active in the maintenance and improvement of the waterway. Research is carried on into the various phenomena which affect the river and lake levels.

Extensive use of these records was made by the Special Projects Branch, Department of Transport, Montreal, in connection with the preparation of construction plans for the proposed St. Lawrence Seaway. The Select Committee of the Ontario Legislature, now studying the problem of present water levels of the Great Lakes, lakeshore erosion, etc., was provided with pertinent data.

TIDAL AND CURRENT SURVEY

An extensive tidal and current survey was carried out in Miramichi Bay on the east coast of New Brunswick at the request of the Federal Department of Public Works. The annual loss in fisheries caused by frequent and unseasonable ice movement is being investigated in an endeavour to discover means whereby this increasingly serious situation may be remedied. The tidal circulation in the bay was determined by the Hydrographic Service and the relationship to ice movement was studied.

A comprehensive study of tides and currents in the Strait of Canso was undertaken, necessitated by the construction of the causeway across that waterway, now in progress.

The aluminium development at Kitimat on the Pacific Coast required the installation of a tide gauge station at that port.

DISTRIBUTION OF HYDROGRAPHIC PUBLICATIONS

	1952–53	1951–52
Catalogue of charts, Sailing Directions and Tidal Information with index maps	2,104	2,110
Navigation charts	54,507	52,057
Instructional charts, special charts, etc.	65,452	4,261
Pilots and Sailing Directions	1,406	1,097
Supplements to Pilots	573	797
Tide Tables	64,484	58,069
Water-level bulletins, graphs, etc., exclusive of those distributed through Notices to Mariners	11,535	10,491

Canadian nautical publications are made available to shipping either from headquarters at Ottawa and Victoria, or from agencies in all principal sea and inland water ports. In accordance with international practice, the information contained in Canadian Hydrographic charts and publications is reproduced by other hydrographic offices. Thus their world circulation is much in excess of the figures given above.

LEGAL SURVEYS AND AERONAUTICAL CHARTS

LEGAL SURVEYS

Provincial Boundary Surveys

The Alberta-Northwest Territories boundary was surveyed and monumented westerly from the Little Buffalo River to a point 65 miles east of the Mackenzie Highway—a distance of 50 miles. Sixty miles of this boundary still remain to be surveyed.

The survey of the Alberta-British Columbia boundary was completed by continuing it northerly 48 miles to its junction with the Alberta-Northwest Territories boundary.

The British Columbia-Northwest Territories boundary was surveyed 48 miles westerly from its eastern terminus at longitude 120°, and 26 miles easterly from its lower crossing of the Petitot River at about longitude 123°. Eighteen miles of trial line were surveyed westerly from the latter point.

On behalf of the respective boundary commissions, arrangements were made with the Geodetic Survey for taking two precise astronomical observations for latitude to control the location of the easterly part of the Alberta-Northwest Territories boundary.

Indian Reserve Surveys

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

Prince Edward Island	Lennox Island.
Nova Scotia	Escasoni, Sheet Harbour.
Ontario	Chapleau, Kettle Point, Lac Seul, Mountbatten, Spanish River.
Manitoba	Dawson Bay.
Saskatchewan	Sakima, The Key.
Alberta	Peigan, Pigeon Lake, Sarcee.
British Columbia	Cape Mudge, Comox, Cowichan, Dolphin Is., Kitimat, Masset, Port Simpson, East Saanich, South Saanich, Skidegate, Tsahaheh.

Surveys in Yukon

Two survey parties headed by staff surveyors operated in the Yukon.

One party was engaged exclusively on mineral claim surveys in the Mayo area and completed the survey of 102 claims. In addition, a number of claims in this area were surveyed by a private surveyor employed by local mining companies; survey instructions for these latter surveys were issued by the Surveyor General.

The second party carried out miscellaneous legal surveys at Dawson and at Whitehorse. The work at Dawson comprised the survey of sites for St. Mary's Hospital, an Old People's Home, the Canadian Legion canteen, a reservation for married quarters, and a warehouse for the Department of National Defence. The work at Whitehorse consisted of a traverse of the Yukon River along the waterfront; the survey of a cemetery subdivision, of three parcels for the Department of National Defence, and of a lot for a private company in the vicinity.

Under instructions from the Surveyor General, private surveyors surveyed that portion of the British Yukon Railway right-of-way from the British Columbia boundary to Whitehorse and in Whitehorse itself, as well as a lot near Watson Lake.

Surveys in Northwest Territories

A party headed by a staff surveyor surveyed a subdivision of Pine Point townsite; the Mackenzie Highway right-of-way from the 60th parallel to Hay River—a distance of 82 miles; a road between Hay River and the adjacent Fishing Station; lease ties to the Mackenzie Highway and the foregoing road; a road traverse to a gravel pit on Hay River off the Mackenzie Highway; and 42 miles of Snare River transmission line right-of-way in the Yellowknife area.

Instructions were issued to a private surveyor for survey of 66 mineral claims in the Yellowknife mining district.

Other Surveys

At the request of the National Parks Branch, Department of Resources and Development, legal surveys were carried out in the following national parks: Prince Edward Island; Fort Anne, in Nova Scotia; Banff, in Alberta; and Mount Revelstoke, in British Columbia. Historic sites were surveyed at Halifax and Lunenburg in Nova Scotia.

At the request of the Lands Division, Department of Resources and Development, retracement and subdivision surveys were made of the north and south ordnance reserves at Owen Sound, Ontario.

Office

The Division made 248 miscellaneous plans, tracings and Indian location ticket sketches; prepared plans and field notes of 161 mineral claims in Yukon Territory for record purposes; prepared final draughts of 85 plans of base lines in Alberta, preparatory to confirmation; examined returns of the 1951-1952 survey of the Alberta-Northwest Territories boundary and prepared a report thereon for the Boundary Commission; examined the plan of survey of the Trans-Mountain pipeline through Jasper National Park; and processed the returns of miscellaneous surveys in Indian reserves and Crown lands.

It recorded 102 plans and the respective field notes in the surveys records of the Indian Affairs Branch, Department of Citizenship and Immigration, and sent 98 plans and 57 field books to Legal Surveys records; examined 209 plans of legal surveys and the field notes thereof; despatched 2,239 letters, 3,694 blue or "OCE" prints and 1,270 photostatic copies of survey records; and prepared 262 legal descriptions for use in conveyances of land rights, 35 descriptions of mineral claims and 330 descriptions for petroleum and natural gas permit applications.

AERONAUTICAL CHARTS

The Division supplies the basic topographical information for the construction of aeronautical charts required for civil and military use, and compiles the air information shown on all aeronautical charts.

Air Photogrammetry

One mile to 1 inch, and 1½ miles to 1 inch plots from tri-camera photographs were made as follows:

National Topographic Series Index No.	Area plotted in square miles
13	39,715
24	24,055
33	4,310
55	23,250
56	7,975
76	4,027
78	3,372
79	12,868
86	12,118
87	12,119
88	16,760
89	19,867
97	343
Total	180,779

The Division indexed and filed more than 15,000 tri-camera photographs and prepared operational flight line maps, covering about 48,000 square miles, for completion of the tri-camera photography program for Canada.

At the request of the Defence Research Board it plotted the north coast of Ellesmere Island at a scale of 2 miles to 1 inch.

Chart Construction and Air Information

The Division prepared 18 new air information plates for the 8-mile-to-1-inch series of aeronautical charts and examined 177 charts for revision, 63 of which were revised and the remainder reprinted.

It examined 55 sheets at the 1:1,000,000 scale, for revision, 28 of which were revised and the remainder reprinted.

At the request of the R.C.A.F., it commenced work on a new series of aeronautical route charts at scale 1:1,000,000. This series will consist of 14 charts of a strip design and will cover the principal military and civil air routes of Canada.

A revised edition of the aeronautical planning chart for Canada designed to facilitate flight planning was issued. It gives all air navigation aids and an index to the 1 inch to 8-mile and 1:1,000,000 scale aeronautical charts and it shows critically high elevation points.

Work was continued on the preparation and overprinting of a special Georef 10 minute grid for the 37 sheets of the World Aeronautical Chart (1:1,000,000) falling within the Air Defence Identification Zone. To date, 27 charts have been overprinted and supplied to the R.C.A.F. Air Defence Command.

Two new compilations for Saskatoon and Scott Islands at a scale of 1:1,000,000 were prepared as special sheets to afford a more convenient coverage for R.C.A.F. training requirements. In addition, two special sheets—Penhold and Claresholm—at a scale of 1 inch to 8 miles were compiled, drawn, printed and sent to the R.C.A.F. to meet a similar requirement.

Two special plotting charts at a scale of 1:500,000 were prepared for the Royal Canadian Navy, together with a standard symbol sheet printed on the back of each chart.

Canada Air Pilot

Amendments to the Canada Air Pilot are issued weekly, alternating between the Eastern Volume and the Western Volume. Each amendment includes a mimeograph correction list of all corrections to the master copy and a section of revised and new sheets for the manual.

Six hundred and thirty-three new or revised sheets were issued, comprising: 504 revisions to black and white sheets; 90 revisions to two- or three-coloured sheets; 13 new aerodrome pages; 9 new instrument approach and landing charts to ICAO specifications; 16 new radio facility charts to ICAO specifications; and 1 new instrument let-down chart.

The new series of radio facility charts (38 charts) to ICAO specifications was completed, with the exception of two charts covering the Arctic islands.

The number of instrument approach and landing charts issued to ICAO specifications now totals 28.

Columbia River Basin

This project calls for the production of 89 detailed and contoured topographical sheets to be printed at a scale of ½ mile for use of the International Joint Commission in its study of the development of the Columbia River system. To date 36 sheets have been printed or proofed and the compilation of an additional 9 sheets was completed during the year. Field work for the remaining sheets was completed in 1952.

Radar Altimetry

Radar altimetry operations provided 25,000 line-miles of ground profile readings, of which 15,000 line-miles were recorded during R.C.A.F. tri-camera operations in northern regions and 10,000 line-miles were recorded in Ontario and Alberta by a commercial company under contract agreement. The year's operations brings the grand total since the work began in 1948 to 58,000 line-miles. As a result of field operations during the year elevations were established in areas totalling 325,000 square miles, with sufficient accuracy to provide 500-foot contours and spot heights of critical points for sixteen 8-mile-to-the-inch aeronautical charts. Including the work in 1952, elevations have now been established in areas totalling 840,700 square miles, or 37 charts. Contour and spot height manuscripts have been completed for 9 of these charts.

With the assistance of the National Research Council, experimental operations to determine the value of the radar altimetry technique to mapping in general were continued.

SURVEY RECORDS AND ELECTORAL MAPS

Survey Records

New Recordings—Field Books of Survey	255
—Plans of Survey	117
Abstracts from Record—Photostatic copies from Field Books, pages	836
—Copies from Record plans	123
Printed Plans Issued—Township Plans	747
—Settlement Plans	333
Field Books loaned to Province of British Columbia, (reference Peace River Block)	94

Electoral Maps

Major attention was given to preparation of the schedule of the Representation Act, 1952, and to preparation of the federal electoral district maps according to this schedule. The Parliamentary General Redistribution Committee met continually in the first quarter of the fiscal year as did the sub-committees for the various provinces. Much information was supplied to these committees of Parliament, such as population maps, geographical information relating to boundaries, copies of electoral maps according to previous Representation Acts, and preliminary maps of proposed changes in boundaries. When the final boundaries were agreed upon by the Committee, the official descriptions were prepared. Thirty new electoral districts were formed, the boundaries of 105 were changed, and it was necessary to revise the descriptions of 45 other electoral districts.

By the end of the fiscal year 120 of the 304 electoral maps had been printed and work on the remainder was well advanced.

Miscellaneous

Two hundred and eighteen air-line distances were computed and supplied to meet requests, mainly from the Post Office Department.

Astronomical field tables for the altitude and azimuth of the Pole Star and for the right ascension and declination of the Sun for 1953 were checked and prepared for reproduction.

The plan of survey by J. W. Pierce, D.L.S., in 1932 of the Manitoba-Ontario boundary from the initial monument to monument No. 82 was investigated and a memorandum was forwarded for the consideration of the Boundary Commission.

MAP DISTRIBUTION OFFICE

During the fiscal year 49,894 requests for maps, charts, and publications were dealt with compared with 37,643 in the previous fiscal year. Two hundred and three new maps were received from the press.

The following publications were distributed:

	1952–53	1951–52
National Topographic series maps	153,215	169,092
National Defence maps	106,119	93,267
Aeronautical and plotting charts	547,314	331,278
Sectional maps	11,327	11,674
Old Geographic series	1,535	3,604
Miscellaneous maps	64,423	67,715
Forestry maps		5,004
Electoral District Maps	9,462	4,338
Distribution—Maps and aeronautical charts	893,395	685,972
Publications	3,757	5,789
Total, exclusive of Canada Air Pilot	897,152	691,761
Canada Air Pilot (Volumes I and II)	367	
Amendments	39,288	
Sheets	19,840	
Total issue, Canada Air Pilot	59,495	
Total publications distributed	956,647	

BOARD OF EXAMINERS FOR DOMINION LAND SURVEYORS

The principal meeting of the Board was the regular annual meeting called for by Section 10 of the Canada Lands Surveys Act. Examinations were held at Ottawa, Toronto, Regina, Edmonton, Calgary, Vancouver, and Victoria. Ten of the 84 candidates passed the preliminary examination and 14 the final.

Nine certificates of preliminary examination, 6 commissions to Dominion Land Surveyors, and 3 Dominion subsidiary standard measures of length were issued as provided for in the Act.

The Regulations as approved by the Governor in Council under the Canada Lands Surveys Act were issued as the 15th edition of the Rules and Regulations of the Board.

MAP COMPILATION AND REPRODUCTION DIVISION

The Division is responsible for the compilation, draughting and reproduction of maps, charts and plans. The ever-increasing demand for these has caused it to investigate and develop new methods of map reproduction in order to increase production. It has adopted a new technique utilizing thin plastic sheets and contact film screens which has shortened reproduction time, given greater flexibility in the preparation of printing plates, simplified reprinting, and eliminated the costly procedure of storing metal printing plates. Many new techniques are being developed in the fields of draughting and photo-mechanical methods which it is hoped will give greater efficiency in map reproduction.

The Division printed 736 maps and charts compared with 567 in the previous fiscal year, the total number of copies printed—1,907,947—being

nearly 600,000 more than in the previous year. The list includes 3 new and 6 revised Canadian charts of the world aeronautical charts series at scale of 1:1,000,000, produced under Canada's agreement with the International Civil Aviation Organization; 2 new special and 19 revisions of aeronautical charts of areas in Canada at 1 inch to 8 miles; a new map of Canada at the scale of 1 inch to 100 miles; 8 additional new sheets of the Columbia River Basin series; 132 revised electoral maps; 101 hydrographic charts of coastal and inland waters; and 14 geological maps or figures.

COMPILING

New compilations included: 4 world aeronautical charts and 2 special aeronautical charts at 1:1,000,000; 13 National Topographic series maps at 1:250,000; and 5 aeronautical route charts at 1:1,000,000. Revisions in full or in part included: 20 eight-mile aeronautical chart bases, 5 National Topographic series maps, and 3 world aeronautical charts at 1:1,000,000.

Summary of Compilation

—	Scale	First edition	Revised edition
Standard aeronautical charts	8 mi.	.....	8
Preliminary aeronautical charts	8 mi.	.....	12
World aeronautical charts	1 : 1,000,000	4	3
Special aeronautical charts	1 : 1,000,000	2	.....
Aeronautical route charts	1 : 1,000,000	5	.....
National Topographic series	1 : 250,000	13	2
National Topographic series	2 mi.	.....	3
Miscellaneous	.....	.....	1

New and Revised Maps for Which Drawings Were Completed

—	Scale	Number
Standard Aeronautical Charts	8 mi.	9
Preliminary Aeronautical Charts	8 mi.	10
World Aeronautical Charts	1 : 1,000,000	6
Special Aeronautical Charts	1 : 1,000,000	2
Aeronautical Route Charts	1 : 1,000,000	4
National Topographic Series (Map Compilation and Reproduction)	1 : 250,000	27
National Topographic Series (Topographical Survey)	2 and 1 mi. 1 : 250,000	78
Columbia River Basin Series	1 : 31,680	3
Electoral Maps	.....	173
Overprints	.....	170
Miscellaneous	.....	18

Photo-Mechanical

Photo Processing

Wet plate negatives (sq. ft.)	546
Film negatives (sq. ft.)	12,505
Photo-litho plates	1,042
Ferro-prussiates	650
Multilith plates	642

Photography

Infra red (plates developed)	2,672
Infra red (enlargements)	2,212
Roll film (rolls developed)	195
Bromide enlargements (sq. ft.)	4,773
Velox prints	5,935
Transaloid (sq. ft.)	255
Sensitized linen (sq. ft.)	2,059
Photostat (sheets)	10,436

Contact and Blue Printing

Blue prints (sq. ft.)	56,597
Vandyke prints (sq. ft.)	22,521
OCE prints (sq. ft.)	131,400

LITHOGRAPHIC

The new and revised maps printed during the fiscal year are listed in the table at the end of the Division's report. Reprints included 19 world aeronautical charts, 78 eight-mile aeronautical charts, 14 sectional maps and miscellaneous maps such as, air plotting charts, all sheets of the 35-mile map of Canada, a Canadian Arctic regions map, 8 Royal Canadian Navy aeronautical charts, Yukon Territories at 1 inch to 20 miles, etc.

Summary of Printing

—	Maps published	Total copies	Impressions
New Maps Printed	25	104,120	486,720
Revised Maps Printed	129	457,070	1,676,840
Maps Reprinted	175	734,865	3,391,780
Maps Reproduced	1	2,800	11,200
Hydrographic Charts	137	117,840	244,740
Overprints	269	491,252	491,252
	736	1,907,947	6,302,532

In addition, 19 new 1:250,000 maps compiled and draughted by the Division were printed by the Army Survey Establishment, the number of copies being 48,500 and the number of impressions, 164,500.

List of New or Revised Maps
Produced by Map Compilation & Reproduction Division
Fiscal Year 1952-53

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(I) Aeronautical Charts—National Topographic Series				
Newfoundland	11 NE.	La Poile-Burgeo	8 mi.	46°00′ to 48°00′	56°00′ to 60°00′	Stan. edn.—revision
Labrador	13 NE.	Hamilton-Hopedale	8 "	54°00′ " 56°00′	55°00′ " 60°00′	Prelim. edn.—revision
Nova Scotia	11 SW.	Halifax-Louisburg	8 "	44°00′ " 46°00′	60°00′ " 64°00′	Stan. edn.—revision
Quebec	33 SW.	Eastmain	8 "	52°00′ " 54°00′	76°00′ " 80°00′	Prelim. edn.—revision
Quebec-Ontario	31 NW.	Upper Ottawa River	8 "	46°00′ " 48°00′	76°00′ " 80°00′	Stan. edn.—revision
Manitoba-Saskatchewan	63 SW.	Pasquia Hills-Swan River	8 "	52°00′ " 54°00′	100°00′ " 104°00′	" "
Manitoba-Saskatchewan	63 NW.	Flin Flon	8 "	54°00′ " 56°00′	100°00′ " 104°00′	Stan. edn.—part. rev.
Manitoba-Saskatchewan	64 NW.	Wollaston Lake	8 "	58°00′ " 60°00′	100°00′ " 104°00′	Prelim. ed.—part. rev.
Saskatchewan	72 E.	Swift Current-Regina	8 "	48°00′ " 50°00′	104°00′ " 108°00′	Stan. edn.—part. rev.
Saskatchewan-Alberta	73 SW.	Wainwright-Battleford	8 "	52°00′ " 54°00′	108°00′ " 112°00′	Stan. edn.—revision
Alberta	82 NE. SE.	Penhold	8 "	51°00′ " 53°00′	112°00′ " 116°00′	Special 1st edn.—(for R.C.A.F.)
Alberta	82 NE. SE.	Claresholm	8 "	49°00′ " 51°00′	112°00′ " 116°00′	" "
British Columbia	92 SW.	Nootka-Nanaimo	8 "	48°00′ " 50°00′	124°00′ " 128°00′	Stan. edn.—revision
British Columbia	93 NW.	Smithers-Fort St. James	8 "	54°00′ " 56°00′	124°00′ " 128°00′	" "
N.W.T.	48 N.	Devon East	8 "	74°00′ " 76°00′	78°00′ " 80°00′	Prelim. ed.—revision

N.W.T.	56 S.	Wager Bay	8 "	64°00′ " 66°00′	88°00′ " 96°00′	" "
N.W.T.	58 N.	Wellington Channel	8 "	74°00′ " 76°00′	88°00′ " 96°00′	" "
N.W.T.	65 N.	Dubawnt Lake	8 "	62°00′ " 64°00′	96°00′ " 104°00′	" "
N.W.T.	77 N.	Victoria Island East	8 "	70°00′ " 72°00′	104°00′ " 112°00′	" "
N.W.T.	85 SE.	Great Slave	8 "	60°00′ " 62°00′	112°00′ " 116°00′	" "
N.W.T.	87 N.	Fort Collinson	8 "	70°00′ " 72°00′	112°00′ " 120°00′	" "

(II) Other National Topographic Series Maps

Labrador	13 E	Winokapau Lake	1 : 250,000	53°00′ to 54°00′	62°00′ to 64°00′	First edition
Labrador	13 L	Kashishibaw	1 : 250,000	54°00′ " 55°00′	62°00′ " 64°00′	"
Quebec	23 I	Michikamau	1 : 250,000	54°00′ " 55°00′	64°00′ " 66°00′	"
Quebec	24 C	Cambrian Lake	1 : 250,000	56°00′ " 57°00′	68°00′ " 70°00′	"
Quebec	24 K	Fort Chimo	1 : 250,000	58°00′ " 59°00′	68°00′ " 70°00′	"
Ontario	31 F/13	Grand Lake	1 mi.	45°45′ " 46°00′	77°30′ " 78°00′	Revision
Manitoba	64 A	Split Lake	1 : 250,000	56°00′ " 57°00′	96°00′ " 98°00′	First edition
Saskatchewan	64 M	Phelps Lake	1 : 250,000	59°00′ " 60°00′	102°00′ " 104°00′	"
Alberta	83 N	Winagami Lake	1 : 250,000	55°00′ " 56°00′	116°00′ " 118°00′	"
British Columbia	94 M	Rabbit River	1 : 250,000	59°00′ " 60°00′	126°00′ " 128°00′	"
British Columbia	104 O	Jennings River	1 : 250,000	59°00′ " 60°00′	130°00′ " 132°00′	"
N.W.T.	56 H	Douglas Harbour	1 : 250,000	65°00′ " 66°00′	88°00′ " 90°00′	"
N.W.T.	75 J	Lynx Lake	1 : 250,000	62°00′ " 63°00′	106°00′ " 108°00′	"
N.W.T.	85 E	Mills Lake	1 : 250,000	61°00′ " 62°00′	118°00′ " 120°00′	"

List of New or Revised Maps Produced by Map Compilation and Reproduction Division, Fiscal Year 1952-53—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
		(II) Other National Topographic Series Maps—Concluded				
N.W.T.	85 F	Falaise Lake	1 : 250,000	61°00′ to 62°00′	116°00′ to 118°00′	First edition
N.W.T.	85 G	Sulphur Bay	1 : 250,000	61°00′ " 62°00′	114°00′ " 116°00′	"
N.W.T.	85 L	Willow Lake	1 : 250,000	62°00′ " 63°00′	118°00′ " 120°00′	"
N.W.T.	86 G	Red Rock Lake	1 : 250,000	65°00′ " 66°00′	114°00′ " 116°00′	"
N.W.T.	95 I	Bulmer Lake	1 : 250,000	62°00′ " 63°00′	120°00′ " 122°00′	"
Yukon	105 C	Teslin	1 : 250,000	60°00′ " 61°00′	132°00′ " 134°00′	"
Yukon	105 F	Quiet Lake	1 : 250,000	61°00′ " 62°00′	132°00′ " 134°00′	"
Yukon	115 H	Aishihik Lake	1 : 250,000	61°00′ " 62°00′	136°00′ " 138°00′	"
		(III) *World Aeronautical Charts*				
Newfoundland	2260	Harbour River	1 : 1,000,000	44°00′ to 48°00′	48°00′ to 56°00′	Partial revision
Newfoundland-Quebec	2223	Natashquan River	1 : 1,000,000	48°00′ " 52°00′	56°00′ " 64°00′	" "
Quebec-N.W.T.	2108	Soper River	1 : 1,000,000	60°00′ " 64°00′	64°00′ " 72°00′	First edition
Quebec	2145	Kogaluk River	1 : 1,000,000	56°00′ " 60°00′	72°00′ " 80°00′	"
Ontario-Manitoba	2182	Sachigo River	1 : 1,000,000	52°00′ " 56°00′	88°00′ " 96°00′	Partial revision
Manitoba-Saskatchewan	2218	Assiniboine River	1 : 1,000,000	48°00′ " 52°00′	96°00′ " 104°00′	" "
Saskatchewan-Alberta	2217	South Saskatchewan River	1 : 1,000,000	48°00′ " 52°00′	104°00′ " 112°00′	" "
N.W.T.	2083	Davis Strait	1 : 1,000,000	64°00′ " 68°00′	52°00′ " 64°00′	First edition

N.W.T.	2110	Sutton River	1 : 1,000,000	60°00′ " 64°00′	90°00′ " 98°00′	Revision
		(IV) Columbia River Basin Series				
British Columbia	13	Lower Arrow Lake Area	1 : 31,680	49°00′ to 49°08′	117°30′ to 117°47′	First edition
British Columbia	14	Lower Arrow Lake Area	1 : 31,680	49°08′ " 49°24′	117°36′ " 117°46′	"
British Columbia	21	Upper Arrow Lake Area	1 : 31,680	50°38′ " 50°50′	117°38′ " 117°55′	"
British Columbia	53	Upper Kootenay River Area	1 : 31,680	49°22′ " 49°34′	115°13′ " 115°33′	"
British Columbia	54	Upper Kootenay River Area	1 : 31,680	49°27′ " 49°35′	115°23′ " 115°43′	"
British Columbia	55	Upper Kootenay River Area	1 : 31,680	49°31′ " 49°43′	115°43′ " 116°11′	"
British Columbia	56	Upper Kootenay River Area	1 : 31,680	49°35′ " 49°43′	115°30′ " 115°50′	"
British Columbia	61	Creston Area	1 : 31,680	49°00′ " 49°12′	116°18′ " 116°34′	"
		(V) Miscellaneous				
Canada		Geographical Map	100 mi.			First edition
Western Canada		Petroleum and Gas in Western Canada				New; for Canada Year Book
Saskatchewan		Saskatchewan South	16 "			Partial revision
Northwestern Canada		Northwest Canada Transportation Facilities	50 "			Revision
World		Canada's Defence Against Aggression Overseas				For Dept. National Defence (French and English Editions)

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment. Fiscal Year 1952-53

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Nova Scotia	11 E/16	Gurnsey Cove W ½	1 : 50,000	45°45′ to 46°00′	62°15′ to 62°30′	First edition
Nova Scotia	11 E/16	Malignant Cove E ½	1 : 50,000	45°45′ " 46°00′	62°00′ " 62°15′	"
Nova Scotia	11 F/4	Country Harbour	1 : 50,000	45°00′ " 45°15′	61°30′ " 62°00′	"
Nova Scotia	11 F/5	Gusysborough	1 : 50,000	45°15′ " 45°30′	61°30′ " 62°00′	"
Nova Scotia	11 F/9	Framboise	1 : 50,000	45°30′ " 45°45′	60°00′ " 60°30′	"
Nova Scotia	11 F/12	Antigonish	1 : 50,000	45°15′ " 45°30′	61°30′ " 62°00′	"
Nova Scotia	11 F/14	Whycocomagh	1 : 50,000	45°45′ " 46°00′	61°00′ " 61°30′	"
Nova Scotia	11 K/3	Lake Ainslie	1 : 50,000	46°00′ " 46°15′	61°00′ " 61°30′	"
Nova Scotia	11 K/4	Port Hood	1 : 50,000	46°00′ " 46°15′	61°30′ " 61°45′	"
Nova Scotia	21 A/9	Chester	1 : 50,000	44°30′ " 44°45′	64°00′ " 64°30′	"
Nova Scotia	21 A/12	Digby	1 : 50,000	44°30′ " 44°45′	65°30′ " 66°00′	"
Nova Scotia	21 A/14	Bridgetown	1 : 50,000	44°45′ " 45°00′	65°00′ " 65°30′	"
Nova Scotia	21 B/8	Church Point	1 : 50,000	44°15′ " 44°30′	66°00′ " 66°30′	"
New Brunswick	21 G/2	St. George	1 : 50,000	45°00′ " 45°15′	66°30′ " 67°00′	"
New Brunswick	21 G/10	Fredericton Junction	1 : 50,000	45°30′ " 45°45′	66°30′ " 67°00′	"
Nova Scotia	21 H/3	Margaretsville	1 : 50,000	45°00′ " 45°15′	65°00′ " 65°15′	"
Newfoundland	23 J/14	Elross Lake	1 : 50,000	54°45′ " 55°00′	67°00′ " 67°30′	"
Newfoundland	23 J/15	Knob Lake	1 : 50,000	54°45′ " 55°00′	66°30′ " 67°00′	"

Manitoba	62 P/6	Koostatak	1 : 50,000	51°15′ " 51°30′	97°00′ " 97°30′	"
Manitoba	63 J/9	Drunken Lake	1 : 50,000	54°30′ " 54°45′	98°00′ " 98°30′	"
Manitoba	63 J/16	Duck Lake	1 : 50,000	54°45′ to 55°00′	98°00′ to 98°30′	"
Manitoba	64 C/5	Kamachawie Lake	1 : 50,000	56°15′ " 56°30′	101°30′ " 102°00′	"
Manitoba	64 C/15	Cockerham Lake	1 : 50,000	56°45′ " 57°00′	100°30′ " 101°00′	"
Manitoba	64 C/16	Barrington Lake	1 : 50,000	56°45′ " 57°00′	100°00′ " 100°30′	"
Manitoba	64 F/2	Wells Lake	1 : 50,000	57°00′ " 57°15′	100°30′ " 101°00′	"
Manitoba	64 G	Big Sand Lake	1 : 250,000	57°00′ " 58°00′	98°00′ " 100°00′	"
Saskatchewan	72 H/8	Radville	1 : 50,000	49°15′ " 49°30′	104°00′ "[104°30′	"
Saskatchewan	72 H/15	Dummer	1 : 50,000	49°45′ " 50°00′	104°30′ " 105°00′	"
Alberta	73 L/1	Reita Lake	1 : 50,000	54°00′ " 54°15′	110°00′ " 110°30′	"
Alberta	73 L/2	Muriel Lake	1 : 50,000	54°00′ " 54°15′	110°30′ " 111°00′	"
Alberta	73 L/10	Marguerite Lake	1 : 50,000	54°30′ " 54°45′	110°30′ " 111°00′	"
Alberta	73 L/12	Beaver Lake	1 : 50,000	54°30′ " 54°45′	111°30′ " 112°00′	"
N.W.T.	75 L/1	Austin Lake	1 : 50,000	62°00′ " 62°15′	110°00′ " 110°30′	"
N.W.T.	75 L/2	La Loche Lakes	1 : 50,000	62°00′ " 62°15′	110°30′ " 111°00′	"
N.W.T.	75 L/3	McDonald Lake	1 : 50,000	62°00′ " 62°15′	111°00′ " 111°30′	"
N.W.T.	75 L/4	Keith Island	1 : 50,000	62°00′ " 62°15′	111°30′ " 112°00′	"
N.W.T.	75 L/7	Snowdrift	1 : 50,000	62°15′ " 62°30′	110°30′ " 111°00′	"
N.W.T.	75 L/8	McLean Bay	1 : 50,000	62°15′ " 62°30′	110°00′ " 110°30′	"
N.W.T.	75 L/9	Tochatwi Bay	1 : 50,000	62°30′ " 62°45′	110°00′ " 110°30′	"
Alberta	83 G/SW	Pembina	2 mi.	53°00′ " 53°30′	115°00′ " 116°00′	"

78926—4½

List of New Maps Compiled by Topographical Survey, Draughted by Map Compilation and Reproduction, and Printed at the Army Survey Establishment. Fiscal Year 1952-53—Concluded

Location	Number	Name	Scale	Latitude	Longitude	Remarks
Alberta	83 G/SE	Warburg	2 mi.	53°00′ to 53°30′	114°00′ to 115°00′	First edition
Alberta	83 G/NW	Chip Lake	2 mi.	53°30′ " 54°00′	115°00′ " 116°00′	"
Alberta	83 H/11	Edmonton	1 : 50,000	53°30′ " 53°45′	113°00′ " 113°30′	"
Alberta	83 H/12	St. Albert	1 : 50,000	53°30′ " 53°45′	113°30′ " 114°00′	"
Alberta	83 H/13	Morinville	1 : 50,000	53°45′ " 54°00′	113°30′ " 114°00′	"
Yukon	105 B	Wolf Lake	1 : 250,000	60°00′ " 61°00′	130°00′ " 132°00′	"

GEOLOGICAL SURVEY OF CANADA

W. A. Bell, Director

The Survey placed seventy-eight parties in the field, fifty of which were engaged on regional geology assignments, thirteen on Pleistocene and engineering geology, six on palæontological studies, six on fuel resources investigations, and three on investigations in connection with radioactive minerals. In the previous year eighty-eight parties were assigned to field work, the chief causes for the reduction in 1952 being the difficulty of recruiting qualified geologists, and the assigning of five geologists to a project known as "Operation Keewatin", consisting of a reconnaissance survey of 57,000 square miles of the District of Keewatin, Northwest Territories. In reference to the first-mentioned cause it may be noted that thirteen geologists resigned during the year to accept more remunerative positions.

The distribution of the 78 field parties in 1952 was as follows: Yukon, 7; Northwest Territories, 7; British Columbia, 14; Alberta, 8; Saskatchewan, 5; Manitoba, 4; Ontario, 6; Quebec, 7; Quebec-Labrador, 4; New Brunswick, 3; Nova Scotia, 2; Newfoundland, 7; General (more than one province) 4.

Much field and office work, in Ottawa and in the Calgary office, continued to be devoted to stratigraphic problems relating to the occurrence of oil and natural gas. In addition, records and facilities were placed at the disposal of visiting oil geologists employed in Canada.

To aid in the search for minerals, over 10,000 specimens sent in from all parts of Canada were reported upon during the fiscal year. As agent for the Atomic Energy Control Board, the Geological Survey examined quantitatively for radioactivity more than 3,000 samples of radioactive minerals submitted by prospectors.

Geophysical work was concentrated on aeromagnetic surveys, and an area of approximately 31,000 square miles in the bituminous sands district of Athabasca River, Alberta, was flown in 1952.

The second annual report of the National Advisory Committee on Research in the Geological Sciences was published. Seventeen grants totalling $19,122 were made to various Canadian universities for conducting specific research projects approved by the Committee.

Through his death on October 4, 1952, the Geological Survey lost the valuable services of H. V. Ellsworth, who became head of the Radioactive Resources Division in 1948, the position he held at the time of his death. Dr. Ellsworth joined the Geological Survey in 1918 and soon became known internationally as an authority on the chemistry and mineralogy of radioactive and rare-earth minerals. He was also a pioneer in the development of a light portable Geiger counter on which many of the commercial units now in use in Canada are modelled. As head of the Radioactive Resources Division he was chief consultant to the Geological Survey in its capacity as agent for the Atomic Energy Control Board. Dr. A. H. Lang has succeeded Dr. Ellsworth as head of the Division.

REGIONAL GEOLOGY DIVISION

Forty-two of the fifty geologists in charge of field parties were engaged in geological studies and mapping in potential mineral and fuel areas of Canada; the others made special detailed studies in relation to mineral deposits and strategic minerals.

Field Work

Standard geological mapping on scales of 1 inch to 1 mile or 4 miles was conducted in 32 areas across Canada; conventional reconnaissance surveys were made in 6 regions; and detail mapping was commenced in the Goldfields region of northern Saskatchewan, and was continued in Dasserat township, Quebec, and in the Ungava iron belt. The field work also included: the aforementioned Operation Keewatin; an airborne magnetometer survey of a large region lying mainly in northern Alberta; and studies of the iron deposits of Ontario, mica in Ontario and Quebec, and chromite of western Newfoundland.

NORTHWEST TERRITORIES AND ARCTIC

C. S. Lord had charge of "Operation Keewatin", the Geological Survey's largest project in Northwest Territories in 1952. He was assisted by four of the Survey's experienced geologists, namely, G. M. Wright, H. A. Quinn, K. E. Eade, and H. E. Lee. The project consisted of a reconnaissance survey of a 57,000-square mile part of the District of Keewatin, in which, for the first time in Canada, use was made of helicopters in geological mapping. In the barren lands of northern Canada the season for canoe travel is seldom more than 2 months, and the helicopter project was an attempt to use a method that would permit work for a season of normal length so as to increase output and cut down the cost per square mile of area examined.

The project was definitely successful. Although the work cost $3.63 a square mile, which is approximately the cost by conventional methods, the area mapped was about thirty times greater than a normal field party would have covered in one season. The geologists engaged on the project outlined about 14,000 square miles of promising mineral ground, or 25 per cent of the total Precambrian area observed. This percentage is large in comparison with other known Precambrian areas, and hence the possibilities for mineral discoveries are considered to be above average. H. A. Lee was mainly interested in the glacial history and glacial deposits of the region and on these he obtained much information.

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

Y. O. Fortier completed, for the present, geological explorations of the coasts of southern Baffin Island. The geology is characteristic of the Grenville type of prevailing granitic rocks and mixed gneisses grading into less metamorphosed sedimentary strata. The region appears favourable for the occurrence of industrial minerals.

W. W. Heywood commenced a reconnaissance geological survey of Ellef Ringnes Island in the northern Arctic.

R. W. Hutchinson continued a detailed study of the regional zonation, internal structure, and rare-element mineral composition of pegmatites in the Yellowknife-Beaulieu River region. These contain the strategic minerals beryl, spodumene, tapiolite, and columbite-tantalite.

A. B. Irwin visited various operating mines in the District of Mackenzie, and supplied prospectors at Fort Simpson, Fort Norman, and Aklavik with instruction material for prospectors' classes. His duties as supervisory petroleum engineer for the Department of Resources and Development necessitated two visits to Ottawa, a 3-weeks boat trip down Mackenzie River to inspect drilling operations and staking of permits at Wrigley, and brief visits to Norman Wells, Deep Bay, and Fort Simpson. He also visited geophysical and geological exploration parties in scattered localities.

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

R. Thorsteinson completed a geological reconnaissance of the coast of Cornwallis Island, comprising a strip varying in width from 6 to 20 miles, and extended the work to nearby 'Little Cornwallis' Island. These islands are underlain mainly by a thick series of folded Palæozoic sedimentary rocks that appear to include petroliferous horizons. On the southwest coast of Cornwallis Island a much younger, possibly Tertiary, coal-bearing formation was discovered.

YUKON TERRITORY

R. B. Campbell continued geological mapping of the Glenlyon area (longitude 134° to 136°, latitude 60° to 61°), and spent some time in more detailed mapping of the Glenlyon Range, which appears favourable for prospecting for a variety of minerals, particularly base metals.

L. H. Green commenced geological mapping of the Mayo Lake area (longitude 134° 30′ to 135°, latitude 63° 45′ to 64°), which lies just east of Galena and Keno Hills where silver-lead-zinc ore is being mined and which contains vein deposits of similar type.

E. D. Kindle commenced geological mapping of the Keno Hill area (longitude 135° to 135° 30′, latitude 63° 45′ to 64°), which includes Galena and Keno Hills.

J. E. Muller continued geological mapping of the Kluane Lake area (longitude 138° to 140°, latitude 60° to 61°), in which discoveries of nickeliferous pyrrhotite ore containing some cobalt and platinum were made recently.

R. Mulligan continued geological mapping of the Teslin area (longitude 132° to 134°, latitude 60° to 61°), which is traversed by the Alaska Highway and includes parts of the Canol and Atlin roads. Evidence of mineralization was noted along some limestone-granite contacts.

W. H. Poole continued geological mapping of the Wolf Lake area (longitude 130° to 132°, latitude 60° to 61°), which is traversed in the southeast by the Alaska Highway. Prospecting has disclosed lead-silver and tungsten deposits.

J. O. Wheeler conducted a reconnaissance survey of an area in the Selwyn Mountains embracing the headwaters of Rackla, Bonnet Plume, Snake, Stewart, and Hess Rivers. He obtained information on the occurrence of iron formation in the region and on the possibilities of a varied mineralization in the contact zones of several granitic stocks.

BRITISH COLUMBIA

J. D. Aitken continued geological mapping of the Atlin area (longitude 132° to 134°, latitude 59° to 60°). Occurrences of slip-fibre asbestos on Chikoida Mountain and of copper mineralization near the mouth of Llewellyn Inlet were noted.

J. E. Armstrong completed geological mapping of the Vancouver North and Vancouver South areas (longitude 123° to 123° 30′, latitude 49° to 49° 30′) and the adjoining New Westminster area (longitude 122° 30′ to 123°, latitude 49° to 49° 15′).

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

W. E. Cockfield assisted the Dominion-Provincial Board, Fraser River Basin, in connection with flood control projects, and assisted provincial soil survey parties in Kamloops and East Kootenay districts on Pleistocene geology.

He visited a number of mineral properties to obtain information for other government departments and collected several lots of specimens for the Geological Survey of Canada.

S. Duffell completed geological mapping of the Whitesail Lake area (longitude 126° to 128°, latitude 53° to 54°), which occupies part of the eastern flank of the Coast Range batholith and where prospecting and mining activity has increased greatly following the easier accessibility provided through work on the aluminium project at Kitimat. Numerous discoveries of metallic minerals have been made in the area.

H. Gabrielse continued geological mapping in McDame map-area (longitude 128° to 130°, latitude 59° to 60°), which is connected by road with the Alaska Highway to the north. The area contains the Cassiar asbestos deposit, a variety of metallic mineral occurrences, and some coal.

G. B. Leech completed geological mapping of the St. Mary Lake area (longitude 116° to 116° 30′, latitude 49° 30′ to 49° 45′) in which the Consolidated Mining and Smelting Company's Sullivan zinc-lead-silver mine is located.

H. W. Little completed geological mapping of the Nelson area, West Half (longitude 117° to 118°, latitude 49° to 50°), and commenced mapping the adjoining Kettle River area, East Half (longitude 118° to 119°, latitude 49° to 50°), both of which are important contributors to the mineral output of the province. The mapping project will be of particular use in revising and correlating the work of earlier geologists in different parts of the two areas.

J. E. Reesor completed geological mapping of the Dewar Creek area (longitude 116° to 116° 30′, latitude 49° 45′ to 50°) northwest of Kimberley and the Sullivan mine. The area is underlain by a great thickness of Late Precambrian sedimentary formations intruded by a large granitic batholith. Occurrences of copper, lead, and zinc minerals were noted in the southwest corner of the area, but the most favourable prospecting ground is the belt of sedimentary rocks north of the batholith along the northern boundary of the map-area.

J. A. Roddick completed the geological mapping of the bedrock of the Coquitlam area (longitude 122° 30′ to 123°, latitude 49° 15′ to 49° 30′), and gave particular attention to the Coast Range granitic rocks.

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

ALBERTA

E. J. W. Irish commenced geological mapping of the Kvass Flats area (longitude 119° 15′ to 119° 30′, latitude 53° 45′ to 54°), which has large reserves of coal, and structures possibly favourable for the accumulation of oil and natural gas.

ALBERTA AND SASKATCHEWAN

F. P. DuVernet conducted a survey with the airborne magnetometer of an area of 31,433 square miles in Alberta (longitude 110° to 114°, latitude 55° to 58°) and 5,432 square miles in an adjacent part of Saskatchewan (longitude 108° to 110°, latitude 55° to 56°).

SASKATCHEWAN

D. A. W. Blake made a reconnaissance survey of a large and hitherto little-known region south of Lake Athabasca and Black Lake. The region is underlain mainly by the Athabasca series of clastic sedimentary rocks but includes considerable areas of more ancient, granitic rocks, and west of William River, some highly folded, oolitic limestone or dolomite of probably pre-Athabasca age. At one property in the vicinity of Middle Lake the lower beds of the Athabasca series are radioactive, and the mineral autunite was identified in them.

W. E. Hale completed geological mapping of the Black Bay area (longitude 108° 45′ to 109°, latitude 59° 30′ to 59° 45′) and commenced mapping the adjoining Camsell Portage area (longitude 109° to 109° 15′, latitude 59° 30′ to 59° 45′). These areas comprise the western part of the Goldfields region, noted for its uranium-bearing deposits.

L. P. Tremblay commenced detailed geological mapping of the Beaverlodge Lake area north of Lake Athabasca.

MANITOBA

J. C. McGlynn commenced and completed geological mapping of the Naosap Lake area, East Half (longitude 101° to 101° 15′, latitude 54° 45′ to 55°), which contains gold and base metal prospects.

T. Podolsky completed geological mapping of the Cranberry Portage area (longitude 101° to 101° 30′, latitude 54° 30′ to 54° 45′) and commenced and nearly completed mapping the adjoining Ishwasum area (longitude 100° 30′ to 101°, latitude 54° 30′ to 54° 45′). These areas include the old Gurney gold mine and several gold and base metal properties and prospects.

ONTARIO

E. R. Rose conducted a mineralogical investigation of iron deposits in the Grenville series of eastern Ontario, mainly in Hastings county.

QUEBEC

K. R. Dawson commenced a comprehensive geological study of the Preissac-Lacorne batholith, Abitibi county, and its relation to associated mineral deposits.

W. G. Johnston completed detailed geological mapping in Dasserat township, devoting most of the season to the northeast quarter. The entire township is staked and contains several occurrences of lead, zinc, copper, and gold.

G. C. Riley completed geological mapping of the Brock River area (longitude 74° to 75°, latitude 50° to 51°), the southern half of which was mapped in 1941 by E. D. Kindle. A band of volcanic rocks and related diorites centred at Lac Frotet contains local showings of chalcopyrite.

R. B. Rowe commenced and completed a detailed geological study of beryl- and spodumene-bearing pegmatites of the Preissac-Lacorne batholith in Abitibi county.

NEW BRUNSWICK

F. D. Anderson completed geological mapping of the Woodstock area (longitude 67° 30′ west to the Maine boundary, latitude 46° to 46° 15′), which contains iron and manganese deposits.

R. Skinner completed geological mapping of the Bathurst area (longitude 65° 30′ to 66°, latitude 47° 30′ to 47° 45′). Large deposits of base metals were discovered just south of the area during the fiscal year. These deposits are associated with previously known iron deposits, and attention was directed to their occurrence by the pronounced magnetic anomalies in their vicinity. Similar anomalies appear on the aeromagnetic map of the Bathurst area.

NOVA SCOTIA

D. G. Kelly commenced geological mapping of the Baddeck area (longitude 60° 30′ to 61°, latitude 46° to 46° 15′). Previous work by the Geological Survey was done more than 50 years ago and the work in 1952 was the first step toward a complete revision of geological mapping in northern Cape Breton Island. The region is underlain mainly by Precambrian crystalline rocks, with lesser areas of Carboniferous formations, the former favourable for the occurrence of metal deposits, and the latter for gypsum, coal, and possibly base metals.

QUEBEC AND LABRADOR

W. F. Fahrig commenced and completed geological mapping of the Seal Lake (Snegamook, West Half) area (longitude 61° to 62°, latitude 54° to 55°). Part of the area is included in a mining concession held by Frobisher Limited, which has found a large number of native copper and copper sulphide deposits within a broad belt of Proterozoic-type sedimentary rocks and lavas.

M. J. Frarey commenced geological mapping of the Thompson Lake area (longitude 66° to 66° 30′, latitude 55° 15′ to 55° 30′) in the essentially volcanic, eastern part of the 'Labrador trough'. Gossans and sulphide showings consisting mainly of pyrrhotite and pyrite, with subordinate chalcopyrite, were observed but their economic significance is not yet apparent.

J. M. Harrison, assisted by J. E. Howell, continued detailed mapping of a strip through Burnt Creek across the 'Labrador trough' in order to determine the sequence, character, and structure of the constituent Proterozoic formations and their relation to contained iron formations and iron ore deposits. He also supervised the work and servicing of other parties in the Quebec-Labrador region.

S. M. Roscoe commenced and completed geological mapping of the Kasheshibaw Lake, East Half, area (longitude 62° to 63°, latitude 54° to 55°) in central Labrador. Part of this area is also included in the mining concession of Frobisher Limited, where numerous occurrences of native copper, chalcocite, bornite, and chalcopyrite were observed throughout a belt of Proterzoic-type sedimentary and volcanic rocks that underlies most of the map-area.

NEWFOUNDLAND

F. Q. Barnes commenced geological mapping of the St. Georges area (longitude 58° to 60°, latitude 48° to 49°). Lenses of magnetite and bodies of titaniferous magnetite occur in this area, as do almost all of the known gypsum deposits in Newfoundland.

A. M. Christie completed a geological reconnaissance of the Labrador coast. He spent part of the season in traversing the shores of Lake Melville, Grand Lake, Double Mer, and the Backway, and the remainder mainly in work along the coast north as far as Nain. The coast itself is not being prospected, but inland several exploration companies were operating from Goose Bay and North West River, and a Provincial Government party was searching for ilmenite in the Mealy Mountains anorthosite-gabbro mass.

J. Kalliokoski commenced geological mapping of the Springdale area (longitude 56° to 56° 30′, latitude 49° 15′ to 49° 30′). Copper and lead-zinc deposits occur in this area, all in rocks of Ordovician age.

W. D. McCartney completed geological mapping of the Holyrood area (longitude 53° to 53° 30′, latitude 47° 15′ to 47° 30′). Manganese-bearing beds occur near the base of a coastal section of Middle Cambrian sedimentary rocks.

T. O. H. Patrick completed geological mapping of the Comfort Cove area (longitude 54° 30′ to 55°, latitude 49° 15′ to 49° 30′) in which some copper and tungsten minerals occur.

C. H. Smith completed a study of the ultrabasic intrusive rocks of western Newfoundland and their contained chromite deposits. These rocks also contain asbestos.

GENERAL

H. S. Bostock supervised the several field parties in charge of university graduates in Yukon and northern British Columbia and collected information on the numerous mineral developments.

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

FUELS RESOURCES DIVISION

The Division collects, organizes, and files records and samples of wells drilled for natural gas and oil in all parts of Canada, and makes technical studies and interpretations of this material for use in the correlation of subsurface geological formations and the guidance of industry in exploratory drilling. It does research on the microscopic characteristics of individual coal seams to provide information of value in predicting the type of coal to be expected in advance of present workings, and it collects all data on coal occurrences, prospects, and mines for use in making reliable estimates of the coal reserves of Canada.

During the fiscal year 89,849 drill samples were received, bringing the total to 1,555,079 available for study and reference at Ottawa. Approximately 90,500 samples were prepared for microscopic examination. Samples received represented 298 wells drilled in Alberta, 180 wells drilled in Ontario, 6 wells drilled in Quebec, and 1 well drilled in Nova Scotia.

Acknowledgment is made to the following persons and organizations, through whose co-operation information and samples were received: T. B. Williams, controller of Coal, Petroleum and Natural Gas, British Columbia Department of Lands and Forests, for well samples and for maps showing areas under exploration permit; The Petroleum and Natural Gas Conservation Board, Alberta, for periodical drilling reports, interim reports, electrologs, and maps showing areas of drilling in Alberta and for samples of wells drilled; Saskatchewan Department of Natural Resources and Industrial Development for monthly reports on drilling activity and production, for maps showing areas under exploration permit and lease, and for drilling samples; Manitoba Department of Mines and Natural Resources for drilling samples and for interim drilling and production records; R. B. Harkness, Natural Gas Commissioner for Ontario, for drillers' logs and for samples of wells drilled in Ontario; Paul Payette, Montreal, for samples of wells drilled in the eastern Gaspe region of Quebec; I. W. Jones, Chief, Geological Surveys Branch, Quebec Department of Mines, for descriptive logs of wells drilled in Quebec; C. S. Evans, Union Gas Company of Canada Limited, Chatham, Ontario, and W. A. Rolliff, Imperial Oil Limited, Toronto, for information regarding wells drilled by their respective companies in Ontario; and to officials of numerous oil companies for much useful information on activities in many parts of Canada.

Samples from wells drilled in Ontario and Quebec were examined by the Division and descriptive and graphic logs were compiled. Contour maps of bedrock topography and thickness of glacial overburden in southwestern Ontario were compiled and published.

In co-operation with the Mines Branch, the Division advises the Department of National Revenue regarding tax benefits in special cases on deep test wells. It carried out technical examination and appraisal of several applications for such benefits during the fiscal year.

Visiting geologists of several operating companies examined samples and records made available to them by the Division. Geological advice was given to other government departments, notably the Indian Affairs Branch, Department of Citizenship and Immigration, and the Northern Administration and Lands Branch, Department of Resources and Development.

Western Oil and Natural Gas Office, Calgary

This office conducts regional subsurface geological studies in western Canada, maintains well samples, laboratory facilities, and a geological library, and makes these facilities available to the oil industry for study and reference. During the fiscal year the office acquired 204,253 drill samples, comprising 115,123 from wells drilled in Alberta, 68,808 from wells drilled in Saskatchewan, 14,495 from wells drilled in Manitoba, 3,987 from wells drilled in British Columbia, and 1,840 from wells drilled in Northwest Territories.

Studies of the stratigraphy and problems of correlation of subsurface formations in the Plains region resulted in preparation and publication of a report on the sedimentary section in southern Saskatchewan, and the completion, for publication, of a report on the detailed stratigraphy and correlation of formations of Devonian age in the general Edmonton area of Alberta. Material from the exposures of Clearwater formation (Cretaceous) on Athabasca River was collected and examined to correlate outcrop sections with the strata penetrated by wells.

Coal

The work consisted of: detailed geological mapping of coal deposits in selected coal fields; collection of available data on coal occurrences, coal prospects, and coal mines throughout Canada; assistance toward solving geological problems connected with coal mining developments; and an investigation into the possible use of electric logs in the identification of coal seams penetrated by wells drilled for natural gas and oil in Alberta.

At the Sydney, Nova Scotia, office, maintained by the Geological Survey of Canada in co-operation with the provincial Department of Mines and the Nova Scotia Research Foundation, detailed petrographic studies were continued of individual coal seams in the Sydney coalfield and in the Mabou coal area as an aid in determining the stratigraphy, structure, and correlation of the seams and associated coal measures. Petrographic investigation of the Tracy seam in the Sydney field was completed and the results were prepared for publication. A study was commenced of the susceptibility to spontaneous combustion of the Lloyd Cove seam, with special attention to the effect of size and distribution of pyrite particles on the weathering of the coal.

In co-operation with the Mines Branch, a petrographic investigation of samples from coal seams in western Canada was initiated as part of a study of rock pressure and gas outbursts in coal mines.

Plant microfossils in the Phalen seam of Sydney coalfield were separated and identified to determine the usefulness of such work in correlating the seam in the Sydney Mines and New Campbellton districts.

Field Work

ALBERTA AND BRITISH COLUMBIA

D. K. Norris, jointly with the Fuels Division, Mines Branch, continued a detailed and systematic study of the character and distribution of stresses in Crowsnest Pass and Canmore collieries and their relation to observed fault and fold structures. The work involves detailed surface and underground mapping and is intended as an aid in the economic mining of coal at depth where large reserves are available in stressed zones.

ALBERTA

R. T. D. Wickenden examined outcrops and collected samples of the Clearwater formation on Athabasca River near McMurray as part of a study to establish the correlation of outcrop sections with beds of equivalent age penetrated by wells drilled for oil and gas.

ONTARIO

E. W. Best completed a detailed study of the stratigraphy and palæontology of all exposures of pre-Hamilton Devonian formations in southwestern Ontario. The work was undertaken to clarify the position of the United States Detroit River series and to facilitate the structural interpretation of these formations in relation to favoured sites for the accumulation of oil or natural gas.

B. V. Sanford continued to establish the elevations of wells drilled for oil and natural gas in southwestern Ontario since 1945. The information is being used to prepare maps showing bedrock contours and drift thicknesses in this region.

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

GENERAL

P. A. Hacquebard visited the coal areas of Coleman, Fernie, and Canmore in western Canada and collected thirteen coal samples for subsequent petrographic examination. He collected column samples from the following seams in Nova Scotia: the Mullins seam at River Ryan, the Buchanan seam near Grand Lake Road, and LeCras seam at Mira Road, all exposed in prospect pits; from seams exposed at Mabou and Findlay Point; from Dominion No. 7 colliery and from the cliff section at Point Aconi; and from No. 5 seam at St. Rose. He made several visits to Dominion Steel and Coal Corporation's chemical laboratory in Glace Bay to obtain data on washed samples and to use the coal-screening facilities there.

B. A. Latour continued to collect information on coal seams at operating mines in Alberta. He also examined a section of the coal-bearing Edmonton formation as exposed in Red Deer Valley, the better to interpret the electrologs of wells drilled elsewhere through this formation. He spent the rest of the season in a detailed examination of the Mabou and St. Rose-Chimney Corner coalfields of Cape Breton Island, Nova Scotia, and in collecting new data on the nearby Port Hood and Inverness coalfields.

PLEISTOCENE AND ENGINEERING GEOLOGY DIVISION

The program of office, laboratory, and field work designed to shed additional light on the history of glaciation and its effects was continued. Seven field parties mapped glacial deposits in separate map-areas across Canada, in work that has a direct bearing on agricultural development and on engineering studies.

One geologist was assigned to the above-mentioned "Operation Keewatin" to make broad-scale studies of the great Keewatin 'centre' of glaciation. The regional data so gained will advance the knowledge of continental glaciation and facilitate studies elsewhere in Canada. This was the first visit of a Pleistocene specialist to the region, which is of world-wide interest from the standpoint of glaciation.

Four geologists working in the Prairie Provinces made a trip to Athabasca glacier in Banff National Park to confer with a glaciological research party from the California Institute of Technology. This research party was beginning a comprehensive investigation of glacier ice structure and movement, of the character of the debris within and beneath the ice, and by seismic means was determining the depth of the ice. The Division's geologists, accompanied by two Pleistocene geologists of the United States Geological Survey, benefited greatly by this first-hand contact with the research party. They then moved on to nearby glaciers to observe attendant glacial phenomena and till fabric and to inter-relate these with their observations on the Prairies.

A laboratory for sedimentological studies in connection with Pleistocene field work and research was brought into operation.

At the request of the Department of Resources and Development, work in the field of engineering geology was carried out on three possible dam sites on the "Big Bend" of Columbia River in British Columbia. Short geological reports were written on three proposed dam sites on Saint John River in New Brunswick. Geologists of the Division assisted government engineers and private engineering firms on matters pertaining to the glacial soils in areas of proposed construction. One geologist continued to act as consultant to the Engineering and Water Resources Branch, Department of Resources and Development.

Field Work

BRITISH COLUMBIA

J. E. Armstrong completed mapping of the Pleistocene geology of the Vancouver North and Vancouver South areas (longitude 123° to 123° 30′, latitude 49° to 49° 30′) and most of the New Westminster area (longitude 122° 30′ to 123°, latitude 49° to 49° 15′), and commenced work in the adjacent Coquitlam (longitude 122° 30′ to 123°, latitude 49° 15′ to 49° 30′) and Sumas (longitude 122° to 122° 30′, latitude 49° to 49° 15′) areas. He also co-operated with the Provincial Soils Service in the Okanagan district on investigations of water and drainage problems and spent considerable time on special investigations of ground-water and engineering problems for various farmers and municipal and industrial interests. These studies are proving of great assistance to the sand and gravel, peat, and ceramic industries of this region; in the solving of many constructional and engineering, drainage and flood control problems, in the mapping of soils in the agricultural Fraser Valley and Delta; and in town and rural planning projects.

F. G. Fyles continued mapping the Pleistocene geology of the Horne Lake (longitude 124° 30′ to 125°, latitude 49° 15′ to 49° 30′) and adjoining Parksville (longitude 124° to 124° 30′, latitude 49° 15′ to 49° 30′) areas. These areas afford an excellent opportunity for acquiring basic geological data for use in similar studies in other areas.

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

A. G. Jones, at the request of the Engineering and Water Resources Branch, examined geological conditions at three dam-site areas on Columbia River between the Big Bend and Revelstoke, thereby supplementing his work of the previous year on the proposed Mica Creek dam site near the Big Bend.

ALBERTA

E. P. Henderson completed mapping of the Pleistocene geology of the Watino-Sturgeon Lake area (longitude 117° to 118°, latitude 55° to 56°). Two tills were noted in the northern part of the area as were large deposits

of outwash sands and gravels, one covering about 8 square miles and attaining a thickness of more than 15 feet. These sands and gravels are a potential source of road material.

A. MacS. Stalker commenced mapping the Pleistocene geology of the Beiseker area (longitude 113° to 114°, latitude 51° to 52°). The eastern parts of the area are covered by sand, silt, and clay of glacial Lake Drumheller and the western parts by a thin ground moraine.

J. A. Elson spent part of the field season in the Lake Louise and Columbia icefields areas directing a group of Canadian and United States glacial geologists.

SASKATCHEWAN

B. G. Craig commenced mapping the Pleistocene geology of the North Battleford area (longitude 108° to 109°, latitude 52° to 53°). North Saskatchewan River flows easterly through the area and its broad valley was the site of a former glacial lake. A southeastward direction of ice movement is indicated by a marked glacial fluting.

MANITOBA

J. A. Elson completed mapping the Pleistocene geology of the Brandon area (longitude 98° to 100°, latitude 49° to 50°). He obtained much information on the thickness of the glacial drift, which will be of assistance to seismic operations and to drilling for oil and water. The numerous gravel ridges (eskers) in the area are a potential source of road metal, constructional materials, and ground water. He also made a preliminary study of the practicability of diverting Assiniboine River at Portage la Prairie into Lake Manitoba as a flood-control measure.

E. C. Halstead commenced a study of the ground-water supply of the Brandon area (longitude 98° to 100°, latitude 49° to 50°). The investigation covered 66 townships in this area. He measured observation wells monthly and dealt with several special local requests for assistance in ground-water problems.

ONTARIO

C. P. Gravenor completed mapping the Pleistocene geology of the Lake Scugog area (longitude 78° 30′ to 79°, latitude 44° to 44° 15′). The northern half of the area is a continuation westward of the Peterborough drumlin field and is separated from the deeply eroded till plain in the southern part of the area by the Oak Ridges kame moraine, which consists of silt, sand, and gravel and has a thickness of more than 400 feet. The upper parts of this kame moraine are usually dry, but at depth it is an excellent water aquifer.

E. B. Owen completed mapping the Pleistocene geology of Gloucester township and completed a ground-water survey in Gloucester and Nepean townships, Carleton county. He continued a ground-water survey of the city of Ottawa.

QUEBEC

N. R. Gadd completed a study of the Pleistocene and Recent overburden and ground-water resources in Bécancour area (longitude 72° to 72° 30′, latitude 46° 15′ to 46° 30′) and extended the work into the adjoining Aston area (longitude 72° to 72° 30′, latitude 46° to 46° 15′). The Quaternary history of this region is greatly complicated by multiple glaciation and by the intercalation of glacial drift with widespread marine and fluviatile beds.

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

V. K. Prest completed geological mapping of the Pleistocene and Recent overburden in the Island of Montreal. This mapping is of special significance in its relation to sources of constructional material for engineering and building projects in the metropolitan area.

NEW BRUNSWICK

H. A. Lee spent a month in Saint John River Valley, mostly in the vicinity of Edmundston. His work has led to a better appreciation of the history of glaciation in New Brunswick and will assist in a better understanding of soil problems and a greater development of constructional materials. He also mapped the overburden in the vicinity of the proposed dam site of the New Brunswick Electric Power Commission at Hawkshaw near Fredericton.

RADIOACTIVE RESOURCES DIVISION

The Division conducts field and laboratory investigations on Canadian resources of radioactive raw materials, maintains free testing and advisory services for uranium prospectors, and compiles and publishes data on Canadian radioactive deposits. Present interest in uranium has necessitated the handling of many inquiries by correspondence and interviews. As agent for the Atomic Energy Control Board, the Geological Survey of Canada, through the Division, receives reports of new discoveries, results of analyses for uranium and thorium, and monthly reports describing work done by 131 companies and individuals operating under permits from the Board. This information and other related data are incorporated in a confidential inventory that is revised annually. The inventory now contains descriptions of approximately 650 properties and occurrences.

Two geologists made field studies of as many occurrences as possible, mainly in connection with their economic possibilities, but were able to visit only a fraction of the new discoveries and the properties being explored.

The Division tested 3,282 samples quantitatively for radioactivity and reported almost all of the results within a day of receipt of sample. It made 101 identifications of radioactive minerals.

Progress was made in establishing a comprehensive collection of standard X-ray mineral patterns. The equipment for X-ray fluorescence analysis, installed in the previous fiscal year, has proved especially useful for rapid qualitative and quantitative analyses of the elements and compounds in minerals, particularly for heavy elements such as uranium, thorium, columbium, tantalum, tungsten, and molybdenum.

Installation of a new spectrograph and ancillary equipment was completed late in 1952.

Field Work

SASKATCHEWAN

S. C. Robinson continued a detailed study of the mineralogy of the uranium deposits in the Goldfields (Beaverlodge) region. Field work on this project was completed.

W. L. Davidson examined many uranium deposits in the Goldfields region to obtain information for the confidential inventory on Canadian deposits of uranium and thorium.

GENERAL

A. H. Lang examined uranium deposits in Saskatchewan and Ontario, and supervised the field work of other parties. He made a preliminary study of the possibility of finding uranium deposits in sedimentary rocks underlying the Great Plains.

MINERALOGY DIVISION

More than 10,600 specimens of rocks, minerals, soils, and water were sent in from all parts of Canada by prospectors, mine operators, educational institutions, farmers, and others. These were examined free of charge, and reported on as to their nature, uses, and possible commercial value. About 3 per cent of the material submitted was of sufficient interest to warrant further prospecting.

Approximately 200 reports were forwarded in reply to inquiries dealing with mineral localities, largely from citizens of the United States who were planning motor and collecting trips in Canada.

More than 1,000 visitors brought specimens for examination or sought information relating to the mineral industry.

During the fiscal year, 74,902 specimens of rocks and minerals were prepared for distribution to the public, and 2,096 collections were sold to prospectors, universities, and provincial governments. The collections and specimens were distributed as follows:

	Collections	Specimens
Northwest Territories and Yukon	9	257
British Columbia	211	6,996
Alberta	345	12,679
Saskatchewan	134	4,695
Manitoba	67	2,325
Ontario	657	23,127
Quebec	511	19,329
New Brunswick	123	4,285
Nova Scotia	18	430
Foreign	21	679

Many investigations were undertaken in the chemical laboratory on minerals and rocks derived from various geological formations and ore deposits. These included: 6 complete analyses of altered rocks from the Goldfields region in northern Saskatchewan; 6 analyses of carbonatized rocks, and 15 silica determinations of wall-rocks from the Yellowknife area, Northwest Teritories; and 3 analyses of granitic rocks from the Nipissing area, Ontario.

About 500 mineral and rock specimens of museum quality, obtained from various parts of Canada and the United States as donations or in exchange, were added to the Geological Survey collections. A 236-pound siderolite, or stony meteorite, that fell on June 9, 1952, at 11:05 p.m., M.S.T., near Athabasca, Alberta, was purchased from Harry Buryn of Abee, Alberta, who found the stone on his farm 6 feet underground. A large group of minerals from New York, New Jersey, Maine, Connecticut, and New Mexico, representing 65 species, was obtained by exchange through Ronald Januzze of Danbury, Connecticut.

Acknowledgment is made to the following for specimens donated and for assistance in providing material for educational collections: W. E. Cockfield, A. M. Christie, C. H. Smith, S. C. Robinson, H. W. Little, D. J. McLaren, and H. S. Bostock of the Geological Survey of Canada; R. Holt, Blackburn Bros. mica mine, Cantley, Quebec; W. Bray, magnesite mine of Canadian Refractories Limited, Kilmar, Quebec; Canadian Flint and Spar Company, Limited, Buckingham, Quebec; Aluminum Company of Canada Limited, Wakefield, Quebec; B. G. Edward, Black Donald mine, operated by Frobisher Limited, Brougham township, Ontario; Harry Roscoe, Canada Talc Industries, Limited, Madoc, Ontario; W. J. Symons, Reliance Fluorspar Mining Syndicate Limited, Madoc,

Ontario; Jack Graham, Quemont Mining Corporation, Limited, Noranda, Quebec; Bernard Joyal, Molybdenite Corporation of Canada, Limited, Lacorne, Quebec; and S. A. J. Hopper, Golden Manitou Mines, Limited, Val d'Or, Quebec.

PALÆONTOLOGY DIVISION

The Division gives chief attention to the systematic study of Canadian stratigraphy based on the study of palæontological material collected by the Geological Survey of Canada and by oil and mining companies and through other sources. It prepared eighty-nine reports covering thousands of fossil specimens, thirty-two of these reports being for oil companies.

Considerable time was given to research projects, based largely on field work and on Geological Survey fossil collections and related to geological explorations and economic development. Dr. F. H. McLearn and Dr. Alice E. Wilson, two former members of the staff now on superannuation, participated in the work, the results of some of which will be prepared for publication.

Fossil collections were donated by the following organizations: Attwood Copper Mines Limited, The British American Oil Company, Limited, The California Standard Company, Dominion Coal Company, Limited, Granby Consolidated Mining, Smelting and Power Company, Limited, Hudson's Bay Oil and Gas Company, Limited, Royalite Oil Company, Limited, Shell Oil Company of Canada, Limited, Socony Vacuum Exploration Company, Sohio Petroleum Company, and Sun Oil Company. Loans and exchanges of collections for comparative study were arranged with universities and other institutions in Canada and other countries.

Accommodation was provided for several weeks for two geologists of Shell Oil Company who were studying fossil collections obtained by the Division in Alberta and British Columbia.

Field Work

BRITISH COLUMBIA

J. A. Jeletzky continued detailed stratigraphic studies of the fossiliferous Mesozoic and Tertiary formations along a northern part of the west coast of Vancouver Island. He gave particular attention to a thick series of mainly marine Tertiary sedimentary rocks that occupy most of Hesquiat Peninsula, as their identification here and elsewhere along this coastal section offers hope for the eventual discovery of oil-bearing zones similar to those in formations of the same age along the west coast of California and Mexico.

ALBERTA AND BRITISH COLUMBIA

P. Harker examined and measured fossils and obtained fossil collections from exposed sections of Carboniferous formations at various localities in the Rocky Mountains, including the Crowsnest Pass and Fernie region, Sunwapta Pass, Snake Indian River region, Jasper region, and Pine Pass, and at points along the main lines of the Canadian National and Canadian Pacific railways in eastern British Columbia. The work will assist geological mapping and should aid subsurface correlations in productive or potential oil and gas fields of western Canada.

D. J. McLaren examined, and obtained fossil collections from, Devonian formations in the Clearwater and North Ram Rivers region of the central Alberta Rocky Mountains, in the Cecilia-Wapiti Lakes region of the east-central British Columbia Rockies, and at Pine Pass in British Columbia south of Peace River. The work will increase the knowledge of Devonian stratigraphy with particular reference to reef development, and should aid explorations for oil and gas in potential areas of western Canada.

ALBERTA

Hans Frebold commenced a palæontological and stratigraphic study of the Jurassic formations of the Rocky Mountains and Foothills in west-central Alberta as represented by the Fernie group. Results of this study, supplemented by previous work on the Fernie group in more southerly areas, will assist geological mapping, clarify the complex palæogeographic history of the Jurassic period in this region, and, for the oil geologist, should facilitate subsurface studies in the Plains and Foothills.

NEW BRUNSWICK

L. M. Cumming examined and collected fossils from Silurian formations exposed at various localities in southern New Brunswick. The work will assist geological mapping and will provide a better understanding of the geological history and economic possibilities of the region.

NEWFOUNDLAND

R. D. Hutchinson continued a study of the stratigraphy and palæontology of the Cambrian rocks in eastern Newfoundland. The work will assist geological mapping and mineral exploration.

GEOLOGICAL CARTOGRAPHY DIVISION

Maps Published from April 1, 1952, to March 31, 1953

Publication number	Title	Remarks
	CANADA	
900A	Canada, Mining Areas and Principal Producing Mines (third edition); scale, 1 inch to 120 miles	Geology. For separate distribution.
	YUKON	
1012A	Northwest Shakwak Valley; scale, 1 inch to 4 miles	Geology. For Memoir 267 and separate distribution.
	NORTHWEST TERRITORIES	
1011A	MacAlpine Channel, District of Mackenzie; scale, 1 inch to 1 mile	Geology. For separate distribution.
1013A	Walmsley Lake, District of Mackenzie; scale, 1 inch to 4 miles	Geology. For separate distribution.
1014A	Camsell River, District of Mackenzie; scale, 1 inch to 4 miles	Geology. For separate distribution.
1017A	Giauque Lake, District of Mackenzie; scale, 1 inch to 2,000 feet	Geology. For Memoir 266 and separate distribution.
52-5A	McLean Bay, District of Mackenzie; scale, 1 : 40,000	Preliminary geological map. Paper 52-5.

Maps Published from April 1, 1952, to March 31, 1953 (Continued)

Publication number	Title	Remarks
	NORTHWEST TERRITORIES—*Concluded*	
53G	McConnell Island, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
54G	Fort Resolution, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
63G	Deskenatlats Lake North, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
74G	Bear Creek, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
75G	Salt Lake, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
76G	Buffalo River, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
77G	Sandy River, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
78G	Hay River, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
79G	Mackenzie Rocks, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
80G	Breynat Point, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
81G	Ile du Mort, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
82G	Nyarling, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
83G	Sulphur Springs, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
84G	Swampy Lake, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
87G	Long Island, District of Mackenzie; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	BRITISH COLUMBIA	
52-13A	Bonnington, Kootenay District; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-13.
52-15A	St. Mary Lake, Kootenay District; scale, 1 : 40,000	Preliminary geological map. Paper 52-15.
52-21A	Whitesail Lake, Coast District; scale, 1 : 160,000	Preliminary geological map. Paper 52-21.

Maps Published from April 1, 1952, to March 31, 1953 (Continued)

Publication number	Title	Remarks
	ALBERTA	
	Alberta, Oil and Gas Fields (second edition); scale, 1 inch to 20 miles	For separate distribution.
	Alberta, Oil and Gas Fields (third edition); scale, 1 inch to 20 miles	For separate distribution.
52-7A	Copton Creek, West of Sixth Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-7.
52-26A	Grande Cache, West of Sixth Meridian; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-26.
	SASKATCHEWAN	
1015A	Goldfields-Martin Lake; scale, 1 inch to 1 mile	Geology. For Memoir 269 and separate distribution.
52-1A	Nevins Lake, Northern Saskatchewan; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-1.
	SASKATCHEWAN-MANITOBA	
1016A	Reindeer Lake; scale, 1 inch to 8 miles	Geology. For separate distribution.
	ONTARIO	
51-27A	Renfrew, Renfrew and Lanark Counties; scale, 1 : 40,000	Preliminary geological map. Paper 51-27.
52-2	Lambton County (2 maps); scale, 1 inch to 2 miles	Preliminary geological maps. Paper 52-2.
52-4	Kent County (2 maps); scale, 1 inch to 2 miles	Preliminary geological maps. Paper 52-4.
52-14A	Peterborough, Peterborough, Victoria, Durham, and Northumberland Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 52-14.
52-17	Essex County (2 maps); scale, 1 inch to 2 miles	Preliminary geological maps. Paper 52-17.
95G	Kaladar, Hastings, Frontenac, and Lennox and Addington Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
96G	Denbigh, Renfrew, Frontenac, Hastings, and Lennox and Addington Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
97G	Mazinaw Lake, Hastings, Frontenac, and Lennox and Addington Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
99G	Minden, Victoria, Haliburton, and Peterborough Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1952, to March 31, 1953 (Continued)

Publication number	Title	Remarks
	ONTARIO—*Concluded*	
100G	Brudenell, Renfrew County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
101G	Fenelon Falls, Victoria and Peterborough Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
102G	Kawagama Lake, Haliburton County, Muskoka and Nipissing Districts; scale, 1 inch to 1 mile.	Preliminary aeromagnetic map.
103G	Burleigh Falls, Peterborough County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
104G	Halls Lake, Haliburton County and Muskoka District; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
109G	Barrys Bay, Hastings and Renfrew Counties and Nipissing District; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
110G	Wilberforce, Haliburton and Hastings Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
111G	Whitney, Haliburton and Hastings Counties and Nipissing District; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
112G	Huntsville, Parry Sound, Muskoka, and Nipissing Districts; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	QUEBEC	
52-6	Kinojevis, Témiscamingue and Abitibi Counties; scale, 1 : 40,000	Preliminary geological map. Paper 52-6.
70G	Obalski River, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
85G	Lac Gueguen, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
86G	Senneterre, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
88G	Doucet, Abitibi County; scale, 1 inch to 1 mile.	Preliminary aeromagnetic map.
89G	Lac Faillon, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
90G	Rivière Delestre, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
91G	Sabourin, Témiscamingue and Abitibi Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
92G	Villebon, Témiscamingue and Abitibi Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
93G	Despinassy, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
94G	Ducros, Abitibi County; scale, 1 inch to 1 mile.	Preliminary aeromagnetic map.
98G	Cuvillier, Abitibi County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.

Maps Published from April 1, 1952, to March 31, 1953 (Concluded)

Publication number	Title	Remarks
	QUEBEC—*Concluded*	
114G	Rosaire, L'Islet and Montmagny Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
115G	St. Magloire, Montmagny, Bellechasse, and Dorchester Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
116G	St. Pamphile, L'Islet and Montmagny Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
117G	Ste. Justine, Dorchester, Bellechasse, and Montmagny Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
119G	St. Zacharie, Dorchester and Beauce Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
120G	Armstrong, Beauce and Frontenac Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	QUEBEC-NEWFOUNDLAND	
52-16A	Willbob Lake; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-16.
	NEW BRUNSWICK	
52-23	Nepisiguit Falls, Gloucester and Northumberland Counties; scale, 1 inch to 1 mile	Preliminary geological map. Paper 52-23.
121G	Big Bald Mountain, Northumberland County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
122G	Serpentine Lake, Northumberland and Victoria Counties; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
123G	McKendrick Lake, Northumberland County; scale, 1 inch to 1 mile	Preliminary aeromagnetic map.
	NOVA SCOTIA	
52-18	Wolfville (East Half), Hants and Kings Counties; scale, 1 inch to ½ mile	Preliminary geological map. Paper 52-18.
	NEWFOUNDLAND	
1018A	Torbay; scale, 1 inch to 4 miles	Geology. For Memoir 265 and separate distribution.
52-9	Unknown River (Ossakmanuan Lake, East Half), Labrador; scale, 1 inch to 2 miles	Preliminary geological map. Paper 52-9.
52-22A	Northern Labrador Coast (2 maps); scale, 1 inch to 4 miles	Preliminary geological maps. Paper 52-22.

Three maps were published to accompany water supply papers; 141 maps and scientific figure drawings were draughted for reproduction by photo-lithography or by zinc-cut process for illustrating memoirs, reports, articles, and papers.

Three geological maps were at the Printing Bureau for lithographing at the end of the fiscal year; 2 map figures were at the Surveys and Mapping Branch for printing; work was in progress on 7 standard geological sheets, 11 preliminary geological maps, and 10 preliminary aeromagnetic maps.

BRITISH COLUMBIA OFFICE, VANCOUVER

A total of 3,545 visitors registered at the office, and many inquiries were handled by mail and telephone. In all, 2,947 reports and 2,479 maps were issued in response to requests from the public. Determinations were made of many rock and mineral specimens.

YELLOWKNIFE OFFICE, N.W.T.

The resident geologist co-operates with the Northern Administration and Lands Branch, Department of Resources and Development, in assisting prospectors and mine operators in the region, and provides field supervision for explorations for oil and natural gas. The office has a reference library of maps and reports and of air photographs covering favourable prospecting areas, and distributes Government publications dealing particularly with the geology and mineral deposits of the Northwest Territories. It co-operates with the Yellowknife Branch, Canadian Institute of Mining and Metallurgy, in the courses for prospectors given by that Branch.

GEOLOGICAL INFORMATION AND DISTRIBUTION SECTION

One hundred and seventy-one reports and maps were issued, 65 of which were reprints of previous editions. New editions included 6 Memoirs, 4 Geological Survey Bulletins, 10 Miscellaneous Series, 26 Preliminary Papers, 48 Geophysics Papers (Maps), 4 Water Supply Papers, and 8 Geological Maps.

Publications totalling 118,916 were supplied to the public, to other Government services, and to universities, scientific organizations, and societies in response to written or personal requests for general or specific information. In addition, the Department's Editorial and Information Division distributed 684 publications of the Geological Survey in French. The policy of providing free copies of geological maps, reports, etc., was discontinued on July 1, 1952, and with the exception of selected mailing lists, a charge is now made for all publications.

LIBRARY

Acquisitions:

Books acquired by purchase	581
Books (complete unbound volumes by purchase)	548
Books by transfer, exchange, and gift	329
Canadian periodicals	1,441
Canadian Government publications	3,001
British and foreign Government publications	4,265
Proceedings, transactions, and bulletins of societies	3,060
British and foreign periodicals	7,304
	20,529

Other data:

Recorded loans of books, pamphlets, and periodicals	23,523
Inter-library and occasional loans	2,790
Books borrowed from other libraries	528
Maps and charts added to the library	2,388
Maps and charts borrowed from the library	715
Lantern slides borrowed	365
Lantern slides added to library	273
Cards added to slide catalogue	832
Photographs loaned (exclusive of albums)	1,956
Volumes bound	665
Volumes accessioned	1,458
Cards added to general catalogue	18,127
Cards added to map catalogue	528
Letters and cards received	3,505
Letters and cards sent	6,732
New serials received and catalogued	219

PHOTOGRAPHIC SECTION

The output included the following major items:

Kodalith and Vandyke negatives and prints, to 40″x49″	4,700
Exposures developed, field work	4,957
Contact prints made, up to 40″x49″	21,077
Bromide enlargements, up to 40″x49″	4,658
Magnetometer film developed	26,185 feet
Magnetometer film printed	34,650 feet

REPRODUCTION PROCESSES

The principal output comprised:

Blueprints, blue lines, etc.	430,424 sq. ft.
Océ prints	16,002 " "
Photostats (18″x22″)	10,648 sheets
Mimeograph	990,124 impressions

LAPIDARY

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

Thin sections	3,779
Polished sections	371

MINES BRANCH

John Convey, Director

Uranium and titanium received a major share of the attention in the research and investigative work of the Branch during the fiscal year. In the case of uranium much of the effort was on the development of a simplified carbonate leaching process applicable to the treatment of uranium ores of the Beaverlodge region in northern Saskatchewan. The work on titanium was directed largely toward development of a cheap method of recovering the metal from its ores, a baffling problem to which metallurgists in Canada and elsewhere have been devoting considerable attention in recent years. Concurrently, the Branch is conducting investigations on the rolling and fabrication of pure titanium metal and high titanium alloys.

Light-weight aggregates, the industrial waters, and kyanite received chief attention in the work on the industrial minerals. Field surveys of the clays and shales suitable for making light-weight aggregate have been completed in all provinces except Newfoundland and British Columbia. The kyanite being investigated is from recently discovered deposits in eastern Canada. The mineral, which is used in making special high grade refractories, is not produced in Canada, but it is hoped the research in the Branch will help pave the way for the development of Canadian deposits.

The studies of rock pressures in coal mines were extended to include the coal mines of Nova Scotia. These studies now form one of the main projects of the Branch in its work on fuels and are concerned primarily with pressure phenomena that make the deep mining of coal hazardous. Another top-ranking project is the development of a coal-fired gas turbine engine, this being a joint endeavour with the Gas Dynamics Laboratory of McGill University.

Canadian coals and ores are being examined as possible sources of germanium, a metal which is of considerable interest to the electronics industry.

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

The Branch was again called upon to assist in arranging programs of training for engineers and scientists from foreign countries. The number of visitors from Commonwealth and other countries continued to increase.

Officers of the Branch presented 39 papers before technical societies, for publication in the journals of the societies.

MINERAL DRESSING AND PROCESS METALLURGY DIVISION

MINERAL DRESSING INVESTIGATIONS

Fourteen investigations were carried out on lead-zinc, copper-lead-zinc, copper-nickel and nickel ores, and ore treatment methods were designed when requested by companies. Of the mining companies requesting test work, two are in production, one in Quebec and one in British Columbia, and another is erecting a mill in Ontario. Most of these base metal ores were quite complex, consisting of an intimate mixture of two or more minerals which had to be

separated and concentrated, with a minimum of loss, to sufficiently high grade, commercial concentrates. Most contained gold and silver, and treatments were worked out for the maximum and cheapest recoveries of these metals.

Gold ore from only one new property was investigated. Three other investigations aimed at improving recoveries of gold at operating mines were carried out and in each case recommendations were made for increasing recoveries and decreasing costs.

Various low grade ores were investigated to determine the cheapest possible methods of treating the ores for the efficient recovery of the contained metals. The samples comprised an ilmenite ore, five iron ores, one silver-copper-tungsten ore, one molybdenum-copper ore, two cobalt-silver ores, and two antimony ores.

Three investigations carried out to assist Canadian companies in assessing the effectiveness of new Canadian-made flotation reagents showed these reagents to be in every way as effective as those being imported.

Thirteen companies using the laboratory and mill facilities carried out 16 of their own investigations with the assistance of the Division's staff. With one exception the quantities treated ranged from 10 to 112 tons. The results of one of the investigations will be incorporated in the flowsheets of a large copper-nickel concentrator in Manitoba and of the other in a large magnetic iron concentrator in Ontario.

RESEARCH

Research was started on the testing of a new theory formulated by the Division involving the grinding of ores at higher temperatures. As a result of several experiments, it was established that the efficiency of grinding increases markedly as the temperature increases. This research is being continued because of the encouraging results obtained and the widespread interest manifested by operators.

Research was continued on the extraction of gold from concentrates obtained from complex ores occurring particularly in Northwest Territories. Studies of this problem, which has long been a source of difficulty to practising metallurgists, have yielded valuable new information on the behaviour during processing of some of the minerals commonly present in such concentrates, with the result that greatly improved recoveries have been made of the gold content of some of these concentrates.

Working on the process it developed in 1951 for recovering elemental sulphur from pyrite and pyrrhotite, the Division carried out a series of experiments on a laboratory scale using a pyrrhotite concentrate from a Canadian mine which produces large tonnages of the concentrate as a waste product. These tests showed that 80 per cent of the sulphur in the pyrrhotite can be converted into elemental sulphur and that the sulphur can be separated in a pure form using simple procedures only, such as screening, tabling and filtration. Iron oxide, containing from 5 to 10 per cent of sulphur, is a by-product of this process and laboratory tests showed that sintering will drive off this sulphur to meet the specifications for iron ore sinter. A second mining company is testing the process to assess its applicability to the company's own large reserves of pyrrhotite, some of which will be concentrated as a by-product of its regular operation.

In its work on the extraction of titanium dioxide from ilmenite ore from the deposit at Allard Lake in eastern Quebec, the Division has produced, on a laboratory scale, a concentrate containing 94 per cent titanium dioxide by means of a pressurized sulphuric acid leach which removes the iron as iron sulphate. The deposit contains over 110,000,000 tons of ore averaging about 32 per cent titanium dioxide. The iron sulphate thus removed can be sintered to make iron sinter, a by-product. The titanium dioxide produced can be used to advantage in the manufacture of pigments. The process consumes only

small amounts of sulphuric acid as compared to the process used by pigment manufacturers, which requires excessive amounts of the acid, this being one of the chief causes of the present high cost of titanium dioxide.

The Division continued its detailed studies of the properties of the titania-rich slags manufactured in Quebec province. It assisted the company in the production of a slag acceptable to the industry as a source of titania pigments and in overcoming some of the difficulties encountered in operation, particularly in relation to methods of handling and cooling the hot slag.

Research into the economic production of titanium metal was continued, and although some progress has been made in obtaining metal of higher purity, no satisfactory method of overcoming the affinity of titanium for such gases as oxygen, nitrogen, and hydrogen has been developed as yet. However, metal suitable for alloying purposes was produced on a laboratory scale.

The Division sought means of overcoming the difficulties encountered in carrying out the chemical analysis of titanium and its alloys, and to this end developed a method whereby the total non-metallic impurities present in any sample can be measured satisfactorily in one operation. The method has been adopted by producers. The Division also improved, both in accuracy and speed, the available methods of determining the amount of metallic titanium present in samples of oxidized metal, a matter which has caused industry considerable difficulty.

At the request of the Geological Survey of Canada, the Division has been engaged in the study of shales associated with the iron deposits in the Quebec-Labrador region. The object of the studies is to assist the Survey in solving the problems that have arisen in the identification of shales from the various horizons. Solution of these problems is essential in working out the structure and stratigraphy of the ore deposits and thus in locating new deposits. Similar studies are being made of the carbonate rocks associated with the Steep Rock iron ore deposits in northwestern Ontario.

By means of laboratory studies of the high temperature chemistry of blast furnace and basic open hearth slags, assistance was rendered to the steel industry in improving production of the metal and in removing harmful impurities such as sulphur. The chief factors in the relationship between slag composition and slag melting point were determined. In the case of basic open hearth slags, experiments aimed at showing their condition at steel-making temperatures indicated the presence of significant amounts of undissolved slag constituents in slags formed late in open hearth heats. Liquid metal-slag reactions occurring in the open hearth are thus more complex than generally assumed and it appears that considerable revision must be made of current ideas on slag metal chemistry.

Much work was done on the evaluation and improvement of slag control methods to assist operators in the control of open hearth heats. The limitations and conditions found for obtaining more reliable control were outlined in detail.

In response to requests from plant operators, a study was undertaken of the effect of magnesia content on the properties of blast furnace slags. Experiments have shown that dolomite can be almost entirely substituted for limestone without raising the melting point of the slag. This is of importance to the industry, as a lack of available supplies of limestone for use as a flux sometimes makes it advantageous to use local supplies of magnesian limestone or dolomite.

A study was made of the fusion characteristics of magnetite concentrates. A process for melting, casting and consolidation of magnetite to give a hard dense lump suitable for open hearth additions was worked out in the laboratory.

Two officers who conducted the investigation visited the plant of the company concerned where the feasibility of large scale production of fused magnetite was demonstrated.

The Branch's publication, *Methods of Analysis of Iron and Steel Used in the Mines Branch Laboratories*, has received wide acceptance by the industry. Recent refinements of the methods developed by the Branch has necessitated the preparation of a revised edition now under way.

In conjunction with other divisions of the Branch a survey of all possible Canadian sources of germanium is being carried out, involving microscopical studies and spectrochemical analyses of such materials as coal ash, lead and zinc concentrates from producing base metal mines, and various minerals in base metal ores which are normally the most favourable carriers of the element. Germanium is of particular importance for use in the development of military radio communications.

Research on the spectrographic analysis of the rare earth elements resulted in the development of a rapid method suitable for some elements in the group. The demand for such a method has been increasing steadily as the conventional chemical determination is exceedingly difficult and time-consuming.

The Division is continuing its research on the production of metals such as chromium, vanadium, lithium, sodium, potassium and antimony in a purer state and at lower costs. For example, a combination of the distillation and electrolytic methods of refining antimony were found to be particularly effective in reducing impurities. These metals are becoming increasingly important in industry because of their unusual properties.

Much information has been obtained on the factors affecting the transformation of ordinary white tin into undesirable grey tin under low temperature conditions. This is of great importance to Canada in view of the extensive use of tin in food containers, equipment and other articles in northern regions. Methods of reducing this transformation have been developed and it is believed that the formation of grey tin may be prevented if certain precautions are taken.

Numerous problems on metal corrosion which annually cost Canada an estimated $500,000,000 were investigated, particularly for the Department of National Defence, for industries producing defence equipment and for organizations active in atomic energy work. In one of these problems, different methods for testing the corrosiveness of turbine fuels on aircraft fuel systems were investigated and in another a method was developed for producing improved protective films on aluminium by anodizing.

Looking to the possible establishment of a bone china industry in Canada, the Division has undertaken a program on high temperature physical and crystal chemistry research of calcium phosphates and alumino-silicates approximating bone china compositions. This work has demonstrated the fundamental factors involved in the firing of bone china and has laid the foundation for a scientific approach to its improved production. Present day production in other countries involves a high percentage of "rejects".

Several years of research and experimentation have resulted in the development of a method for the semi-quantitative spectrographic analysis of powder samples. The value of the method lies chiefly in the effectiveness with which it can be applied to a wide variety of materials, ranging from mineral, rock, and ore samples to new and unusual alloys of the metals for which standards are not readily available. Not only does it make possible quantitative determinations which would normally be impossible, but in many instances it saves the time required for the development of highly specialized techniques. It may be used for the routine analysis of minerals, ores, mill products from test treatment of ores, impurities in titanium oxide, thorium in lanthanum oxide, germanium and other rare elements in various materials, and of many other materials.

RADIOACTIVITY DIVISION

The Division is primarily concerned with the development and application of suitable methods, physical and chemical, for the effective recovery of uranium from various types of ores. The treatment of most Canadian ores has required research on the extraction of uranium by leaching methods. In addition to this research the division provides technical assistance and services, including laboratory and pilot plant studies, on the treatment of individual ores for privately owned properties approaching the production stage.

Constant liaison is maintained with similar groups working on radioactive ores in the United Kingdom, United States, South Africa and Australia. To the extent that security regulations permit, technical information is exchanged regularly with these groups, and technical personnel exchange visits for first-hand discussions and observation of new developments.

Assistance is being provided to university research on treatment of radioactive ores. These university projects are sponsored by the Atomic Energy Control Board and at present are under way at the University of British Columbia, the University of Alberta and Queen's University.

ORE DRESSING AND EXTRACTIVE METALLURGY

To cope with the demand for increased uranium production, it has been necessary in Canada and elsewhere to rely on the development of low grade deposits. The economic treatment of these ores has posed a whole new set of metallurgical problems, the solving of which is the object of extensive and continuing research. The Division, working in close co-operation with Crown-owned Eldorado Mining and Refining Limited, bears the main responsibility for Canada's effort in this direction.

In its current major research project, substantial advances were made in the development of a simplified alkaline carbonate leaching process particularly suited to the recovery of uranium from certain low grade ores containing considerable amounts of carbonate minerals. Many of the ores found in the Lake Athabasca area of northern Saskatchewan are of this type. Pilot plant operations at Ottawa using the new process were begun in 1952 and are providing engineering information which is expected to permit full scale plant design by late 1953.

The development of simplified leaching methods which will permit the economic treatment of ores of progressively lower grades is a continuing objective of the Division. The results of small scale experimental work to this end have been encouraging in the application of a simplified acid leach process to granitic ores such as are found in the Charlebois Lake area of northern Saskatchewan and elsewhere. These ores are less complex than the Port Radium type of uranium ore.

Experimental investigations were begun on the treatment of ores in which uranium occurs in refractory minerals of the columbate-tantalate type. Such ores differ decidely from pitchblende and uraninite ores and quite different methods of treatment will be required.

As part of its services to Eldorado, staff members made several trips to Port Radium, Great Bear Lake, to assist the company with the initial operation of the new acid leach plant. The new leaching process which was developed by the Division, has been in full scale operation at the mine since May, 1952. The recovery of uranium from average mine ore is now 30 per cent higher than before, as a result of the addition of the leaching plant. The plant is being used also for the retreatment of old dump tailings from which the uranium was not recoverable by previously known methods. This has brought about a further increase in uranium production in Port Radium operations.

The Division installed in its Ottawa laboratories an alkaline-carbonate pressure-leaching pilot plant which it designed for work on the process being

used in initial operations at Eldorado's Ace mine in northern Saskatchewan. At that time installation of the full scale pressure leaching plant was under way at the mine and the pilot plant at Ottawa was operated for several months as part of a training program for staff recruited by Eldorado for its new plant.

In its services to private companies and individuals, the Division carried out sixteen investigations on the treatment of radioactive ores from various properties. At the end of the fiscal year work had been completed and confidential reports prepared and issued on eleven of these investigations. As a service to one private company, the Division supervised the installation of the automatic picker belt system developed in 1946 by the Mines Branch.

ANALYTICAL CHEMISTRY

Owing to the continued activity in uranium prospecting during 1952 a large number of samples was received for analysis, including many of a refractory nature requiring special treatment. There was a considerable increase in the number of samples received for thorium analysis and other determinations of a more difficult nature such as for niobium and tantalum.

The Division did a considerable amount of umpire assaying on samples from Eldorado's metallurgical plants and gave assistance and advice in standardizing and improving analytical methods for metallurgical control. It assisted outside laboratories by providing detailed information on up-to-date analytical methods and by training personnel in the analysis of radioactive ores. It also loaned members of its analytical staff to other laboratories for brief periods to assist in setting up new instrumental methods, particularly the fluorimetric method of uranium analysis. In this connection, the Division designed and constructed a simple fluorimeter for field use.

In its work on the analysis of thorium, it improved the means of determining small amounts of the element by using a colorimetric method in conjunction with the column separation procedure. In another project on thorium analysis, it did some preliminary work on the development of a simpler method having interesting possibilities and based on the fluorescence of thorium with several organic compounds.

In the work being done on treatment of radioactive ores by chemical extraction methods, large numbers of chemical assays are required, not only for uranium but for many other constituents. Faster and better analytical methods are constantly being sought for all types of assays required.

Work was commenced on the application of polarographic methods, including amperometric titrations, to a number of analytical problems, and investigations were conducted on other electrolytic methods including potentiometric titrations and mercury cathode reduction.

In another project the Division worked out a rapid and sensitive fluorimetric method for the analysis of aluminium in widely different types of samples. This has proven very satisfactory. It made important modifications in a colorimetric method for the rapid determination of copper and tested colorimetric methods for the determination of molybdenum and cerium. It is also investigating improvements in the methods for determining niobium and tantalum.

Several publications (See Publications—Mines Branch p. 97) were issued on new and improved methods of analysis.

PHYSICS AND ELECTRONICS

Radiometric assays increased from 1,599 during the previous fiscal year to 1,977.

A valuable step forward in the standardization of radiometric assay methods for mineral and ore samples was made as a result of the work of the

Division in improving and perfecting the procedure involved, and the equipment used in the equilibrium correction method for radiometric assays. Based on the simultaneous measurement of beta and gamma activity, the method permits, in most cases, a reasonably accurate calculation of the actual per cent U_3O_8 in a sample regardless of the presence of thorium or lack of radioactive equilibrium. It is particularly useful for assay of exploration and development samples, mine samples and samples from gravity and physical concentration operations. It is not suited, however, to uranium assays on samples from chemical leaching operations because of the extreme disturbance of equilibrium resulting from chemical extraction. Following the streamlining of the counter assembly, the Division arranged for the commercial production of the counter units by a prominent manufacturer. Detailed information on the method and unit are available in various publications.

The Division continued to investigate the application of radioactivation methods to the analysis of tantalum, tungsten and other elements in metallurgical samples.

In order to develop improved radiation detectors for various types of counting equipment, work was continued on experimental liquid and plastic phosphor materials. The Division developed and tested thin sheet plastic phosphors and supplied a number of these to outside organizations interested in their possibilities in various research projects.

Equipment is also being developed that will permit the quick approximate radiometric assay of coarse and bagged ore.

To assist in Mines Branch investigations where the radioactive tracer technique may be helpful, laboratory facilities were set up for the handling of radioactive isotopes as tracers in metallurgical and ore dressing research. It is intended to build up the laboratory gradually as demand increases. A few tracer experiments are under way and others are being planned.

Assistance was given to Eldorado in the design and installation of radiometric monitors and electronic devices for use in specific plant operations, and to outside laboratories in radiometric methods of analysis.

MINERALOGY

Mineralogical studies were carried out on ores and ore treatment products from 23 occurrences.

INDUSTRIAL MINERALS DIVISION

The Division is concerned with the development, treatment and utilization of Canada's resources of non-metallic minerals, clays, sands, rocks and industrial waters, which comprise in large part the raw materials of the chemical and construction industries.

During the fiscal year field work in connection with the examination and sampling of deposits of industrial minerals was carried out in nine of the ten provinces and in the Northwest Territories. Visits were made to industries in various parts of Canada using industrial minerals as raw materials, in the course of which information on the most recent developments in processing minerals was obtained.

Demands for beneficiation tests, mineral sample examination, and for general information on industrial minerals reached record levels, as did the use made of the services in examining and appraising non-metallic minerals and rocks for prospectors and the general public. In all, 674 samples were examined and reported on by letter. The Division answered 1,640 requests for technical information on subjects relating to industrial minerals.

During the year 390 samples of industrial minerals ranging in size from 10 pounds to 65 tons were processed. Most of these were collected by the Division but many were sent in by industry and the public. Their regional origins are shown below.

Samples	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Asbestos	1			7	3				2		
Barite		3						1			
Bentonite						1		1			
Apatite				2	3						
Vermiculite					3						
Kyanite					7						
Silica sand		6		4	5						
Ochres			1	2	1	2					
Diatomite		4	1		4				3		
Roofing granules				5	6						
Rhyolite			16								
Anorthosite				2							
Ceramic clay and shale	6	5	3	26	23	14	2	3	17	9	
Light-weight aggregates		6		32			2	7			
Concrete aggregates					44						
Gravel	10				1						
Gypsum		4									
Brucite				1							
Volcanic ash							2				
Sodium sulphate							1				
Glacial silt					4						
Columbite-tantalite											61
Graphite				1	1						
Mica				1	2				2		
Pyrophyllite	2					2					
	19	28	21	83	107	19	7	12	24	9	61

In addition to the above, 674 samples of rocks and minerals submitted for examination and evaluation were examined and reported on and 660 samples of water were analysed.

The survey of the industrial water resources of Canada was continued. With the near completion during the year of the sampling program in the basin of the Mackenzie River, in the Canadian part of the Mississippi River

basin, and in the Canadian part of the Yukon River basin, the work in connection with the basic survey of the waters of western Canada is now almost finished. Sampling in Yukon and Northwest Territories was done through the co-operation of the Royal Canadian Mounted Police. The mobile water-analysis laboratory was operated in western Canada from June 16 until August 31 in making on-the-spot analyses of water samples as a check on the analyses of the same samples made later in Ottawa. Six hundred and sixty samples of water, obtained by the Division's collectors or submitted by the Geological Survey of Canada, were analysed. Two water survey reports (see list of publications, Mines Branch, page 97) were issued, four others are in press, and three more are in course of preparation. Following the publication of the two reports, a greatly increased number of requests has reached the Division for information on industrial waters, and for assistance in solving problems concerning improving the quality of water.

In addition to the routine analysis of regular samples of water, much work was done on special samples submitted in connection with specific problems by the National Research Council, the Department of Resources and Development, the Department of Citizenship and Immigration, and by industry. Research on methods of determining sulphate and silica in water was undertaken at the request of the American Water Works Association, and of the American Society for Testing Materials, and reports were submitted to the two organizations.

In the investigation into the possibilities of making light-weight aggregates from clays and shales, field work in Quebec was completed. The samples obtained were processed and a preliminary report was prepared and awaits publication. Preliminary reports on raw materials available in Ontario and in the Maritime Provinces were issued earlier in the fiscal year. Field work has now been completed in all parts of Canada except Newfoundland and British Columbia.

As a direct result of the Division's work on light-weight aggregates, two plants have been built to manufacture these products and a third is in prospect.

A special survey was completed of deposits of rock, sand, and gravel in the vicinity of the St. Lawrence River between Cornwall and Kingston. Seventy-six rock deposits and 35 sand and gravel deposits were sampled and later tested in the Division's laboratory to determine their suitability for concrete aggregate. The report on the results of this work will make available information on the relative suitability of these materials for use in the proposed power and seaway projects on the St. Lawrence.

Because of the impending shortage of clean, sharp sand for construction purposes in the neighbourhoods of some Canadian cities, research is being done on the commercial practicability of making sand and gravel from different kinds of rock. This involves studies of the ease with which rocks of various types will break down into small particles, and of the type of equipment that will give the largest yield of material in the desired size range.

Studies were continued on the effects of the inclusion of various kinds of chert in concrete aggregates and also of the possibilities of reducing or nullifying the reactivity of certain types of chert by the addition of other materials to the concrete, such as various poszolanic materials. The whole matter of reactive aggregates has come into prominence in the past few years because the failure of some large concrete structures has been ascribed to that cause.

The granite quarries in Ontario and Quebec were visited to obtain information for the preparation of a report on the Canadian granite industry.

The Division's ceramic section is the only research organization devoted entirely to serving the ceramic industry in Canada. In this field it was engaged during the year in a program of research on new raw materials

and new products, and also accomplished much in the development of specifications for refractory products. Equipment was installed to make determinations of the thermal conductivity at high temperatures of refractory insulating materials in accordance with the method approved by the American Society for Testing Materials. It is the only equipment of its kind in Canada and permits an expansion in the services that can be rendered to users and manufacturers of these products.

Research on methods of improving the quality of refractory products made in Canada was continued with encouraging results, and recommendations made are being put into use at manufacturing plants. These relate to the control of grain sizes to improve density and strength, and to changing the composition of firebrick to improve refractoriness.

The development of a semi-silica refractory brick, using Canadian quartzite and imported fireclay, was undertaken at the request of a Canadian steel company. After the correct proportioning of the ingredients to give the maximum refractoriness had been determined and the most satisfactory processing method had been worked out, a large number of bricks were made and subjected to a complete series of tests. The results indicate that a satisfactory semi-silica brick can be made from the quartzite used and it is proposed to extend the work to include other quartzites.

Work was continued on kyanite-bearing rocks from deposits in eastern Canada with the object of finding the most economical way of recovering the kyanite in as coarse a state as possible, and at the same time, of obtaining marketable by-products. The by-products are muscovite or garnet, or both depending upon the deposit. Kyanite is an aluminium silicate used for making certain special high grade refractories that have important industrial applications. It has not hitherto been produced in Canada.

Complete tests were made on 33 brands of refractories used in Canada, bringing to 78 the total of all brands tested. The information obtained is supplied to the Department of National Defence, the Canadian Government Specifications Board, and to industry. In addition, 27 special tests were made on samples of refractory products submitted by the Department of National Defence.

In co-operation with the Defence Research Board, Department of National Defence, the development of a certain type of piezo-electric ceramic material for use in ultrasonic equipment was undertaken and is actively in hand.

The Division examined and tested 142 samples of clays, shales, and ceramic products submitted by industry, the general public, and various government departments.

Thirteen pilot-plant scale tests were made on samples of asbestos-bearing rock ranging in size from 300 pounds to 10 tons, the purpose being to determine the fibre yield and grade and to obtain information on the milling characteristics. The samples came from Newfoundland, Quebec, Ontario, and British Columbia.

In its work on the rare-element minerals the Division, at the request of the Department of Defence Production, sampled deposits of columbite-tantalite in the Yellowknife area, Northwest Territories, in detail and milled the samples to obtain an idea of the potentialities of the deposits. Apart from this it obtained much information on sources and occurrences of other rare-element minerals, including cerium, gallium, germanium, beryllium, lithium, and zirconium, and investigated Canadian sources of tourmaline, sphene, rutile, and quartz crystals, all of which are required for defence purposes.

During a part of the fiscal year the Division continued to supervise the production of quartz crystals of piezo-electric quality from Canada's only producing deposit near Lyndhurst, Ontario. Later, the operations at the property were taken over by private interests.

In its field survey of the mineral resources of Newfoundland, the Division has already examined and sampled most of the readily accessible deposits as the basis for the preparation of a report. This survey led to the discovery of a deposit of shale near Georges Brook that is highly suitable for making structural clay products and use is being made of the shale for the production of building brick. Distribution by the Division of samples of pyrophyllite (a variety of talc) from Manuels that were processed in its laboratories, resulted in the owners of the deposit receiving an initial order from the United States for 200 tons of the mineral.

The preparation of a bibliography of published and unpublished reports dealing with industrial minerals in Canada was largely completed. This work is being done in co-operation with the provinces and is the result of a resolution passed at the 1951 Mines Ministers' Conference. It is proposed to publish this bibliography as a printed report.

The activities also included research on: the production of vermiculite from Canadian deposits; the utilization of apatite and its associated gangue minerals as a source of phosphatic fertilizer; the production of high-grade silica sand from Canadian sandstones; the dehydration of Glaubers salts from western Canada; the utilization of anhydrite; the production of roofing granules from Canadian sources; and the activation of bentonite. Reviews of 1952 on each of the industrial minerals produced in Canada were prepared.

FUELS DIVISION

The economic utilization of Canada's fuel resources is the main goal of the Division research and investigative work. Close liaison is maintained with the Dominion Coal Board and the Division acts as consultant to the Board on technical matters related to fuels. It is consulted by the Department of National Defence and other government departments in many matters concerning the supply and consumption of suitable fuels. The information and facilities available in the Division have also been freely drawn upon by private industry.

DEEP MINING PROJECT

The investigation of rock pressure in several coal mines of western Canada was extended to Nova Scotia at the request of the Provincial Government. The rock pressure project is being carried out in co-operation with the Geological Survey of Canada and is concerned chiefly with the violent pressure relief phenomena known as "bumps" and "outbursts" which make the mining of the coal at depth hazardous and thus interfere greatly with production. Apart from its specific application the investigation should provide much additional knowledge of the problems relating to deep mining as a whole.

Work on the project in the western mines during the year included special surveys and other observations in three mines in Alberta and one in British Columbia. Stress measuring equipment of two types, designed and constructed by the Mines Branch, was installed in the western coal mines being investigated. This equipment is being supplemented by the installation of indicating- and measurement-recording instruments to expedite the work and to provide a more accurate record.

Until such time as staff engaged on the project in the western mines can be spared, the work in Nova Scotia will be confined to preliminary surveys, which are being carried out by a mining company in consultation with the Division.

In a closely related project extensive tests are being made concerning the association of methane gas with coal.

ROOF-BOLTING INVESTIGATION

Continuing its investigation of a system of roof bolting for coal mine entries and haulage ways, which replaces the use of wood and steel props for roof support, the Division made arrangements to bolt an experimental length of underground roadway in an Alberta mine. Careful surveys will be made in order to detect any tendency toward bed separation. It is planned to extend this experimental work to other mines in Alberta and British Columbia.

MINE AIR ANALYSES

Regular analyses of air from coal and metal mines in Nova Scotia, Alberta, and British Columbia, were made to assist the operators in the maintenance of proper and adequate ventilation of the working areas.

COAL PREPARATION

The Division devotes considerable attention in the field and in the laboratory to investigations dealing with the cleaning and beneficiation of coals. With particular reference to western coals these studies include briquetting tests to determine the possibility of producing from the fine sizes, which are difficult to market, coal in agglomerate form which can be readily marketed. The Division has set up a laboratory in Calgary with an engineer in charge, in which it will carry out preparation and sampling analyses at mine plants as a supplement to its work in Ottawa.

Physical and chemical surveys and washability investigations were conducted on coals from eastern Canada.

COKING AND DOMESTIC STOKER INVESTIGATIONS

Blending tests on Nova Scotia coals of varying volatile content and coking characteristics were conducted in an experimental semi-plant scale coke oven. It was found that the addition of selected medium volatile coal from the New Glasgow area to the regular high volatile Cape Breton coals greatly improved the structure of the resultant coke for use in steel plant blast furnaces.

Tests on the non-caking variety of coals from western Canada were made with encouraging results on two different types of domestic mechanical stokers. A new project is in progress to determine the cost of house heating by such mechanical stoker heating units, in comparison with oil, using properly selected and sized coals.

COAL FIRED GAS TURBINE PROJECT

Progress was made toward completing the installation of the component parts of the 500 h.p. prototype engine at Ste. Anne de Bellevue, Quebec, and the Division assisted in the development and installation of the coal-handling and combustion equipment. It is expected that the unit will be in operation in 1953. This project is a joint investigation with the Gas Dynamics Laboratory of McGill University, the eventual goal being the development of a gas turbine unit for locomotives and for stationary electric power generation. Such a development would enable the coal industry to retain part of the market that would othewise be lost to diesel and other oil-fired prime movers.

PEAT

Visits were made to various plants and bogs in Ontario, Quebec, and New Brunswick as a means of keeping abreast of developments in the peat moss industry in these provinces. In the course of these visits information was given to correspondents who had requested assistance in developing new properties.

A unit for burning peat was designed and constructed. The unit can be attached to any standard coal or wood-burning furnace. In a test it was attached to a large Quebec heater and a number of tests were run on peat which had been air-dried for a short period. It was found possible to maintain a fairly high heat release over an 8-hour period without attention.

BITUMEN AND CRUDE OILS

The investigation of hydrogenation as a means of producing gasoline and light oils from Canadian bitumen and other heavy oils was continued. Some of the high-pressure equipment under construction failed in preliminary test and was replaced by the manufacturer. However, definite progress was made toward the establishment of a small-scale pilot plant for hydrogenation tests on heavy oils and coal-in-oil pastes.

Research conducted on the desulphurization of bitumen and heavy crude oils by hydrogenation at low pressure showed that the oils can be rendered suitable for transportation by pipeline and as a crude stock for petroleum refineries. Continuous operation in excess of 140 hours has indicated that the catalyst will not need to be replaced at frequent intervals.

Research was continued on the isolation and identification of constituent chemical compounds in bitumen and other petroleum oils. Different fractions of bitumen were examined by various methods to determine the molecular weight of the components.

GASOLINE SURVEY

A total of 112 samples of motor gasoline from all provinces except Prince Edward Island were analysed to ascertain the quality of gasoline currently marketed in Canada and to compare it with that sold in former years. A report (Memorandum Series No. 124) giving the results was issued.

ANALYSIS SURVEYS AND LABORATORY INVESTIGATIONS

The physical and chemical survey was continued as part of the basic study of the properties and beneficiation of Canadian coals. The data resulting from this study on the characteristics of Canadian coals as mined, is the basis for fundamental research as well as for the evaluation and improvement of the quality of the coals being prepared for marketing.

An analysis directory of Canadian coals is being prepared for publication as an aid to coal miners and coal users in comparing the quality of coal actually marketed from different areas.

PHYSICAL METALLURGY DIVISION

Major attention was again given to problems related to defence. Much of the work was financed in part by the Department of National Defence, mainly through the Defence Research Board. The Division handles the metallurgical problems of Atomic Energy of Canada, Limited, and to fulfil these duties it maintains a staff at Chalk River, Ontario. However, problems involving heavy equipment and special instruments are investigated at Ottawa. Activities in the metal forming laboratory were devoted almost entirely to development and prototype work on metals involved in the use of atomic energy, and especially on requirements for the reactor. The investigation of several different methods of sheathing uranium indicates that two of the newly developed methods will yield higher neutron efficiencies or allow higher operating temperatures in power-producing piles than was possible by the older sheathing methods.

Largely because of the potential importance of the metal in military and naval equipment, the Division is carefully following developments in the fields

of fabrication and utilization of titanium. The most difficult problem in its fabrication arises from its powerful affinity for oxygen, a fraction of 1 per cent of which renders the metal too brittle for fabricating. The chemical determination of such small quantities of oxygen in the metal is difficult. In this connection the Division has perfected the design and construction of very sensitive apparatus and has mastered delicate techniques so that uniform analyses are now consistently obtained. It has designed and constructed vacuum melting and casting equipment in which titanium ingots are regularly produced without contamination by oxygen or nitrogen. A notable and essential achievement in this program has been the production in Canada of a low-oxygen titanium sponge from which a ductile metal can be cast and rolled. This result was achieved by Canadian industry in co-operation with the Division. The next step in the titanium program will be the practical evaluation, for industrial production, of various titanium base alloys whose mechanical properties have already been determined in the laboratory.

In the field of ferrous alloys, the Division has been working on the development of readily available substitutes for nickel and molybdenum, which have been in short supply. In co-operation with the Steel Castings Institute of Canada it successfully developed eight low-alloy steels in which nickel and molybdenum were replaced by boron. Added in only fractions of a per cent, boron, which is in good supply, imparts remarkable deep hardening properties to steel. Other important contributions to ferrous metallurgy included: determination of optimum pouring temperatures for manganese steel castings to obtain a fine grain-size and the consequent superior mechanical properties; and determination of the influence of lead, tin, zinc, and antimony on the graphitization of malleable cast iron, and the establishment of modified annealing cycles to counteract these influences. Preliminary investigations have shown that controlled additions of specific alloys to ductile cast iron increase the hardenability, and, therefore, the strength of the iron, without interfering with the nodular form of graphite formation, the essential feature from which the material obtains its special merit.

In the work on light alloys, the magnesium-zinc-zirconium alloy, developed in the Division and now used regularly by the aircraft industry, was further improved. Light alloy parts for guided missiles and for a light-weight mortar were designed and cast for the Department of National Defence. After proper foundry techniques were developed, special magnesium anodes were cast for the protection of naval vessels from corrosion. A number of large aluminium alloy castings were produced for Cobalt-60 "bomb" therapy units.

The Division co-operated with the Royal Canadian Navy in the development and production of a Canadian designed depth-charge thrower. The relative merits of centrifugally cast barrels versus welded barrels were determined by internal pressure tests and subsequent firing trials. A number of different designs of the breech end and various fabricating methods were similarly tested. The weapon finally evolved is considered to be highly efficient and free from difficult features of construction.

Theoretical and experimental methods of stress analysis have been worked out, successful application of which to such articles as pressure vessels, gun cradles, under-carriage bolts, and torsion bar suspensions has yielded data essential to design engineers of the Department of National Defence. Modifications of non-destructive testing methods, utilizing ultrasonic waves and alternating magnetic fields, have been devised and applied to the inspection of such items as large naval rotor forgings, cartridge cases, shells, tracers, and igniters. As the detection of internal flaws without destroying the part has always been one of the most troublesome problems of inspection, the importance of the work is apparent.

At the request of the Department of National Defence, the Division investigated problems of cracked ingots and unsatisfactory mechanical properties in gun tube forgings. Adoption of its recommendations virtually eliminated rejections for cracked ingots, and resulted in a marked decrease in rejections for failure to meet specified mechanical properties. At the same time the changed forging practice cut these costs at least in half.

In research on welding problems at low temperatures, cold room tests down to -80° F. revealed the necessity for further modifications of welding and control equipment. Mechanical troubles involved in welding at low temperature were identified and corrective measures devised. Lubrication, and sticking of moving parts due to uneven contraction, are examples of the difficulties encountered. Investigation of causes of microcracking in the weld when welding is carried on at low temperature gave information which indicates that the kind of welding electrode used has considerable influence on the extent of microcracking in the weld. One type of electrode least likely to cause such failure was determined. Much additional data on welding at low temperatures are needed before satisfactory results can be achieved.

The Division co-operates closely with naval and shipyard engineers in connection with problems involved in welding high-temperature, high-pressure steam lines for naval vessels. During the fiscal year it reviewed British and United States specifications for marine welding of pipelines and conducted practical welding tests in the laboratory. The information so obtained is being used in the formulation of specifications for the shop-welding of steam lines and subsequent installation in the vessels.

The program for directing radiographic control of quality in castings for R.C.A.F. aircraft was continued. Radiographers from companies producing castings for the Air Force were trained in the latest radiographic procedures, and industrial radiographic laboratories were inspected to ensure that they conformed to R.C.A.F. requirements.

Assistance was also given to the R.C.A.F. in connection with incidents arising from failure of metallic components in aircraft and land structures. Following investigations, recommendations were made for the prevention of failures. An example is the case of cracked welds in communication towers. Inspection methods were devised to locate the defects and repair methods were developed and applied so that twenty-one towers were salvaged.

Two Canadian clays were investigated to determine their use as bonding agents for foundry moulding sand and both were found to be more suitable than the imported varieties now used. A similar investigation involved the testing of waste sulphite liquors for use as core binding agents, and the determination of the most efficient core mixtures.

Other activities included: the development of satisfactory substitutes for certain temperature-sensitive iron alloys used in energy-measuring meters no longer available from sources outside Canada; and development of a new method of fabrication of mining drill sets by which the strength at the joint between the rod and the bit has been greatly enhanced.

A number of fundamental research projects are in progress. In one of these the Division is investigating the mechanism of formation of orientation textures that impart marked directional properties to metals. The exact mechanism by which the preferred orientation is brought about has been quite obscure and this research has been directed toward elucidation of the fundamental factors involved. These factors are now sufficiently well understood so that, in certain cases, properties may be predicted from the observed texture of the metal.

The technique of spectrographic microanalysis has been extended to increasingly small segregates in ferrous and non-ferrous alloys. This method yields essential information regarding the distribution of segregates, and the identity and source of non-metallic inclusions.

The process of carbide precipitation that occurs during the tempering of quenched steel is the object of a fundamental research investigation. Significant facts have been established that should lead to improvements in the industrial heat treatment of steel.

Lack of adequate information on the mechanism by which metals creep when under stress at elevated temperatures handicaps the scientific approach to the development of superior alloys for high-temperature service. The Division, working with single crystals and also investigating the influence of minute amounts of impurities, has obtained data that go far toward clarifying the problem. In particular, the brittleness observed when normally ductile metals are broken in creep-rupture tests has been shown to be attributable to the concentration of specific impurities at the grain boundaries of the metal in the course of the test. Uncertainty as to the cause of the phenomenon has been a major obstacle to an understanding of the creep process.

During the fiscal year the Division issued 14 research reports, 41 reports of investigations, 270 test reports, and provided advice on 140 inquiries referred to it by the Technical Information Service, National Research Council. Officers of the Division gave 20 lectures before metallurgical societies and prepared 22 scientific papers that were published in technical periodicals.

MINERAL RESOURCES DIVISION

Increased interest in the development of Canadian mineral resources, particularly iron and the base metals, resulted in a heavy demand on the services of the Division. Canada's position as a future supplier of raw mineral products to meet increasing world demands is assuming international importance. Worthy of note is the number of inquiries from the United States and foreign countries for information relating to taxation, staking, and general conditions of conducting mining enterprise in Canada.

Approximately 3,000 inquiries for information were received, many of which entailed the preparation of lengthy memoranda. The division has therefore continued to improve its compilation of statistical and economic information relating to the mineral industry, not only for Canada but for the major mineral-producing countries.

The mineral resources inventory, begun in 1946, is being enlarged constantly as a result of new discoveries and from the compilation of information from old reports. During the fiscal year 424 new entries were made.

Field work included visits to the cobalt-silver mines of the Cobalt-Gowganda area, Ontario, to the base metal mines of the Sudbury and eastern Quebec areas, and to the iron mines of Ontario. Visits were made also to various metal-fabricating plants in southwestern Ontario to acquaint officers of the Division with the industrial problems of fabrication, consumption, and uses of various metal products.

The Division continued to assist the Department of National Revenue in the administration of Section 74 Income Tax Act, and Section 1203 of the Income Tax Regulations. Fifty investigations were undertaken and recommendations were made. It also assisted in the processing of nine applications by oil companies for approval of tax concessions on proposed deep test wells.

The full time of two engineers was provided for administration of the Emergency Gold Mining Assistance Act. Their work included inspection trips to all gold mines receiving assistance under the Act.

Manuscript maps showing the distribution of all the active mining properties in Canada, and of the oil and gas fields and iron ore deposits were completed for inclusion in the new atlas of Canada being prepared by the Geographical Branch.

On January 1, 1953, the distribution office of the Mines Branch was transferred to the Division. During the fiscal year 50,948 publications were distributed. As from January 1, 1953, the policy of charging for all Mines Branch publications was put into effect.

The Chief of the Mineral Resources Division who had been on loan to the Non-Ferrous Metals Division, Department of Defence Production, returned to his Division on August 1, 1952.

LIBRARY

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

With the marked increase in the activities of the Branch during the past several years, working space for the library staff and reader space for the branch officers are both considerably short of requirements. The matter of providing the needed space has been under study.

The following acquisitions were recorded.

Publications received:	
Canadian Government	2,096
British, United States and foreign governments	1,989
Scientific societies	1,343
Periodicals	5,879
Books and pamphlets ordered	587
	11,894
Recorded loans, inclusive of Branch circulation of periodicals (13,893) and inter-library loans (borrowed 602, lent 336)	17,881
Cards added to the reference catalogue	1,635
Periodicals and annuals subscribed for	397
Volumes bound	321
Items accessioned	941

DOMINION OBSERVATORIES

C. S. Beals, Dominion Astronomer

The Dominion Observatories comprise the Dominion Observatory at Ottawa with its subsidiary stations, and the Dominion Astrophysical Observatory at Victoria, B.C. The work of these two institutions is organized into a number of Divisions, corresponding to the various aspects of astronomical and geophysical science in which they are engaged.

THE DOMINION OBSERVATORY, OTTAWA

POSITIONAL ASTRONOMY

This Division makes determinations of the positions of stars and utilizes this and other data to maintain the time service of Canada, one of its main functions, and for general astronomical research.

Star Positions. The positions of 1,200 stars which are used for precise time determinations in Canada, England and the United States were observed. As a modern time service depends mainly on observations with photographic zenith telescopes, these stars are located in three narrow zones across the sky which are not well covered by existing star catalogues. Accordingly, it is necessary to re-observe their positions and this is being done at the national observatories of the above three countries. The results are pooled for greater accuracy. This work is done with a large transit instrument known as a meridian circle telescope. During the fiscal year the Division devoted 139 nights to this program and obtained 6,907 observations of position. It expects to complete the program during the coming year.

Determination of Time. At Ottawa, time determinations were made on 197 nights, making use of the new photographic zenith telescope, the number of star transits observed being 3,435. A comparison with observations made in former years with the more conventional type of transit instrument showed a considerable increase in accuracy and this improvement was confirmed by foreign observers who receive Canadian time signals regularly. Much effort was devoted to the development of time-saving methods of observing and computation in the determination of time. This has involved the use of facilities of the Computing Centre of the University of Toronto for calculating the times of transit of the clock stars. It has also involved the construction of an automatic machine for setting in motion the mechanism of the photographic zenith telescope as the clock stars approach the meridian. When this machine is set accurately for the first star on the program it will carry on automatically with the remaining observations throughout the night with only minor supervision, leaving the observer free for computations or other duties.

Latitude Variation. The photographic zenith telescope is used also to study the variation of latitude, a phenomenon presumably due to wobbling of the earth's axis. A year's observations indicate a cyclic change of the order of one second of arc, confirming previous observations by other observers.

Distribution of Time. For the most part distribution of time is accomplished by means of radio time signals. For the more populated regions of the country, time is made available for reception on ordinary radio sets by the daily C.B.C. broadcast at one o'clock eastern standard time. (E.D.T. in summer). For surveyors, aerial navigators, ships at sea and persons stationed in remote or isolated areas of the country, short wave radio broadcasts of

time signals are maintained on a 24-hour basis, the broadcast frequencies being 3,320, 7,335 and 14,670 kilocycles. A new transmitter put into operation recently radiates the 7,335 frequency at a power of 3,000 watts. In addition to the radio broadcasts, time signals are transmitted twice daily by wire to station CFH in Halifax for broadcast to ships at sea. The two main railway and telegraph companies, and the Bell Telephone Company also receive signals by wire for transmission over their own networks. Numerous government buildings in Ottawa, including the Parliament Buildings, have their clocks synchronized by wire from the Observatory.

STELLAR PHYSICS

This Division makes use of astronomical observations to study the physical characteristics of the earth's atmosphere, of the sun and of other heavenly bodies, such as meteors, comets and stars.

Studies of Meteors. During the fiscal year emphasis was placed on the use of meteoric observations to study the characteristics of the upper atmosphere, specifically its density and the resistance it is likely to offer to high speed military projectiles. Meteors are almost ideal for this purpose as they are projected into the atmosphere at speeds of 30 to 70 miles per second, and become luminous, so that their trajectories can be accurately observed. Most meteors are very faint and can be photographed only with high speed cameras and for this reason two Super-Schmidt cameras of the reflecting telescope type have been permanently mounted in the meteor observatories at Meanook and Newbrook, Alberta. Sky tests indicate that the optical performance of the new cameras is excellent, and their very large focal ratio (0·65) makes them approximately twenty times as fast as the best previous equipment. Most of the auxiliary equipment required for the operation of the cameras has been installed as has a two-way radio communication system between Meanook and Newbrook. This is required so that simultaneous photographs may be taken at the two stations for photographic triangulation of meteor paths.

Routine observations of meteors at Ottawa and at the stations in western Canada using visual, photographic and radar observations, were continued throughout the year. In all, 720 exposures were made with meteor cameras and 1,570 meteors were observed visually. Among the photographs were four very good meteor spectra, three of which were photographed at Meanook and one at Ottawa. These were obtained with new grating spectrographs and show more detail than was previously available. Analyses of the best of these spectra has resulted in the identification of ionized iron and hydrogen, atoms not previously recognized in meteor spectra. The general study of meteor spectra was actively pursued in preparation for publication of a comprehensive survey of this subject.

The statistical study of meteor radar echoes was continued. An investigation of exceptional echoes arising both from meteors and from the aurora was completed in co-operation with National Research Council.

Arrangements were made for the purchase by the Federal Government of the Abee meteorite which fell just 8 miles south of the Newbrook Meteor Observatory in Alberta on June 9, 1952. This is the largest Canadian meteorite that has been seen to fall, weighing 237 pounds. Visual observations of the accompanying fireball were collected in the Edmonton-Athabasca area.

Solar Physics. Spectra of the sun with a high dispersion spectrograph were obtained on 72 days. These spectra, most of which were in the far infrared region, were used mainly to study lesser-known constituents of the

atmospheres of the earth and sun. In particular an investigation was made of the abundance of carbon monoxide in the terrestrial and solar atmospheres from the intensities of the infra-red molecular bands recorded on a large number of spectrograms. For comparison an investigation was made of the absorption spectrum of carbon monoxide in the laboratory. It was shown that the amount of carbon monoxide in the earth's atmosphere is not always constant although no reason could be found for the variations.

The Lyot monochromatic filter and automatic camera, designed to continuously record solar atmospheric eruptions in red hydrogen light, were installed on the mounting of the 15-inch telescope. Preliminary photographs were obtained and it is hoped that during the coming fiscal year this equipment will provide an extensive record of the curious outbursts of hydrogen on the sun's surface known as solar flares. Flares are commonly accompanied by the emission of ultra-violet light and by the ejection of atoms from the sun's surface, causing auroras and disturbances in radio reception on the earth.

Theoretical Astrophysics. The methods of mathematical physics were used to study a number of problems, including the physical conditions necessary for the appearance of bright emission lines in the spectra of stars. It was shown that a large shell of gas surrounding a hot star is necessary before a star spectrum can show emission lines, and that the motions in the gaseous shell can be inferred from the shapes of the lines. The results of these studies were presented at scientific meetings in Canada and in England.

Investigation of the application of the theory of relativity to a number of important phenomena associated with radiation indicated that such apparently unrelated phenomena as light and gravity in a metrical world are two aspects of the same phenomenon.

General. The Division was represented at the spring meeting of the American Association of Variable Star Observers at Potsdam, N.Y., in May; at the 87th meeting of the American Astronomical Society at Victoria, B.C., in June; and at the meeting of the Royal Society of Canada at Quebec City in June. During the year 8 lectures were given to technical and non-technical groups in various parts of Canada.

TERRESTRIAL MAGNETISM

Magnetic Mapping. This Division produces magnetic maps of Canada showing the variation of the compass from true North, the vertical and horizontal strength of the earth's magnetic field, and its inclination to the vertical. Magnetic survey operations to provide the necessary data were carried out in Quebec, Ontario, Alberta, British Columbia, Yukon and Northwest Territories. Observations were made at 72 locations, one of them in Alaska by a party making observations along the Alaska Highway. Thirty-one of the observations were made at repeat stations (necessary because of slow changes in the earth's field) and 41 in new areas. The latter were along the Alaska Highway between Athabasca and Fairbanks; along the Mackenzie highway between Peace River and Hay River; on the coasts of James Bay and southern Hudson Bay; and in the vicinities of Lakes Mistassini and Chibougamau in Quebec.

Progress was made on the reduction of all Canadian magnetic observations to the epoch 1955·0 in preparation for the construction of new magnetic maps of Canada which will be included in magnetic maps and charts of the world as a whole.

In the mathematical analyses of the earth's magnetic field in Canada special attention was given to the phenomenon of long-term changes of interior origin. A study of the magnetic field existing in the interior of the earth was commenced in order to acquire further knowledge of the cause of the earth's magnetism, the inter-relation between changes in the magnetic field and crustal and core phenomena, and field changes associated with broad geological formations.

Magnetic data necessary for new and revised topographical map sheets and marine and air navigation charts were supplied for a total of 937 items. These comprised, 529 for the Surveys and Mapping Branch, 14 for the Geological Survey of Canada, 352 for the Department of National Defence, and 42 for other agencies. Considerable information of a similar nature was supplied to private investigators and prospecting companies.

Magnetic Observatories. Observatories with photographic recording instruments to follow and record continuously the variations in the earth's magnetic field are maintained at Agincourt, Ontario; Meanook, Alberta; Resolute Bay, N.W.T., and Baker Lake, N.W.T. Such records provide checks or controls on field observations and are used also to accumulate scientific data of value in studies of the origin of the earth's magnetic field. Three-hour range indices (so-called K indices) which provide a measure of the frequency and intensity of magnetic disturbances, were measured from observatory magnetograms and supplied monthly to research centres in the Netherlands, Germany, United States, and Canada.

The Meanook Magnetic Observatory was enlarged by the construction of a caretaker's residence, a combined two-car garage and workshop, and a pumping station for additional water supply and fire protection. The Northland Utilities power line was extended to Meanook and the use of diesel power plants on the site was discontinued except for stand-by purposes. The transfer of instrumental equipment from the old to the new magnetic observatory building was completed.

Magnetic Laboratory. The magnetic laboratory in Ottawa was moved from the basement of Observatory House to a building on the Prescott Highway formerly occupied by the Radio Physics Laboratory of Defence Research Board.

A new magnetometer designed to measure all the elements of the earth's magnetic field from the air rather than the ground reached the final stages of development and is ready for test flights during the summer of 1953. A so-called absolute magnetometer for the purpose of checking and calibrating the recording instruments at the magnetic observatories was constructed and was installed at Meanook during the year.

Dr. Julius Bartels, Professor of Geophysics and Director of the Geophysical Institute at the University of Göttingen was attached to the Division from August 6 to October 27.

GRAVITY

Gravity measurements are used to investigate the nature of the earth's outer and lighter crust and are of international importance in studies to determine the shape and form of the geoidal or level surface of the earth. The results are of value to commercial geophysical firms who use the data for reference and for control of more detailed gravity surveys in the search for oil and other minerals.

New Gravity Maps. The Gravity Division completed the construction of four gravity maps for the Prairie Provinces and for the Maritime Provinces. The maps for Alberta, Saskatchewan and Manitoba are on a scale of 20 miles to an inch, and those for the Maritime Provinces on a scale of 12 miles. The gravity data, which are given for more than 4500 stations at intervals of 8 to 20 miles, are the combined results of several years of field work, and include the results of all gravity measurements so far obtained in these provinces. The maps are now available for distribution and are of particular interest to oil and gas exploration companies.

Gravimeter Observations. Much time was devoted to improving the gravity ties between gravimeter bases established on previous surveys in northern Canada and in southern Ontario and Quebec, and to improving the connections between these bases and the national gravity base station in Ottawa. Using gravimeters, the three field parties engaged on the project re-occupied 301 gravimeter base stations and 34 pendulum stations, and established 250 new stations. In southern Canada the bases extend from Rivière du Loup in Quebec to Vancouver, and in northern Canada the network of bases extends about 1,200 miles northwest from Nakina, Ontario to Lake Athabasca in northern Saskatchewan. Approximately 20,000 miles of automobile transportation and about 15,000 miles of aircraft transportation were required to complete the project.

The results of the 1952 program have been of great assistance in adjusting, to a high standard of accuracy, the observations for nearly 5000 gravimeter stations previously established throughout these areas. New values of gravity, consistent with the 1952 base station values and the Bouguer anomalies, have been recomputed for all stations.

Progress was made in the preparation of additional gravity maps similar to those already mentioned and it is expected that in the near future maps covering northern and southern Ontario and extensive areas of the Northwest Territories will be available for publication.

Pendulum Observations. On the basis of a proposal put forward at the 1951 meeting of the International Union of Geodesy and Geophysics at Brussels, the pendulum gravity apparatus of Cambridge University was loaned to the Dominion Observatory for the purpose of establishing a line of pendulum stations extending over a great range of latitude on the North American Continent. The aim of this project was, in part, to correlate the gravity networks of Europe and North America and partly to provide a series of accurately determined stations for the calibration of gravimeters.

After discussions with United States and Mexican scientists it was agreed that this line of stations should extend from Mexico City through the United States and Canada to Fairbanks, Alaska. In co-operation with the United States Coast and Geodetic Survey the southern half of the program comprising nine stations extending from Mexico City to Winnipeg was completed in the summer of 1952.

The total change in gravity covered was over 3000 milligals, and calculations show the error of each determination to be less than one-half a milligal. It is expected that the northern half of the chain of stations will be completed in 1953.

SEISMOLOGY

This Division maintains a network of seismographs across Canada for the detection of earthquakes. These are in constant operation, and are located at Halifax, N.S.; Seven Falls and Shawinigan Falls, Quebec; Ottawa and Kirkland Lake, Ontario; Saskatoon, Saskatchewan; Victoria, Horseshoe Bay, and Alberni, B.C., and Resolute Bay, N.W.T. The records are read carefully and the data are reported to other stations throughout the world by means of regular

bulletins. Preliminary readings of three key stations are reported daily by radio to a central office in Washington, D.C., maintained by the United States Coast and Geodetic Survey.

A new station has been installed at Halifax, equipped with the most modern instruments, and a new vault is under construction at Victoria which will eventually house the most up-to-date seismograph station in Canada. Instruments for this latter station have already been purchased and, by the re-allocation of equipment, it will be possible at the same time to improve the instrumentation of the station at Seven Falls, Quebec.

Seismicity of Canada. An attempt is being made to study the seismicity of the St. Lawrence Valley and the coastal area of British Columbia in detail. The program is well advanced in British Columbia and annual reports are published listing all earthquakes. A similar program is planned for the St. Lawrence area and it is eventually intended to report annually on all earthquakes of this region also.

Crustal Studies. The Division has completed an elaborate study of the earth's crust using rockbursts as a source of energy, and is now embarking on an enlarged program to apply still more modern techniques in studying the finer details of the structure, and in extending the studies to other areas. Instruments will have to be developed for the purpose and, with this in mind, a well-equipped seismic laboratory is being set up. The general purpose of this study is to ascertain whether the earth's crust consists of two or more layers of granite and basalt as earlier seismological studies seemed to indicate or whether there is a single layer only with gradually varying physical characteristics throughout its thickness. A second object which eventually may prove more important is to develop methods of "hard rock" seismology which will make it possible to ascertain the thickness and other dimensions of crustal details such as lava flows and igneous intrusions.

Mechanism of Earthquakes. For several years past the Division has been studying the direction of relative earth motion or faulting in large earthquakes. The method, which depends on a knowledge of the direction of initial ground motion at seismograph stations throughout the world, has been known for many years but has never been systematically developed. It is proposed to make the Dominion Observatory a centre for research of this type. To this end, tables, analogous to map projection tables and necessary for this type of analysis, have been prepared for a large number of different types of seismic waves. The analysis has been applied to about 40 earthquakes, with emphasis on shocks of the North Pacific. If the direction of motion of a sufficient number of earthquakes throughout the world is known, it is hoped that the physical processes responsible for their occurrence will become clear.

DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.

The facilities of the Observatory are utilized largely for research in stellar spectroscopy and stellar motions, and the telescope is used chiefly for photographing spectra of stars. During the fiscal year observations were made on 192 nights for a total of approximately 1,100 hours, in spite of interruptions occasioned by the attachment of the new spectrograph. An important step forward was the construction of a stellar photometer, employing a modern photo-electric detector, which will enable the spectroscopic observations to be supplemented with measures of stellar colours and luminosities. The new stellar spectrograph has been in operation since June, 1952.

Stellar Spectroscopy. The principal aims in this field are to observe the radiations of celestial bodies and to interpret the observations in terms of the

physical conditions, including the mechanism of energy generation prevailing in the stars. Several investigations were in progress during the fiscal year. One, now completed, has shown the existence of powerful material surges or explosions in stellar atmospheres thought to resemble the prominences on the sun, but on a vastly increased scale. Other work will yield much detailed information on the absorptions in stellar spectra which, combined with measures of the radiation and atomic laboratory data, will give the composition of the matter and the abundance of the chemical elements in the stars and in interstellar space.

An interesting development was initiated in applying an electronic computing machine to astrophysical problems. The machine, at the University of Toronto, is being used to calculate a number of "models" of theoretical stellar atmospheres. It is then possible to compare the models with actual stars and to see how closely the assumptions made in the models correspond to the star actually observed. Apart from the interest attached to these calculations for their immediate application to stellar work, this project is of value in suggesting other problems which can be solved similarly with a great saving of time.

Stellar Motions. The stellar motion programs are devoted to determination of the line-of-sight speeds of large numbers of stars, and to the investigation of close double stars which can never be seen separately but are revealed by spectroscopy. In the former, programs are chosen so as to shed light on the movements of groups of stars, which in turn gives knowledge regarding the structure of the universe and how the laws of mechanics apply in the galaxy outside the solar system. In the latter, double stars are observed as they pursue their orbital motions, and from these observations it is possible to deduce the sizes, densities, and other interesting information regarding the individual stars. This information dovetails with other physical studies bearing on stellar structure and the origin of stellar energy.

During the fiscal year more than 700 photographs were measured for the determination of the line-of-sight speeds of stars and the motions of seven double stars were studied in detail. Two main radial-velocity programs were under observation and measurement. One embraces a large number of distant stars situated in the plane of the galaxy. The measurements on these stars will expand the knowledge of the dynamics of the galaxy and the motions and distribution of the interstellar matter. A second program deals with the stars in the neighbourhood of the pole of the galaxy. The radial-velocities of these stars give the motion perpendicular to the galactic plane and will therefore enable measurement of the mean density in space in the neighbourhood of the sun. It is expected that observations on this project will be completed during 1953.

A fundamental program revising the wave-lengths used for radial-velocity measures of the high-temperature stars was completed; the results will be used at the Victoria and other observatories and will make more certain the dynamical results on the motions of the stars.

Research into double stars was continued with the determination of the orbits and the dimensions of seven massive spectroscopic binaries. In the interpretive field a theoretical study was begun into the origin and evolution of double stars. Employing only the simplest of assumptions, and gravitational forces, the preliminary results are promising in that they explain why every third or fourth star is a double or multiple object.

A modern electronic photometer was installed on the telescope. After testing, this instrument will be used to measure the colours and brightnesses of stars, observed with the spectroscope.

In June the Observatory was host to the American Astronomical Society and the Astronomical Society of the Pacific at a joint meeting at Victoria.

The Observatory was represented at five other scientific conferences during the fiscal year, including the 8th General Assembly of the International Astronomical Union in Rome. Scientific contributions by staff members were presented at all these meetings.

An estimated 26,000 persons visited the Observatory. This included a number of educational, cultural, and scientific groups.

Staff members, on request, delivered 19 addresses in the Victoria area.

Information on sunrise, sunset, moonrise and moonset was given to airport authorities.

GEOGRAPHICAL BRANCH

J. W. Watson, Director

The Branch continued the surveys of the physical geography of northern regions and of the economic and social geography of selected areas in southern Canada. It did field work in Keewatin and Franklin Districts, Northwest Territories, for use of the Department of National Defence and rendered various other services to that department. It carried out investigations in Alberta, Manitoba, Ontario, and Nova Scotia as a service to the Civil Defence Division, Department of National Health and Welfare, and made basic surveys for civilian purposes in Alberta, Nova Scotia, and Newfoundland. By the end of the fiscal year, a considerable part of the data required for preparation of a new atlas of Canada had been compiled.

FIELD SURVEYS

In continuation of the regional geographical surveys in the Atlantic provinces, investigations were carried out in Cape Breton Island, Nova Scotia, and in the Burin and Bonavista peninsulas of Newfoundland. In the rural areas, full information on the use of the land was gathered and was later plotted on aerial photographs. In the urban centres the location, function, and inter-relationship of industrial, commercial, and residential developments were mapped and subsequently were described and interpreted to provide a better understanding of the areas and of the best methods of future development.

A field party in southern Alberta worked in the general area surrounding Calgary and Medicine Hat, in co-operation with the Provincial Department of Municipal Affairs. The survey is expected to continue for 3 or 4 years and is mainly a study of the geographical aspects of hydrology, soils, and agriculture of the region, with special attention to the influence of dry farming and irrigation on population and settlement. This project was undertaken in accordance with an arrangement made with the UNESCO Arid Zone Committee.

At Wager Bay, across the sound from Southhampton Island, the general survey of the physical geography of the west coast of Hudson Bay, begun in 1948, was continued. The survey comprised: delimiting the major land forms; studies of the extent of post-glacial emergence of land, and of the history of glaciation in the area; and studies of the relation of plant cover and the distribution of wild life to the physical environment. Similar work was carried on at Resolute Bay and Alert, in the northern Arctic. In these surveys, photo-interpretation keys that will serve for interpretation of aerial photographs of larger areas than those studied were prepared from the ground data. Copies of these keys will be supplied to the Department of National Defence.

Two geographical observers made reports on land forms and ice conditions noted during a trip to the eastern Arctic with the Joint Canadian-United States Weather Station Sea Supply Mission.

Systematic surveys were made of urban geography in Edmonton, Winnipeg, Toronto, Hamilton, London, Windsor (Ontario), and Sydney. These studies dealt with such matters as the delimiting of commercial, industrial, and residential areas, the location of public facilities and transportation systems, and the distribution of population at various times of day and night. Pertinent information on the surveys was supplied to the Civil Defence Division of the Department of National Health and Welfare.

NEW ATLAS OF CANADA

This is the most important project now in hand in the Branch. The purpose is to provide a comprehensive view of the geography of each aspect of the physical environment and of the geography of economic development and settlement. The work is being done on an interdepartmental basis, each department contributing its share of the basic data, which are then prepared for representation in the atlas. By the end of the fiscal year the compilation of data was completed on historical maps, history of Canadian exploration and of Canadian political evolution, on the development of the chief metropolitan areas, on mineral occurrences, mining areas, and mineral production, forestry and forest products, on distribution of the principal animals and birds, on national and provincial parks, on Indian tribes and Eskimo groups, and on climate, weather, and transportation. Work is in progress on the compilation of data on water resources, the composition and distribution of population, and on agriculture, fisheries, trade and commerce, and finance.

It is expected that all material from the various Federal Government departments will have reached the Branch by 1955, and that the atlas will be published in 1956 or 1957. It is to be printed in loose-leaf form to facilitate periodic revision of individual sheets.

OTHER OFFICE PROJECTS

The systematic study and recording of ice conditions on the Atlantic coast and in Arctic regions was continued. The purpose of this project is to maintain a reference file of all ice information useful to navigation in the waters of these areas. However, there has been a growing demand for the mapping, and especially the interpretation, of this mass of data, and preparation of a map-report is in progress on the ice distribution in the Gulf of St. Lawrence during break-up and freeze-up. This is the first of a series of such map-reports based on the reference file. The over-all project will be expanded later to include a study of ice conditions in Canada's inland waterways.

Plotting was continued on a sheet by sheet basis of all published information on terrain conditions in the northern parts of British Columbia and Alberta and in the Northwest Territories. This project is to provide data on land forms, drainage, soil, and vegetation for the use of the Department of National Defence.

Special reports prepared by the Branch included: the section (Chapter II) of the Report of the Royal Commission on the South Saskatchewan River dealing with the geographical setting; a bibliography of Churchill, Manitoba, for the Department of National Defence; the text of a pamphlet, Canada and Sea Trade, for the Department of Defence Production.

Studies of foreign areas similar in nature to parts of northwest Canada were made in order to evaluate the relative development of the northern regions of Canada, Alaska, Scandinavia, and Russia.

BOOK AND MAP LIBRARIES

The annual, annotated bibliography of new maps published in Canada was prepared for the International Cartographical Bibliography published in Paris. Bibliographies on Canadian geography were published, including an annotated bibliographical index of articles on Canadian geography published in periodicals.

PUBLICATIONS

Department of Mines and Technical Surveys

English Publications

Report No.

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

French Translations

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

Reprints

"Post-War Expansion in Canada's Mineral Industry" from Canada Year Book 1952-53, by G. H. Murray and M. J. Giroux.

Surveys and Mapping Branch

HYDROGRAPHIC SERVICE

English Publications

Great Lakes Pilot, Vol. II.
Tidal Current Charts—Vancouver Harbour (Tidal Publications No. 22).

1. *Tide Tables for the Atlantic Coast of Canada for the year 1953.*
2. *Tide Tables for Quebec and Father Point for the year 1953.*
3. *Tide Tables for Charlottetown for the year 1953.*
4. *Tide Tables for Halifax and Sydney, N.S., for the year 1953.*
5. *Tide Tables for Bay of Fundy, for the year 1953.*
6. *Tide Tables for St. John's Argentia, Newfoundland, for the year 1953.*
10. *Tide Tables for the Pacific Coast of Canada, for the year 1953.*
11. *Tide Tables for Vancouver and Point Atkinson, B.C., for the year 1953.*
12. *Tide Tables for Prince Rupert, B.C., for the year 1953.*
13. *Tide Tables for Port Alberni and Clayoquot, B.C., for the year 1953.*

GEODETIC SURVEY

English Publications

Report of the International Boundary Commission on the Establishment of the Boundary between Canada and the United States, Tongass Passage to Mount St. Elias.

10. *Instructions for Building Triangulation Towers* (Third Edition, Revised), by C. K. McElroy.
22. *Precise and Secondary Levelling in Saskatchewan,* by David McMillan.
68. *Triangulation in Nova Scotia (1927 Datum),* by W. H. MacTavish.

LEGAL SURVEYS

English Publications

Canada Air Pilot:

Vol. I. Amendment Nos. 117 to 121.
Nos. 1 to 21.
Vol. II. Amendment Nos. 127 to 131.
Nos. 51 to 70.

GEOLOGICAL SURVEY OF CANADA

English Publications

2429 Memoir 203. *Geology of Teslin-Quiet Lake Area, Yukon*, by E. J. Lees.
2501 Memoir 262. *Ashcroft Map-area, British Columbia*, by S. Duffell and K. C. McTaggart.
2502 Memoir 263. *The Stratigraphy and Trilobite Faunas of the Cambrian Sedimentary Rocks of Cape Breton Island, Nova Scotia*, by R. D. Hutchinson.
2503 Memoir 264. *Carboniferous Stratigraphy and Palæontology in the Mount Greenock Area, Alberta*, by R. A. C. Brown.
2505 Memoir 265. *Torbay Map-area, Newfoundland*, by E. R. Rose.
2506 Memoir 266. *Giauque Lake Map-area, Northwest Territories*, by L. P. Tremblay.
2507 Memoir 267. *Geology of Northwest Shakwak Valley, Yukon Territory*, by H. S. Bostock.
2504 Ec. Geol. Ser. No. 16. *Canadian Deposits of Uranium and Thorium*, by A. H. Lang.
Bulletin 21. *Ammonite Faunas of the Upper Cretaceous Rocks of Vancouver Island, British Columbia*, by J. L. Usher.
Bulletin 22. *Deep Wells and Subsurface Stratigraphy of part of the St. Lawrence Lowlands, Quebec*, by Helen R. Belyea.
Bulletin 23. *Petrology of the Richardson Radioactive Deposit, Wilberforce, Ontario*, by R. B. Rowe.
Bulletin 24. *The Coral Microcyclus and some of its Devonian Species*, by C. R. Stauffer.
Publications of the Geological Survey of Canada, compiled by Lorne B. Leafloor.
Water Supply Paper No. 312. *Ground-water Resources of Tignish Map-area, Prince County, Prince Edward Island*, by E. I. K. Pollitt.
Water Supply Paper No. 316. *Ground-water Resources of Edwardsburgh Township, Grenville County, Ontario*, by E. B. Owen.
Water Supply Paper No. 320. *Ground-water Resources of Whitchurch Township, York County, Ontario*, by H. N. Hainstock, E. B. Owen, and J. F. Caley.
Paper 51-26. *Reliance, District of Mackenzie, Northwest Territories*, by G. M. Wright. (Map and descriptive notes.)
Paper 51-27. *Renfrew Map-area, Renfrew and Lanark Counties, Ontario*, by H. A. Quinn.
Paper 52-1. *Nevins Lake Map-area, Saskatchewan*, by D. A. W. Blake.
Paper 52-2. *Lambton County, Ontario*, by J. F. Caley and B. V. Sanford. (Two maps.)
Paper 52-4. *Kent County, Ontario*, by J. F. Caley and B. V. Sanford. (Two maps.)
Paper 52-5. *McLean Bay Map-area, District of Mackenzie, Northwest Territories*, by F. Q. Barnes.
Paper 52-6. *Kinojevis, Témiscamingue County, Quebec*, by A. S. MacLaren.
Paper 52-7. *Copton Creek Map-area, Alberta*, by E. J. W. Irish.
Paper 52-8. *Pegmatitic Mineral Deposits of the Yellowknife-Beaulieu Region, District of Mackenzie, Northwest Territories*, by R. B. Rowe.
Paper 52-9. *Unknown River (Ossokmanuan Lake, East Half), Labrador, Newfoundland*, by K. E. Eade.
Paper 52-11. *Notes on the Subsurface Stratigraphy and Oil and Gas Geology of the Lower Cretaceous Series in Central Alberta*, by P. C. Badgley.
Paper 52-12. *The Princeton Coalfield, British Columbia*, by W. S. Shaw.
Paper 52-13. *Bonnington Map-area, British Columbia*, by R. Mulligan.
Paper 52-14. *Glacial Geology of Peterborough Map-area, Ontario*, by C. P. Gravenor.
Paper 52-15. *St. Mary Lake, British Columbia*, by G. B. Leech. (Map and descriptive notes.)

Paper 52-16. *Willbob Lake, Quebec and Newfoundland,* by M. J. Frarey. (Preliminary map and notes.)

Paper 52-17. *Essex County, Ontario,* by J. F. Caley and B. V. Sanford. (Two maps.)

Paper 52-18. *Wolfville (East Half), Hants and Kings Counties, Nova Scotia,* by D. G. Crosby.

Paper 52-19. *The Tulameen Coalfield, British Columbia,* by W. S. Shaw.

Paper 52-20. *The Quebec-Labrador Iron Belt, Quebec and Newfoundland,* by J. M. Harrison.

Paper 52-21. *Whitesail Lake Map-area, British Columbia,* by S. Duffell.

Paper 52-22. *Geology of the Northern Coast of Labrador, from Grenfell Sound to Port Manvers, Newfoundland,* by A. M. Christie.

Paper 52-23. *Nepisiguit Falls, Gloucester and Northumberland Counties, New Brunswick,* by R. Skinner and J. D. McAlary. (Preliminary map.)

Paper 52-25. *Geological Notes on Localities in James Bay, Hudson Bay, and Foxe Basin Visited During an Exploration Cruise, 1949,* by C. A. Burns.

Paper 52-26. *Grande Cache Map-area, Alberta,* by R. Thorsteinson.

Paper 52-29. *The Mesozoic and Palæozoic Formations of South-central Saskatchewan as encountered in the Norcanals Ogema No. 1 Well,* by R. T. D. Wickenden and L. L. Price.

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

Geophysics Paper 53. *McConnell Island, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 54. *Fort Resolution, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 63. *Deskenatlata Lake North, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 70. *Obalski River, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 74. *Bear Creek, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 75. *Salt Lake, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 76. *Buffalo River, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 77. *Sandy River, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 78. *Hay River, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 79. *Mackenzie Rocks, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 80. *Breynat Point, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 81. *Ile Du Mort, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 82. *Nyarling, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 83. *Sulphur Springs, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 84. *Swampy Lake, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 85. *Lac Gueguen, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 86. *Senneterre, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 87. *Long Island, District of Mackenzie, Northwest Territories.* (Aeromagnetic map.)

Geophysics Paper 88. *Doucet, Abitibi County, Quebec.* (Aeromagnetic map.)

Geophysics Paper 89. *Lac Faillon, Abitibi County, Quebec.* (Aeromagnetic map.)
Geophysics Paper 90. *Rivière Delestre, Abitibi County, Quebec.* (Aeromagnetic map.)
Geophysics Paper 91. *Sabourin, Témiscamingue and Abitibi Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 92. *Villebon, Témiscamingue and Abitibi Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 93. *Despinassy, Abitibi County, Quebec.* (Aeromagnetic map.)
Geophysics Paper 94. *Ducros, Abitibi County, Quebec.* (Aeromagnetic map.)
Geophysics Paper 95. *Kaladar, Hastings, Frontenac, and Lennox and Addington Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 96. *Denbigh, Renfrew, Frontenac, Hastings, and Lennox and Addington Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 97. *Mazinaw Lake, Hastings, Frontenac, and Lennox and Addington Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 98. *Cuvillier, Abitibi County, Quebec.* (Aeromagnetic map.)
Geophysics Paper 99. *Minden, Victoria, Haliburton, and Peterborough Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 100. *Brudenell, Renfrew County, Ontario.* (Aeromagnetic map.)
Geophysics Paper 101. *Fenelon Falls, Victoria and Peterborough Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 102. *Kewagama Lake, Haliburton County, Muskoka and Nipissing Districts, Ontario.* (Aeromagnetic map.)
Geophysics Paper 103. *Burleigh Falls, Peterborough County, Ontario.* (Aeromagnetic map.)
Geophysics Paper 104. *Halls Lake, Haliburton and Muskoka Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 109. *Barrys Bay, Hastings and Renfrew Counties and Nipissing District, Ontario.* (Aeromagnetic map.)
Geophysics Paper 110. *Wilberforce, Haliburton and Hastings Counties, Ontario.* (Aeromagnetic map.)
Geophysics Paper 111. *Whitney, Haliburton and Hastings Counties and Nipissing District, Ontario.* (Aeromagnetic map.)
Geophysics Paper 112. *Huntsville, Parry Sound, Muskoka, and Nipissing Districts, Ontario.* (Aeromagnetic map.)
Geophysics Paper 114. *Rosaire, L'Islet and Montmagny Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 115. *St. Magloire, Montmagny, Bellechasse, and Dorchester Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 116. *St. Pamphile, L'Islet and Montmagny Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 117. *Ste. Justine, Dorchester, Bellechasse, and Montmagny Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 119. *St. Zacharie, Dorchester and Beauce Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 120. *Armstrong, Beauce and Frontenac Counties, Quebec.* (Aeromagnetic map.)
Geophysics Paper 121. *Big Bald Mountain, Northumberland County, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 122. *Serpentine Lake, Northumberland and Victoria Counties, New Brunswick.* (Aeromagnetic map.)
Geophysics Paper 123. *McKendrick Lake, Northumberland County, New Brunswick.* (Aeromagnetic map.)

French Publications Issued

Paper 50-3. *Northwest Dasserat Township, Témiscamingue County, Quebec,* by K. R. Dawson.

Page 97, Multilithed Reports - English,

add the following:

Technical Paper No. 1 - The Determination of Thorium in Ores by the Column Method, by R.J. Guest, Radioactivity Division.

Memorandum Series No. 117 - Preliminary Report on Coated Lightweight Concrete Aggregate from Canadian Clays and Shales, Part I, Alberta, by J.G. Matthews, Industrial Minerals Division.

Memorandum Series No. 118 - Sulphur and Pyrites in Canada, by T.H. Janes, Industrial Minerals Division.

Memorandum Series No. 119 - Methods of Analysis of Iron and Steel Used at the Mines Branch Laboratories, compiled by J.S. McCree, Mineral Dressing and Process Metallurgy Division.

Memorandum Series No. 120 - Preliminary Report on Coated Lightweight Concrete Aggregate from Canadian Clays and Shales, Part II, Manitoba and Saskatchewan, by J.G. Matthews, Industrial Minerals Division.

Memorandum Series No. 121 - Preliminary Report on Coated Lightweight Concrete Aggregate from Canadian Clays and Shales, Part III, Ontario, by J.G. Matthews, Industrial Minerals Division.

Memorandum Series No. 122 - Preliminary Report on Coated Lightweight Concrete Aggregate from Canadian Clays and Shales, Part IV, New Brunswick, Nova Scotia and Prince Edward Island, by J.G. Matthews, Industrial Minerals Division.

Memorandum Series No. 123 - Electronic Concentration of Ores with the Lapointe Picker Belt, by C.M. Lapointe and R.D. Wilmot, Radioactivity Division.

Memorandum Series No. 125 - Tin in Canada: Occurrences and Uses, by W.R. McClelland, Mineral Resources Division.

MINES BRANCH

English Publications

831 *Analyses of Canadian Coals and Peat Fuels,* by J. H. H. Nicolls.
833 *(Water Survey Rept. No. 1) Industrial Water Resources of Canada, Scope, Procedure, and Interpretation of Survey Studies,* by J. F. J. Thomas.
834 *(Water Survey Rept. No. 2) Industrial Water Resources of Canada, Ottawa River Drainage Basin, 1947-48,* by J. F. J. Thomas.
List No. 4-1: Coal Mines in Canada 1952.

French Translations

* The Canadian Mineral Industry, 1951.

Multilithed Reports—English

Technical Paper No. 2, *Constitution of Bone China, Part I, High Temperature Phase Equilibrium Studies in the System Tricalcium Phosphate-Alumina-Silica,* by P. D. S. St. Pierre, Mineral Dressing and Process Metallurgy Division.
Memorandum Series No. 124, *Gasoline Survey for Summer 1952,* by H. McD. Chantler, P. B. Seely, and R. G. Draper, Fuels Division.
List No. I-I, *Metallurgical Works in Canada, Part I, Primary Iron and Steel,* by K. Buck, Mineral Resources Division.
List No. 5-2, *Petroleum Refineries in Canada,* Mineral Resources Division.

* Mimeographed.

DOMINION OBSERVATORIES

DOMINION OBSERVATORY

English Publications

Vol. XIV, No. 10: *Bibliography of Seismology, July-December, 1951.*
Vol. XV, No. 2: *Catalogue of 1589 Stars,* by W. S. McClenahan.
Vol. XVI, No. 2: *Dominion Observatory Seismic Station at Resolute Bay, Northwest Territories,* by Peter C. Bremner.
Vol. XVI, No. 3: *Canadian West Coast Earthquakes, 1951,* by W. G. Milne and F. Lombardo.
Vol. XVI, No. 4: *Application of Gravimeter Observations to the Determination of the Mean Density of the Earth and of Rock Densities in Mines,* by A. H. Miller and M. J. S. Innes.

Reprints

Vol. I, No. 9: *Marine Clays of Eastern Canada, and their Relation to Earthquake Hazards,* by Ernest A. Hodgson.
Vol. I, No. 13: *Gravity Measurements on the Barnes Ice Cap, Baffin Island,* by Charles A. Littlewood.

ASTROPHYSICAL OBSERVATORY

English Publications

Vol. IX, No. 2: *Spectrophotometric Study of the Shell Star Tauri,* by Anne B. Underhill.
Vol. IX, No. 3: *Wave Lengths for Radial-Velocity Determinations based on Measures of One Hundred F. to M. Type Stars,* by K. O. Wright.
Vol. IX, No. 4: *The Spectroscopic Orbits of H. D. 100018 (A. D. S. 8189),* by R. M. Petrie and Dorothy M. Laidler.
Vol. IX, No. 5: *A Spectrographic Study of the Eclipsing Binary 32 Cygni,* by K. O. Wright.
Vol. IX, No. 6: *Radial-Velocity Variations of ζ Tauri,* by Anne B. Underhill.
Vol. IX, No. 7: *The Shell Star 14 Comae,* by Anne B. Underhill.

Reprints

Contribution No. 25. *A Spectrographic Study of the Double-Lined Binary System H. D. 27483,* by Ruth J. Northcott and K. O. Wright.

Contribution No. 26: *On the Spectrum of the Green Flash at Sunset,* by T. S. Jacobsen.

Contribution No. 24: *Large Scale Motion of Ionized Calcium in the Atmosphere of a Giant Star,* by A. McKellar, G. J. Odgers, L. H. Aller and D. B. McLaughlin.

GEOGRAPHICAL BRANCH

English Publications

Geographical Bulletin No. 2.
Geographical Bulletin No. 3.