CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT

CALENDAR YEAR 1958

For Geological Survey Use Only

OTTAWA

1958

CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT - CALENDAR YEAR 1958

Note - the enclosed data are those submitted for the 1958 Departmental Annual Report. They have been re-arranged for ready reference, but have not been edited. They are intended only for Geological Survey office use and record.

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GEOLOGICAL SURVEY OF CANADA

INTRODUCTION

by

J. M. Harrison, Director

Most of the Geological Survey staff and funds were used for field work required to map and otherwise study the geology of Canada; and for office and laboratory research required to supplement and assemble the field data, to ensure that the results were of modern scientific standard, and to make them available to the public, as appropriate maps and reports, at the earliest practicable date.

By the end of the year geological maps, mainly on reconnaissance scales, had been published for 36 per cent of Canada; and field work, for which maps had not been released, had been completed for another 5 per cent or more. With so much of Canada still unmapped, all practicable effort continued to be directed towards an early completion of a reconnaissance geological map of Canada.

A third of the field parties, slightly more than a third of the available field staff, and half the field appropriation was devoted to reconnaissance mapping of bedrock in virgin territory. The remaining field projects were mainly detailed or special investigations aimed at solving critical geological problems or affording more direct assistance to mineral exploration.

Field work was completed, or nearly completed, on forty of the seventy-six projects undertaken. The combined area of all projects completed was about 77,000 square miles, excluding airborne geophysical surveys, geochemical surveys, and miscellaneous exploratory and special projects not confined to regular map-areas. One project, not yet completed, resulted in a geological survey of an additional 35,000 square miles.

Twenty-five of the seventy-six field parties were engaged in 4-mile or less detailed mapping of bedrock and surficial deposits; 22 in 1-mile mapping; and 29 were occupied by other projects, including airborne geophysical surveys, geochemical surveys, mineral deposit and mineralogical studies, stratigraphic palaeontology, water supply surveys, palaeomagnetic studies, and detailed mapping.

The functional distribution of effort, by parties, was as follows: bedrock mapping, 43; surficial mapping, 8; ground-water surveys, 2; geophysics, 2; geochemistry, 3; bedrock stratigraphy and palaeontology, 6; mineral deposits and mineralogy, 6; and other, 6.

The geographical distribution of the parties was as follows:

Province	1958
Franklin	3
Mackenzie and Keewatin	5
Mackenzie and Yukon	1
Yukon	2
British Columbia	9
British Columbia and Alberta	4
Alberta	2
Alberta and Saskatchewan	2
Saskatchewan	3
Manitoba	3
Ontario	9
Ontario and Quebec	1
Quebec	2
New Quebec and Labrador	4
New Brunswick	6
Nova Scotia	5
Prince Edward Island	1
Atlantic Provinces and Quebec	1
Newfoundland	4
Miscellaneous	9
Total parties	76

Information Circular No. 2, issued by the Geological Survey in January 1959, presented an account of the progress made on each of these projects, summarized some of the results, and contained information concerning geological features or mineral occurrences that may be of immediate or direct economic interest.

Geological reconnaissance between Hudson Bay and James Bay, and the Labrador Trough, was continued by Helicopter-supported Operation Fort George; and, as a result, a map of about 35,000 square miles was published early(?) in 1959. As another step in the Survey's policy of developing efficient and rapid reconnaissance techniques best adapted to each of the large unmapped areas of Canada, trial use was made of a Piper Super Cub in northwest Queen Elizabeth Islands. A party of only two geologists and a pilot, using this aircraft to land at numerous unprepared localities, mapped about 20,000 square miles in sufficient detail for publication at a scale of 1 inch to 8 miles, and did so at a remarkably low cost. The experiment was thus eminently successful and the technique, with some modifications, promises to be very useful in other parts of the Arctic Islands and possibly in parts of the northern mainland. Nevertheless, the total effort on large individual reconnaissance projects in 1958 was somewhat less than in previous years, due in part to the need of preparing for publication the vast amount of data accumulated for previous helicopter-supported projects, and to the advisability of conducting preliminary ground reconnaissance in Cordilleran areas to ensure that anticipated major projects there be carried through at maximum efficiency.

Thus, during the past field season, preliminary ground reconnaissance was undertaken in northern British Columbia and west-central Yukon in preparation for future helicopter-supported projects; preliminary reconnaissance was completed for Operation Pelly planned for 1959 in southeastern Yukon; and caches of fuel and other items were established for helicopter-supported Operation Coppermine in northern District of Mackenzie, and an aircraft-supported reconnaissance of Banks and Victoria Islands in District of Franklin, both proposed for 1959.

The aeromagnetic surveying of New Brunswick, Nova Scotia, and Prince Edward Island was completed. In addition, an aeromagnetic survey was made of the Gulf of St. Lawrence south of Anticosti Island, and of Bay of Fundy, projects expected to provide significant information concerning submarine geology.

The geochemical reconnaissance of mainland Nova Scotia, commenced in 1956, was completed.

Seven graduate students were engaged as seasonal party chiefs on field projects expected to provide doctorate theses; and the continuing staff was supplemented by nine other seasonal party chiefs in order, mainly, to provide employment for promising geology students not otherwise occupied during the 1958 field season.

In addition to research conducted in its own laboratories and offices, which is mainly an extension of field investigations or in direct support of these, the Survey helped to support basic research at Canadian universities through grants-in-aid from funds provided by Parliament and awarded on the advice of the National Advisory Committee on Research in the Geological Sciences. These grants-in-aid totalled $50,000 in 1958, an increase of $10,000 over 1955, and were made to ten universities in support of twenty-five research projects.

Three geologists, recipients of National Research Council post-doctorate fellowships, elected to pursue fundamental research in Survey laboratories, and were provided with appropriate facilities, assistants, and encouragement.

Eloquent testimony of the high regard in which the Survey's work is held by the nation's foremost academic and commercial geologists, and of the pressing need for the early expansion of these efforts, was expressed by a joint committee of the Royal Society of Canada and the Geological Association of Canada in a Brief presented to the Prime Minister on 21 October 1958.

PRECAMBRIAN DIVISION

Y.O. Fortier, Chief

GENERAL

Field activities of the past were or may have been substantial factors in 1958 mineral exploration.

The Brock River Sheet (Map 1060A), issued in 1958 was in the limelight of the Press in December. The area, to the southwest of Mistassini Lake, was then the object of a staking rush following the discovery of mineralized float. The press attached much significance as a prospecting guide to the greenstone and ultrabasic rocks reported on the map. E.D. Kindle had mapped the southern part of the area in 1941 and G.C. Riley, who wrote the descriptive notes, the northern part in 1952.

Iron deposits, located some 40 miles inland from Great Whale River, Quebec, and lying in quartz-magnetite iron formations, were a focal point of mineral exploration in 1958. K.E. Eade had found these in 1956 while in the field preparatory stage of Operation Fort George. The operation mapped the formations in the 1957 field season. Eade does not know whether the present activities which commenced with staking early in 1957, resulted from his findings or not.

The year 1958 was the second year of exploration of iron deposits on the south coast of Baffin Island, west of Amadjuak the former H.B. Co. trading post. Present staking started early in 1957. In 1951 and 1953 W.L. Davison had mapped quartz-magnetite iron formations and paragneisses with iron concentrations in the area. R.G. Blackadar had reported these in Toronto at the 1955 Annual Convention of the Prospectors and Developers Association. Previous to 1957 and thence on, many representatives of exploration companies, including those currently engaged in drilling, visited Geological Survey of Canada offices for information on the iron occurrences.

Staking resulted immediately after the publication early in 1958 in the G.S.C. Information Circular No. 1 of the 1957 mapping by R.G. Blackadar of massive magnetite and banded iron formation on the coast of Baffin Island adjacent to northeastern Foxe Basin.

Deposits of sulphides mapped by R.G. Blackadar in 1954 at Admiralty Inlet were geophysically surveyed in 1958 by a company that staked the deposits in 1957 following publication of Blackadar's results.

FIELD ACTIVITIES

The constant G.S.C. research to improve its reconnaissance mapping technique was carried on during the year and concrete results were achieved.

R. Thorsteinsson and E. T. Tozer carried out successfully geological reconnaissance mapping on Melville, Prince Patrick Islands and the Borden group of islands, using a light, fixed-wing aircraft for traversing and other transportation requirements. A Piper-Cub with standard wheel landing gear except for low pressure tires enabled them to make over 400 landings on unprepared sites. This mode of operation in barren land without or with very rare lakes presents very substantial economies over other airborne operations in the region in which it was tried.

F.C. Taylor mapped three 4-mile areas in the forested south-eastern part of the Mackenzie District, combining observations made by standard canoe parties with those made on traverse with a fixed-wing aircraft equipped with floats. This was an experiment in reconnaissance mapping in forested region. Some studies have been undertaken as to the possibility of speeding up reconnaissance mapping in forested regions by tackling areas in blocks in northwestern Ontario and in the eastern part of the Grenville province. Short field studies were thus made by Y.O. Fortier and G.M. Wright, and the latter has had a flight over the Grenville block in order to assess the country from an operational point of view. For both above blocks K.E. Eade compiled all types of information available, made preliminary air photo studies, and made some recommendations as to modes of mapping.

Operation Fort George went on its second helicopter-borne season successfully. At the start of field operations, W.W. Heywood took command from K.E. Eade who could not be in the field for part of the summer.

For complete list of field projects, see G.S.C. Information Circular No. 2.

OFFICE ACTIVITIES

YELLOWKNIFE OFFICE

J.C. McGlynn - Resident Geologist

The amount of mining activity in the Territories during the summer of 1958 was considerably less than in previous years. There has been, therefore, a parallel decrease in activity in the Yellowknife office of the Resident Geologist. The following figures and comments outline the work of the Resident Geologist for the past year.

In 1958, $125.00 worth of maps and reports were sold from the Yellowknife office. A break down of this figure, show that 145 coloured maps, 115 preliminary papers, 31 memoirs, and 7 geophysical papers were sold.

During this calendar year there were approximately four hundred visitors to the Yellowknife office. A visitors' book is not kept because some people seem very reluctant to sign it and so this figure is an estimate.

A considerable amount of time is spend accumulating data of mineral exploration and development in the Territories for the monthly reports to Ottawa, and to be used in the revision of the memoir of the Mineral Industry of the District of MacKenzie (memoir 261). This information is gathered from conversations with exploration geologists, prospectors, and by making property examinations.

During the past summer fourteen property examinations were made. Many of these trips were completed in one day, but several took up to four days. The local mines at Yellowknife are visited regularly.

A number of services or forms of assistance are offered to prospectors in the area, such as advice as to areas that should be prospected, the value of individual mineral showings in the general region and examination of showings held by individual prospectors with advice as to what work to do, or not to do, to develop these showings. Many mineral identifications are made in the year for prospectors and a limited number of samples are sent to Ottawa for spectrographic analysis. During the past year four samples were forwarded to Ottawa for spectrographic analysis and four mineral specimens were sent for mineral identification. An unknown number of mineral identifications were made in the Yellowknife office. Related to the efforts to assist prospectors is work done by the Resident Geologist at the annual prospectors course, which is sponsored by the local branch of the C.I.M. in Yellowknife. The Resident Geologist usually does much of the organising of this course and also gives several of the lectures. Organizational work includes arranging subject matter of the course, giving lectures, arranging for appropriate films to be brought in at the proper time, etc. Mineral collections used in the course are also examined each year by the Resident Geologist, and losses from previous courses are replaced from Survey collections.

A number of services are offered to the mining exploration industry by the Survey's Yellowknife office. The most important function of the Resident Geologist in this respect is as a source of useful and hard to get general information. Long conversations with exploration geologists are numerous in the summer months and concern the geology of the region and of individual areas within the region, the distribution of various types of mineral showings and their economic potential, brief descriptions of individual showings that the geologist is interested in or has heard about, and discussions of certain geological problems that interest the geologist or his company. Such conversations are also concerned with more general information such as mining costs in various areas, transportation, facilities and costs, brief reviews of mining activity in the area etc. Practical assistance and advice concerning hiring of men locally, personal introductions to various prospectors etc. is also available. These interviews often take the equivalent of a day. Such conversations were held by twenty-two people representing fifteen or sixteen mining areas during the past summer.

Periodically company geologists desire petrographic information which require studies of thin sections of samples submitted by them. During the past summer twenty-one thin sections were examined for three companies.

These thin sections are usually of interesting rock types and since they remain the property of the Geological Survey form a useful indexed collection for the Yellowknife office.

Periodically minor assistance is given to individuals doing geological research in the Territories. Office assistance usually consists of descriptions or opinions concerning the regional geology, and practical advice concerning hiring of the personnel, and borrowing of equipment.

Some assistance is given to field personnel of the Geological Survey during the summer months. Office space and storage space is found here for their use and a sort of expediting service is available during the summer when they are in the bush. Cooperation between this office and other government departments in the area is complete and consists usually of advice or information concerning mining activity in the area. All geological reports which are turned into Northern Affairs for assessment work are examined by the Resident Geologist, and recommendations made about the acceptability of the work. During the past year thirteen such reports were examined.

During the past two years some time was spent by the Resident Geologist in a study of the Regional Geology of the area in 1957. This study was initiated by Giant Yellowknife Gold Mine and the author worked with their geologists on the project. This study was discontinued by Giant in 1957 but work such as correspondence, checking of the literature, and the writing of a paper continued in 1958. Several revisions of the regional geology have been proposed as a result of this work.

PUBLICATIONS IN SCIENTIFIC AND TECHNICAL JOURNALS

Blackadar, R.G.: Patterns Resulting from Glacier Movements North of Foxe Basin, N.W.T.; Arctic, 11-3 (in press).

Christie, R.L.: A Graduate in Northern Canada-International Geophysical Year; U.B.C. Alumni Chronicle, pp. 22-23, summer 1958.

Eade, K.E.: Geological Reconnaissance by Helicopter in New Quebec; Can. Min. Jour., April, 1958, pp. 118-121.

Fortier, Y.O.: Old and New Ways in Arctic Geology, Can; Geog. Jour., 57-3, pp. 86-91.

Tremblay, L.P.: Geology and Uranium Deposits of Beaverlodge Region, Sask.; Proceedings of the 2nd Int. Conf. on the Peaceful Use of Atomic Energy, Geneva, Sept. 1958.

Seventh Annual Report of the National Advisory Committee on Research in the Geological Sciences 1957-1958 including survey of current research in the geological sciences in Canada.

UNPUBLISHED LECTURES

K.E. Eade in March, 1958, at the Toronto Convention of the Prospectors and Developers Association gave a talk on "Geological Reconnaissance by Helicopter in New Quebec", which was subsequently published in the Can. Min. Jour. R.G. Blackadar addressed the Toronto Field Naturalist Club in April on "Natural History of the North".

R. Thorsteinsson read before the American Society of Photogrammetry at its annual meeting held in March in Washington a paper entitled "Photogeology in the Canadian Arctic Islands".

R. Thorsteinsson spent one week (officeal leave but no expenses paid) at Dartmouth College where he gave the following five lectures:

1. Stratigraphy and structure of the Palaeozoic in the Queen Elizabeth Islands.
2. Stratigraphy and Structure of the Mesozoic in the Queen Elizabeth Islands.
3. Uncompressed graptolites on Cornwallis Island.
4. Surficial features related to permafrost on Cornwallis Island.
5. Travels of the G.S.C. in the Queen Elizabeth Islands.

G.M. Wright lectured on Northern Operations of the G.S.C. at Defence Research Board in March.

Y.O. Fortier lectured in January at McGill Montreal, Laval Universities and at Ecole Polytechnique on the G.S.C. and the Arctic.

P. Harker (and R. Thorsteinsson) presented at the G.S.A. 1958 annual meeting in St. Louis a paper on "Arctic Permian Faunas".

J.V. Ross and J.C. McGlynn presented at the C.I.M.M. Annual Meeting in Vancouver a paper on problems of correlation in the Precambrian of the Mackenzie District.

R. Kretz presented at the G.S.A. 1958 annual meeting in St. Louis a paper on Distribution of elements among coexisting garnet, biotite, and hornblende in Grenville gneisses from Quebec.

COMMITTEES AND SOCIETIES

Of special interest to the Precambrian Division was the formation of a sub-committee on Absolute Age Determination within the new Committee on Isotopic Geology.

Besides the listed field projects, there is a wide range of activities in which staff members are engaged. Such activities are necessary for the operation of the Geological Survey, its relations with the public and the scientific world, or derive from the special qualifications some officers have obtained as staff members or from desire for professional fulfilment by individual scientist or group of scientists.

Contact with the public consists, besides the official G.S.C. publications, listed elsewhere, of papers published in periodicals and talks given at scientific meetings and at universities, also listed elsewhere, unrecorded and numerous interviews, answers to letters of enquiries, preparation of exhibits (Bruxelles, Prospectors and Developers, Museum Hall, Logan Hall), group collaboration (Glacial Map of Canada, Atlas of Canada, G.S.A. Map of North America).

Field preparations always entail accrued responsibilities from some staff members for projects to be carried by seasonal employees. Such projects amounted to 7 this year and necessitated the help of K.E. Eade, S. Duffell, W.W. Heywood, L.P. Tremblay, and J.A. Fraser. Besides these and other chores, Eade served a second year on the Equipment Committee.

J.F. Henderson was Chairman on the Committee on Geological Research of the C.I.M.M. and of the Committee of Barlow Memorial Medal of the C.I.M.M., and was on the Membership Committee of the G.S.A. However, no other member of the division served the profession in learned societies and few availed themselves of the chance or did have the opportunity of attending technical conventions and meetings. However the division staff evidenced its professional interests in many other ways:

a. Half the staff belong to evening geological discussion groups.
b. one officer, in 1957-58, and two in 1958-59, took courses in scientific Russian reading as sponsored by the department.
c. all officers attended two divisional seminars, which, serve as a clearing house for ideas on geological, operational, staff matters.
d. most officers listen to, and some give, technical papers given every second week at the Logan Club, and most belong to the Professional Institute geologists group, which is informally regarded by the Geological Survey administration as the mouthpiece of the staff.

DIVISIONAL MEMBERSHIP IN SOCIETIES AND ATTENDANCE AT MEETINGS

	CIMM	GAC	GSA	RCGS	AINA	RSC	MAC	OTHERS
Baragar, W.R.A.		+	+					
Bell, C.K.	Ottawa Br.		+				+	Geoch. S.
Blackadar, R.G.					+			
Christie, R.L.							+	
Davison, W.L.	Nil							
Duffell, S.	+	+	+	+				
Eade, K.E.	+ Jr.	+			+			PDA
Fahrig, W.F.	Nil							
Fortier, Y.O.	+	+		+	+	+		
Frarey, M.J.	Ottawa Br.							
Fraser, J.A.	"							
Henderson, J.F.	+	+	+	+		+		PDA
Heywood, W.W.	+ Jr.				+			
Jackson, G.D.	+ Jr.							
Kretz, R.	+							
McGlynn, J.C.	±		=					Alta & NW Chamber
Quinn, H.A.	+	+	+	+				S.E.G. of Commerce
Roach, R.A.								
Taylor, F.C.			+					
Thorsteinsson, R.			+		+			P.S.A., A.S.P.
Tremblay, L.P.	Ottawa Br.	+						
Wright, G.M.	"				+			

Note - underline indicates attendance at meeting and double underline attendance but not member.

PERSONNEL

C.H. Stockwell was transferred on April 1, from Chief of the Precambrian Division to Chief of Special Projects, a new G.S.C. post.

Y.O. Fortier was promoted by competition on April 1, to Chief of the Precambrian Division from Head of Arctic Islands Section, a function that will not be discharged by a new head for the time being.

S. Duffell was reclassified on April 1, to Head of the Eastern Shield Section, a position in which he previously acted as G4.

G.M. Wright was declared in December the successful candidate in the competition for Head of the Western Shield Section.

R. Kretz joined the staff in June as G2.

G.D. Jackson joined the staff in June as T.O. 3, filling a G2 position, pending his obtainment of the Ph.D. degree.

J.C. McGlynn is spending a fifth year as Yellowknife Resident Geologist. Canvassing of the staff to obtain replacement failed to attract the proper number of candidates.

R.L. Christie, T.O. 3, had his Ph.D. thesis accepted at the University of Toronto and defended it successfully in December. He is tackling the last Hurdle, the Senate Oral, on January 5th, 1959.

W.R.A. Baragar, T.O. 3, has polished a draft of his Ph.D. thesis and forwarded it in December to Columbia University.

W.W. Heywood, T.O. 3, a veteran of G.S.C. helicopter operations and extended Arctic projects, was granted in the fall educational leave with half pay in order that he complete his Ph.D. qualifications at the University of Washington.

D.J. Jackson, T.O. 3, was granted in the fall educational leave so that all Ph.D. requirements were met at McGill University. Thus the above four T.O. 3 staff members may be reclassified to G2 early in 1959.

H.R. Wynne-Edwards, seasonal T.O. 3, completed his Ph.D. thesis area in a second field season. He is spending the winter at the G.S.C. and hopes to present his thesis at Queen's University at an early date.

J.A. Donaldson, seasonal T.O. 3, and post graduate at John Hopkins University, also completed his Ph.D. thesis area in a second field season. He hopes to present his thesis in the Spring of '59.

H. Williams, seasonal T.O. 3, and post graduate at University of Toronto, commenced the mapping of a thesis area.

K.L. Currie, seasonal T.C. 3, who probably will obtain his Ph.D. in 1959 from the University of Chicago, was a member of Operation Fort George.

S.H. Kranck, seasonal T.O. 3, who probably will obtain his Ph.D. in 1959 from M.I.T., was with R.G. Blackadar on southern Baffin Island.

J.V. Ross, E.H. Chown, L. Kirwan, and R. Lawrence, seasonal T.O.'s were put in charge of field projects, in a supplementary field programme that was authorized to provide summer employment for further students.

POST PRECAMBRIAN DIVISION

L.J. Weeks, Chief

GENERAL

The Post Precambrian Division is responsible for the mapping and study of the bedrock in the Appalachian and Cordilleran districts of Canada; and for the mapping and study of the Surficial deposits in all of Canada. In 1958 the work of the Division was carried out by thirty field parties; in two outside offices; and in two laboratories. Nine officers were assigned to office or supervisory duties.

FIELD ACTIVITIES

The following are the field projects carried on by this Division in 1958, classified by provinces.

YUKON

L.H. Green commenced the reconnaissance of a block of 4-mile areas in the Yukon, comprising Larsen Creek, Dawson, Ogilvie River, and Hart River areas in preparation for an anticipated helicopter assisted Operation Ogilvie about 1960. Some reconnaissance was done in all of the above mentioned map-areas except Larsen Creek. As a result of this work the area for Operation Ogilvie has been re-defined to include only Larsen Creek and Dawson of the above mentioned areas, together with Nash area to the immediate east.

J.A. Roddick and J.O. Wheeler commenced reconnaissance preliminary to a proposed helicopter supported Operation Pelly, to be carried out in 1959. The area under investigation comprises Quiet Lake, Finlayson River, Sheldon Lake, Tay River, and the north half of Wolf Lake map-areas. The field organization was composed of an eleven man party, comprising four traversing units, which worked with a Piper Super Cub on floats. Reconnaissance was not completed, and the Operation will either be enlarged in 1959 or postponed until 1960. In addition to the above mentioned reconnaissance work, fuel caches were laid down for Operation Pelly.

BRITISH COLUMBIA

H. Gabrielse continued the reconnaissance of the Kechika and Rabbit River map-areas, which was nominally commenced in 1957. The area is underlain by tightly folded sedimentary strata and includes both sides of the Rocky Mountain Trench. It is anticipated that the reconnaissance of these two areas will lead to a helicopter assisted Operation in two or three years time. Unforeseen circumstances prevented the completion of the Cry Lake area, to the immediate west of the Kechika area, and part of Operation Stikine (1956). About three weeks work remain in the Cry Lake area.

E.F. Roots completed the clean-up of unmapped gaps in Bowser Lake, Spatsizi, and Dease Lake areas, part of Operation Stikine (1956). Other parts of Operation Stikine are being cleaned up by J.G. Souther and H. Gabrielse.

J.G. Souther cleaned up unmapped gaps in the Iskut River map-area, part of Operation Stikine (1956). Telegraph Creek area, another part of Operation Stikine, was cleaned up in 1957. During 1958 reconnaissance was completed throughout Sumdum, and about half of Tulsequah map-areas. The western part of these map-areas is underlain by Coast Range granitic intrusions, and the eastern part underlain by Permian Triassic and Jurassic sedimentary and volcanic rocks. Molybdenite is a possible economic mineral of the area.

H.W. Tipper continued the 4-mile mapping of the Quesnel area, commenced in 1957. The area is now ninety per cent completed.

H.W. Little commenced the revision of the geology of the west half of the Kettle River 4-mile map-area. The geology of this area was originally, but incompletely done in the 20's and 30's. The stratigraphy of Tertiary volcanic and sedimentary rocks was found to require substantial revision. Considerable revision was also made in the use of the terms Shuswap complex and Shuswap group.

H.H. Bostock commenced the 4-mile mapping of the Squamish area. Field work was seriously hampered by restrictions arising from forest fire hazard and restrictions concerning entry into the area of metropolitan Vancouver water supply. In spite of this however much of the shoreline and some interior work was completed.

J.G. Fyles completed the study of the surficial geology of a coastal strip on Vancouver Island on the scale of one mile to the inch between latitude 49° and 50°. He also commenced and completed the study of the surficial geology of a number of islands in the Strait of Georgia between Sooke on Vancouver Island and Howe Sound on the mainland.

ALBERTA

At the request of the National Parks Branch, E.F. Roots examined the Athabasca Glacier between Banff and Jasper with the object of determining whether it was still safe to permit snowmobiles to carry tourists across the Glacier.

SASKATCHEWAN

E. Hall commenced a reconnaissance survey of the ground-water resources of the Souris River Basin, an area of about 12,000 square miles comprising much of Saskatchewan lying south and east of Regina. Preliminary work indicates that the height of the water table, as measured in bedrock wells, is now about the same as it was in 1935 when a well inventory was last carried out in this area.

J.S. Scott commenced the study of the surficial geology of the Elbow, Hawarden, and Outlook 1-mile map-areas. The site of the proposed Elbow Dam on the south Saskatchewan River, is within the map-area. It is anticipated that the results of this study will be of value from an engineering standpoint. During the field season much test drilling was being done, and this was of great value in the study of the surficial geology.

ONTARIO

N.R. Gadd continued his investigation of geological matters pertaining to the safe, economical, and otherwise satisfactory disposal of radioactive waste materials from the Chalk River plant of Atomic Energy of Canada Limited. A map and report is being prepared for submission to this Crown company. This Fall some time was, however, allotted to continuing the study of the surficial geology of the Ottawa area, commenced in 1956, but side-tracked mainly through the higher priority of the Chalk River project. Two assistants were able to work on the Ottawa district, one studying the thickness of drift in the Ottawa area, and the other the ground-water resources.

E.B. Owen continued on loan to the St. Lawrence Seaway Authority, and devoted his time to the study of engineering geological problems connected with the Seaway.

E. Mirynech commenced the study of the surficial geology of the Trenton and Presqu'ile 1-mile map-areas, adjacent to Lake Ontario. This project is a Geological Survey contribution to cooperative studies of the Lake Ontario Basin being sponsored by the Great Lakes Geophysical Research Group. The western half of the map-areas was completed in 1958.

ONTARIO AND QUEBEC

J. Terasmae spent most of the 1958 field season investigating the surficial deposits within those parts of the St. Lawrence Power and Seaway Development scheduled for flooding; and other surficial deposits in the vicinity made available recently through related construction.

QUEBEC

E.I.K. Pollitt continued the investigation of the ground-water resources of that part of the Lachine map-area lying south of the St. Lawrence River, and including Ile Perrot. At the close of the season the area was about seventy-five per cent completed.

NEW BRUNSWICK

H.A. Lee continued the study of the surficial geology of the Saint John River Valley. This is a long term project covering almost all of Saint John River within the province of New Brunswick between the Maine Border and Fredericton. The results of this project, in addition to the obvious usefulness for engineering geology and soils purposes, should be of particular scientific interest inasmuch as the Saint John River Valley presents a unique opportunity to study the surficial record in a Valley crossing the Appalachian Mountains and trending parallel to the direction of ice retreat.

F.D. Anderson completed the mapping of the Big Bald Mountain 1-mile quadrangle, commenced in 1956. Work was carried out also on the Nepisiguit Lakes, Riley Brook and Serpentine Lake 1-mile map-areas. Field work within these map-areas was commenced by B.R. Rose in 1935 and continued in 1936-37-38. Dr. Rose subsequently died before submitting a map or report on these areas. Field work in 1958 was an attempt to recover some value from this work done in the 30's. Dr. Rose's notes were first plotted during the past winter, and field work was so arranged to check and complement his work. Two of the three areas were completed and one requires a little more work.

W.H. Poole completed the mapping of the Napadogan 1-mile map-area, commenced in 1957. This is part of the belt in New Brunswick of early Palaeozoic rocks intruded by igneous rocks, and in which ore deposits have recently been found.

J.M. Johnston commenced the geological mapping of the St. Leonard 4-mile map-area. About one half of the area was completed in 1958. Geologically this area is underlain by early Palaeozoic rocks that are not known to be intruded by igneous rocks. For this reason such rocks have not been considered by many to be favourable as a source of base metals. It is thought that further study might possibly produce evidence to the contrary.

E.D. Kindle completed the east half of the Waterford 1-mile map-area commenced in 1957. The Fundy National Park lies mainly within the east half of the Waterford area, and that part of the Park that lies east of the area was also completed. The rocks extend in age from Precambrian to Pennsylvanian. The older, harder rocks are considered to comprise what may possibly be a southern mineral belt in New Brunswick.

NOVA SCOTIA

W.G. Smitheringale completed the geological mapping of the Nictaux and Torbrook half-quadrangles. Mapping was done on the scale of 1

mile to the inch and the objective was the study of relationships between intrusive rocks and a group of rocks carrying Devonian fossils and overlying the Meguma series. He then commenced the study and mapping of the Clementsport half-quadrangle, an area in which similar rocks occur and may give further information on the relationships being sought.

I.M. Stevenson completed the mapping of the Chedabucto Bay 1-mile map-area at the eastern end of the Nova Scotia Mainland. Disseminated tungsten minerals occur in the Meguma quartzites of this area, and manganese garnets are known and may occur in commercial quantities.

G.A. Collins commenced and completed 1-mile mapping of the Arichat half-quadrangle. This area, in which no work had been done since the 1870's, is completely surrounded by modern geological mapping. Coal, gypsum, limestone, manganese, and salt springs are known in the area.

D.G. Kelley commenced the study and 1-mile mapping of the St. Ann's area in Cape Breton Island. Part of the area lies within the Cape Breton Highlands, a plateau surface 1,000 to 1,5000 feet above sea level. Very little is known of the rocks of the Highlands in this area.

PRINCE EDWARD ISLAND

G.H. Crowl continued the mapping of the Mount Stewart 1-mile area and completed about eighty per cent of it. This is part of an overall project commenced 1953 with the ultimate object of mapping the surficial geology and bedrock geology of the entire province. Almost two thirds of the Island has been covered under this project.

NEWFOUNDLAND

E.P. Henderson continued the study and mapping of the surficial geology of the Avalon Peninsula on a scale of four miles to the inch. This work has already been of great value to local authorities in their search for new gravel deposits, and in their efforts to obtain shale-free gravels from known gravel deposits.

G.C. Riley completed the mapping on a scale of four miles to the inch of the Burgeo-Ramae area on the south coast of the Island. Part of the area, in which tungsten deposits are known, was mapped on a scale of one inch to the mile.

E.R.W. Neale completed the one mile to the inch mapping of the Baie Verte and Fleur de Lys map-areas, on the northern side of the Peninsula between White Bay and Notre Dame Bay. An asbestos deposit of considerable potential is being developed near Baie Verte. There are a number of prospects of base metals elsewhere in the area.

D.M. Baird commenced and completed the geological mapping of the Deer Lake four-mile quadrangle. The geology of the area is one of the most diversified to be encountered in Newfoundland, extending from Precambrian rocks similar in many respects to the Grenville, to Pennsylvanian coal-bearing beds. It is expected that many geological relationships will be clarified by this study.

OFFICE AND SUPERVISORY ACTIVITIES

H.S. Bostock carried out a supervisory trip in the Cordilleran region, visiting 8 field parties. During most of this trip he was accompanied by J.M. Harrison, Director of the Geological Survey.

V.K. Prest visited two surficial geology parties, one in Ontario and one in Prince Edward Island. In addition, he did a small amount of independent work on the Prince Edward Island project.

B.G. Craig paid an advisory visit to a surficial geology party and a ground-water party in Saskatchewan.

J.E. Muller was employed throughout most of the calendar year as liaison officer between the Geological Survey and those responsible for construction of the new Geological Survey building.

Five officers not mentioned elsewhere in this report, carried on office duties relating to the production of publications resulting from previously completed field work. They are: C.L. Hughes, S.E. Jenness, G.B. Leech, W.D. McCartney and A.M. Stalker.

The Post Precambrian Division is responsible for two outside offices of the Geological Survey of Canada, both in the Cordilleran district.

BRITISH COLUMBIA OFFICE

The British Columbia office, at Vancouver, is under the charge of J.E. Armstrong. One other geologist, E.C. Halstead, a ground-water specialist, and a clerical staff of two, complete the personnel. A complete stock of Geological Survey publications relating to British Columbia, topographic maps, and British Columbia Department of Mines publications is maintained for the use of the public. A number of small short-term field projects are carried out each year by both geologists, mainly at the request of other Government Departments. Included in these are a number of engineering geology reports on dam and power sites along the Columbia River. In 1958 there were 8,039 visitors registered at the British Columbia office, and 17,705 publications of various kinds were distributed.

WHITEHORSE OFFICE

R. Skinner is the resident geologist at this office, which serves the Yukon Territory and northern British Columbia. Within the Yukon Territory, the resident geologist has the status of Government geologist, inasmuch as the mineral resources are held by the Federal Government. In regard to northern British Columbia, the resident geologist is mainly a source of available information. The resident geologist observes and reports on the doings of various prospecting companies and individuals within the Yukon Territory and acts in an advisory capacity when called upon. A stock of publications relating to Yukon and northern British Columbia is kept available for the public. In addition to the resident geologist there is a clerical staff of one. In 1958 there were 1,227 registered visitors at the Whitehorse office, and 2,913 publications were distributed.

LABORATORY ACTIVITIES

SEDIMENTOLOGY LABORATORY

The Sedimentology Laboratory is set up for the purpose of carrying out any physical tests, and some chemical tests on sedimentary rocks or the materials of which they are composed. Although it is principally used by geologists of the Pleistocene Section, it is also used by geologists in all Divisions of the Geological Survey. The Laboratory is run by a technician, with a temporary assistant. In 1958, 153 mechanical analyses of sediments were made, 60 of which were sieve analyses and 93 were complete sieve and pipette analyses. A considerable increase in output has taken place in the latter half of the year, and this reflects a considerable improvement in procedures and equipment. The accelerated output, however, has in its turn increased the demand for analyses. In addition to the physical analyses performed by the laboratory staff, the facilities of the laboratory had been used used freely by Survey Geologists in preparations of samples for further chemical, palaeontological and palynological treatment.

PALYNOLOGICAL LABORATORY

The Palynological laboratory was established during 1958, and at the end of the year was using the facilities of the Sedimentology Laboratory pending the move to the new building of the Geological Survey. The laboratory was established for the purpose of separating organic material from sediments and preparing it for study. During 1958, 650 specimens were mounted and determinations made of their spore and pollen content.

PUBLICATIONS IN SCIENTIFIC AND TECHNICAL JOURNALS

Craig, B.G. See Terasmae, J.

Gabrielse, H. (1958): Geology of the Cassiar Asbestos Mine with Special Reference to Ore Control (Abstract); Can. Min. Jour., Vol. 79, No. 4, p. 91.

Jenness, S.E. (1958): Geology of the Gander River Ultrabasic Belt, Newfoundland; Geol. Surv. Nfld., Report 11.

Jenness, S.E. (1958): Geology of the Newman Sound map-area, Northeastern Newfoundland; Geol. Surv. Nfld., Report 12.

Kelley, D.G. (1958): Mississippian Stratigraphy and Petroleum Possibilities of Central Cape Breton Island, Nova Scotia; Trans. Can. Inst. Mining Met., Vol. LXI, pp. 175-185.

Leech, G.B. See Wanless, R.K.

Muller, J.E. (1958): Tectonics of the Shakwak Lineament, Southwest Yukon and Eastern Alaska; Geol. Soc. Amer., Bull., Vol. 69, No. 12, Pt. 2, pp. 16-19.

Pollitt, E.I.K. (1958): Status of Ground-water Studies in Canada; Trans. Roy. Soc. Can., Vol. 51, Ser. 3, Sec. 4, June 1957.

Skinner, Ralph. See Smith, C.H.

Smith, C.H. and Skinner, Ralph (1958): Geology of the Bathurst-Newcastle Mineral District, New Brunswick; Trans. Can. Inst. Mining Met., Vol. LXI, pp. 78-83.

Stalker, A.M. (1958): The Kipp Section; Jour. Alta. Soc. Pet. Geol., Vol. VI, No. 9, pp. 229-232.

Terasmae, J., and Craig, B.G. (1958): Discovery of fossil Ceratophyllum demersum L. in Northwest Territories, Canada; Can. Jour. Botany, Vol. 36, pp. 567-569.

Terasmae, J. (1958): Microforaminifera from Pleistocene Deposits, Prince Edward Island, Canada; Micropalaeontology, Vol. IV, No. 4, pp. 429-430.

Wanless, R.K. and Leech, G.B. (1958): Lead Isotope Studies of Sullivan Mine and Other Deposits in East Kootenay District, Southeastern British Columbia; Trans. Am. Geophys. Union, Vol. 39, No. 3, p. 535.

Weeks, L.J. (1958): The Proterozoic of Eastern Canadian Appalachia; Roy. Soc. Can., Special Pub. No. 2, 1957, p. 141-149.

FUELS AND STRATIGRAPHIC GEOLOGY DIVISION

J.F. Caley, Chief

INTRODUCTION

The principal work of the division is to determine the succession, age, lithologic character, structure, and correlation of the sedimentary formations in Canada; to map the surface and subsurface distribution of these

formations in specified areas; and to carry forward studies in the petrography and palynology of coal seams.

All this work has research as its basic purpose and it is this research that produces data and information necessary in the exploration for the fossil fuels (oil, gas and coal) and in the evaluation of the general mineral potentialities of a given region.

To facilitate this work the division is constituted as follows:

(a) Geology of Fuels Section
(b) Stratigraphic Palaeontology Section
(c) Coal Research Section (Sydney, N.S.)
(d) Western Oil and Gas Office (Calgary, Alta.)

As the fossil fuels and other minerals have their origin in, and are intimately associated with the sedimentary rocks, any addition to knowledge of the origin, constitution, age, correlation, environment of deposition, and structure of these strata will help in the search for additional reserves.

GENERAL

A total of 189,909 rock samples from wells drilled for oil and gas were received at Ottawa and prepared for microscopic examination. These represent about 1.8 million feet of drilling and total 800 wells as follows: Alberta 415; Ontario 375; Quebec 5; New Brunswick 2; and Prince Edward Island 3.

Acknowledgment is made to the following persons and organizations through whose cooperation information and samples were received: W.A. Roliff, Imperial Oil Limited for samples and general information on exploratory activities in Eastern Canada; A.R. Crozier, Chairman and W.D. Brittain, Chief Inspector, Ontario Fuel Board for drillers logs and for samples of wells drilled in Ontario; B. Graham Rogers, Chief Officer - Geological, Department of Industry and Natural Resources, Charlottetown, for information recording drilling on P.E.I.; Oil and Gas Conservation Board, Province of Alberta, for periodic drilling reports, interim reports and electric logs, and for samples of wells drilled in Alberta; Petroleum and Natural Gas Branch, Department of Mines, Victoria, B.C. for well samples and for interim reports and maps dealing with exploratory activity; Petroleum and Natural Gas Branch, Department of Mineral Resources, Regina, for reports on drilling and production, for information on field boundaries, and for well samples; Department of Mines and Natural Resources, Winnipeg, Manitoba for drilling reports and well samples; Paul Payette for samples of wells drilled in Quebec; and to officers of numerous oil companies for much useful information on oil and gas activities in many parts of Canada.

The services of the division at Ottawa were extended to visiting geologists and palaeontologists of several operating oil companies who examined well samples and fossils made available to them. Companies represented include

Imperial Oil Limited, The California Standard Company, Shell Cil Company Limited, Dome Exploration (Western) Limited, Canadian Husky Cil Limited, Mobil Cil of Canada Limited, Texaco Exploration Company, The Chio Oil Company, Britalta Petroleums Limited, Felmont Oil Corporation, Triad Oil Company, Limited, Amerada Petroleum Corporation, Placid Oil Company, Blue Water Oil and Gas Limited, British American Cil Company Limited.

Geological advice was given to the Department of Northern Affairs and Natural Resources and a paper on the Geological and Geographical Distribution of Cil and Gas in Canada was prepared and submitted to the Royal (Borden) Commission on Energy at the request of the Commission.

FIELD ACTIVITIES

GENERAL

B.A. Latour continued the work of collecting data necessary for estimating the coal reserves of Canada. Mines and prospects in Western Canada were visited and all pertinent information obtained.

B.V. Sanford continued the work of locating and establishing the elevation of wells drilled for oil and gas in southwestern Ontario to provide data for regional subsurface mapping of the productive and potentially productive formations of this region. In addition, he visited the Geological Survey authorities of the adjoining States in the Great Lakes region to obtain information on deep well drilling as an aid to regional correlation throughout this area.

GEOLOGY OF FUELS SECTION

D.K. Norris commenced and completed mapping of the Carbondale area, Alberta (82G 8W 1/2) on scale of 1 inch to 1 mile. The southern part of the map-area is occupied by the Lewis thrust sheet above which Proterozoic and Lower Palaeozoic rocks are exposed. The northern part is underlain by Mesozoic and late Palaeozoic rocks. The stratigraphy of all these formations has been described and correlations established with adjacent regions. Interpretations of the structure suggest that structures within the Palaeozoic rocks, such as the gas-bearing Savana creek structure to the north and the Waterton - Castle River structure to the east, trend southerly and may extend beneath the Lewis thrust sheet.

R.A. Price commenced work in the Fernie east half area, British Columbia and Alberta (82G E 1/2), mapping on a scale of 1 inch to 4 miles, the parts of the area not previously mapped on one inch to one mile (approximately half). Stratigraphic data on formations ranging in age from the Proterozoic Waterton formation to the Tertiary Kishenehn formation was obtained, of which that on the Devonian and Mississippian formations is of particular value, being the best southwesternmost exposures of rocks of those systems. Small bodies of trachyte and syenite intrude rocks of lower Cretaceous and older. Two phases

of deformation occur, the older involving much thrusting and folding, during which the Lewis thrust sheet was displaced easterly an estimated 25 miles, and a younger phase of normal faulting, during which displacement on the Flathead fault totalling 23,000 feet, was accompanied by the deposition of the Tertiary Kishenehn formation.

E.W. Mountjoy completed mapping of the Miette map-area, Alberta (83F4) on scale of one inch to one mile. The western part of the map-area embraces several ranges of the Rocky mountains in which Palaeozoic rocks are exposed. Much detail on the nature and variations of the rocks comprising the Devonian and Mississippian system and on a pre-Devonian unconformity was obtained. In the eastern, foothills part of the map-area, stratigraphic studies of the lower Cretaceous, non-marine, formations were carried out in collaboration with D.C. McGregor. Structural features peculiar to the Proterozoic strata of this and adjacent areas were obtained and their relationship to structures in the overlying Mesozoic rocks studied which will materially assist in the interpretation of the sub-surface structures of adjoining foothills regions.

E.R. Pelletier, with the collaboration of W.B. Brady, commenced and completed mapping of the Tetsa River map-area, British Columbia, (94K9) on scale of one inch to one mile. This area spans the foothills belt from the plains in the northeast corner to the Rocky Mountains in the southwest. Within it, close folds repeat lower Cretaceous, Triassic, and Mississippian strata, permitting examination of several stratigraphic sections and reveal considerable valuations, particularly in the Triassic rocks. Rocks of these systems on the plains to the east have been found productive of gas and oil. Interpretation of the surface folds may reveal potential oil and gas bearing structures in older formations also known to be productive on the plains.

D.F. Stott commenced stratigraphic studies of the upper Cretaceous Smoky Group in lower Cretaceous Fort St. John Group in the foothills of northwestern Alberta and northeastern British Columbia. Much of this region is unmapped and reconnaissance mapping reveals the general distribution and structure of these groups and adjacent formations. Recognition and correlation of several subdivisions of these groups, studied in previous work on the upper Cretaceous Alberta group, indicated the facies variations taking place and the possibility of solution of the problems of correlation with the succession known in the Peace River region to the north.

STRATIGRAPHIC PALAENTOLOGY SECTION

H. Frebold: Stratigraphic investigation of the Jurassic system of the Nelson - Salmo - Lilloett - Tyaughton Lake - Minto Mines - Ashcroft areas of British Columbia and the Miette - Cadomin areas of Alberta.

T.E. Bolton: Stratigraphical and palaeontological study of the Upper Ordovician and Silurian strata of western half of Anticosti Island. Two complete North-South stratigraphic sections were measured and in addition the Ellis Bay formation (top of the Ordovician) was examined in great detail. Studies of

surficial deposits have indicated a Post-glacial marine overlap to a depth of only 250 feet rather than complete submersion of the island.

J.A. Jeletzky: Northeastern Richardson Mountains, N.W.T. and Yukon. An essentially complete sequence of Lower Cretaceous rocks, some 5,000' thick and fossiliferous throughout was found on the eastern flanks and studied in detail. Some 3,000' of fossiliferous Jurassic and 900' of fossiliferous Permian rocks were located on the Porcupine river between Bell and Driftwood rivers, in area formerly believed underlain by Cretaceous strata. Several thousand feet of Cretaceous and ? older Mesozoic rocks were examined around the junction of the Porcupine and East Porcupine rivers (Eagle Plains). Late Lower Cretaceous ammonites were discovered for the first time in the middle part of this sequence.

D.C. McGregor: Lower Cretaceous Palaeobotanical Studies in the Central Alberta foothills. Plant collections from the Nikanassin and Luscar formations in areas previously not collected. Extension northward of flora assemblage previously reported upon by W.A. Bell.

E.T. Tozer: Stratigraphic reconnaissance western Queen Elizabeth Islands, Arctic.

OFFICE ACTIVITIES

GENERAL

B. MacLean continues to be engaged in assembling information on current developments in oil and gas exploration and production in Western Canada, and in the preparation of regional maps showing the distribution of oil and gas fields, pipe lines and refineries in the four western provinces. In addition, he prepared a report on Oil and Gas Developments in Canada - 1957, that was published in American Institute of Mining, Metallurgical and Petroleum Engineers, Vol. 12, pp. 515-534.

R.D. Howie continued the work of collecting, assembling and studying all available current information on drilling and exploration for oil and gas in the Maritime Provinces of Canada. In addition he carried on microscopic examination of cores and cuttings resulting from drilling in this region and prepared maps and reports embodying the results of this work.

B.V. Sanford and R.G. Quillian prepared a paper describing the stratigraphy and structure of the Acton Gas Field in Ontario for publication in the Fourth Annual Report of the Ontario Fuel Board. This field is of special interest and importance in that it represents a new productive zone in the Ordovician succession in southwestern Ontario and this opens further possibilities of production from these rocks throughout a wide area. These geologists also submitted for publication Paper 58-11 (P.S. Map 30-1958) Sub-surface Stratigraphy of Upper Cambrian Rocks in Southwestern Ontario. It includes contours on the Precambrian surface and isopach and distribution maps of the several lithologic units of the Upper Cambrian. It is the first report of its type on this region and will be an invaluable aid to future exploration for gas and oil in these rocks which lie more than 3,000 feet below the surface.

GEOLOGY OF FUELS SECTION

R.J.W. Douglas completed compilation of report and maps on scale of one inch to eight miles of the southern part of the plains examined during Operation Mackenzie in 1957 (85SW, 95SE, and 95SW E1/2)

E.J.W. Irish compiled preliminary map of Charlie Lake map-area, British Columbia (94A). Compilation was started on a map on scale of one inch to two miles on the northern foothills of Alberta between Athabasca River and British Columbia border, and the accompanying memoir dealing with the stratigraphy, structure, and economic possibilities of the region.

STRATIGRAPHIC PALAEONTOLOGY SECTION

Summary

Officers of this section continued the systematic study of Canadian stratigraphy and palaeontology by means of field and office projects.

Stratigraphic field projects ranged from an examination of the Upper Ordovician-Silurian strata of Anticosti Island, Quebec to the Jurassic system in southern British Columbia, Cretaceous strata of the Northeastern Richardson mountains, N.W.T. and Yukon, and a stratigraphic reconnaissance of the western Queen Elizabeth Islands, Arctic Canada. A palaeobotanical study of the Lower Cretaceous of the Central Alberta foothills also was commenced.

Projects undertaken by officers of the Stratigraphic Palaeontology section included regional studies of the Ordovician faunas and floras of Canada; Silurian faunas of Anticosti Island and Ontario; Silurian-Devonian faunas from central New Brunswick and Gaspe; Silurian-Devonian-Mississippian Arthropods from central, western, and Arctic Canada; Devonian Rhynconellid brachiopods of the Waterways and Flume formations of Alberta, and the Middle Devonian faunas from northeastern Alberta and upper Mackenzie basin; Permian faunas of Grinnell peninsula, Arctic Canada; Triassic faunas of the Queen Elizabeth Islands; Jurassic faunas of the Canadian Arctic, Alberta, and British Columbia; and the Cretaceous marine zones of the western interior region of Canada. Micropalaeontological projects involved studies of ostracods from the Silurian of the Maritimes region, Devonian and Mississippian of western Canada, and Jurassic of the Prairie Provinces. Palaeobotanical investigations were conducted on the Cretaceous flora of the west and spore determinations from the Upper Devonian Melville Island formation of the Arctic.

Numerous special projects were undertaken, including 1) Middle Ordovician cephalopods of the Ottawa region (A.E. Wilson), 2) Maritimes Carboniferous flora and fauna (W.A. Bell), 3) Triassic Ammonites of western Canada (F.H. McLearn), 4) Index collection of Canadian Devonian fossils (D.J. McLaren), 5) Famennian (Late Upper Devonian) faunas of western Canada (P. Sartenaer), 6) Development of a reference collection of plant microfossils (D.C. McGregor), 7) Library subdivision (G.W. Sinclair and P. Harker),

8) Reorganization and maintenance of the Survey type Invertebrate collection, one of the most improtant collections in Canada, and preparation of a Catalogue of Types (T.E. Bolton, et. al.), 9) preparation of a Lexicon of Stratigraphic Names in Canada (T.E. Bolton and F.J.E. Wagner) 10) preparation of Eastern Canada Palaeobotanical Excursion itinerary for the forthcoming International Botanical Congress (D.C. McGregor and L.M. Cumming), and 11) representatives of the Geological Survey on various National and International organizations.

In addition to the continuing studies of fossil collections obtained through direct field work, 105 detailed reports were prepared on fossil collections submitted by field officers of the survey (74), other government branches (2), provincial governments (4), oil and mining companies (8), and private individuals (17).

The work of the fossil preparation laboratory is summarized in the accompanying table. A major undertaking of this unit was the reorganization of the palaeontological collections that have accumulated over the past century. This programme involved a systematic reallocation, with sorting, labelling, and cleaning (washing, vacuuming and dusting) of approximately 10,500 trays.

The facilities and collections of the section were made available to numerous visiting geologists and palaeontologists, including Dr. G. Henningsmoor of the University of Oslo, Miss J.R.P. Phillips of Yale University and Australia, J.A. Fagerstrom of the University of Indiana, Mrs. H. McCammon of the University of Indiana and Manitoba Mines Branch, Dr. A. Boucot of M.I.T., and oil-mining Company representatives T. Byrne (Texaco Exploration Co.), A. Patterson (Merrill Oil Co.), C. Hage (Dome Exploration), D. Oswald (California Standard Oil Co.), and Dr. Kent (Triad Oil Co.).

Details

H. Frebold: Head, Stratigraphic Palaeontology Section:

1. The Jurassic System of Canada - continuous project at present concentrating on faunas of the Canadian Arctic and British Columbia, some of the work in close cooperation with certain Oil companies who are greatly interested in the geology of the Canadian Arctic.

2. Chairman of Geological Survey of Canada Committee on Stratigraphic Nomenclature.

3. Commissioner American Commission on Stratigraphic Nomenclature.

4. Representative International Commission on Stratigraphy Subcommission on Stratigraphic Terminology.

T.E. Bolton:

1. Canadian Fossil Arthropods - Eurypterida and Phyllocarida - bulletin completed with M.J. Copeland.

2. Silurian faunas of Manitoulin Island, Ontario.

3. Post-glacial marine overlap on Anticosti Island, Quebec - paper prepared with P.K. Lee for outside publication.

4. Maintenance of Survey invertebrate fossil type collection.

5. Preparation of Catalogue of Invertebrate types in the collection of the Geological Survey of Canada - volume I submitted for Survey publication.

6. Preparation of Lexicon of Stratigraphic Names of Canada - card index compiled from U.S.G.S. Lexicon (to 1950), U.S.G.S. photostat information, and Alberta Soc. Petrol. Geol. Lexicon. Literature reviewed includes G.S.C. Summ. Rept's. to 1895, complete Trans. Roy. Soc. Can. and C.I.M.M.

M.J. Copeland:

1. Continuing study of Jurassic Ostracods from the Prairie Provinces.

2. Continuing study of Silurian Ostracods from Eastern Canada - Arisaig, Nova Scotia, New Brunswick, and Anticosti Island, Quebec.

3. Devonian and Mississippian ostracods of Western Canada.

4. Canadian Fossil Arthropoda - Eurypterida and Phyllocarida. Submitted Bulletin includes a record of Canadian Eurypterids, with the first reported occurrence in Arctic North America of the European Eurypterus fischeri Silurian fauna. Also are descriptions of the first Western Canada Echinocarids (Devonian and Lower Mississippian) and a Phyllocarid fauna from the Canadian Arctic (Silurian-Devonian).

L.M. Cumming:

1. Identification of Silurian-Devonian fossil collections obtained from a continuing mapping program of the central Mineral belt in New Brunswick, and from reconnaissance surveys by Oil companies in the Gaspe peninsula.

2. Assisted in preparation of the Eastern Canada Palaeobotanical Excursion itinerary for the forthcoming International Botanical Congress.

P. Harker:

1. Monograph on the Permian megafossils of the Grinnell Peninsula, Arctic was completed. This account will form the basis of Permian correlation in the Canadian Arctic and sub-Arctic.

2. Memoir on the Carboniferous and Permian Stratigraphy of the Liard and associated ranges, N.W.T. nearing completion, based on field work carried out on Operation Mackenzie.

3. Survey representative in the discussions of the U.S.G.S. Committee on North American Permian subdivision.

4. As Chairman of G.S.C. Library committee, undertook settlement of the final disposition of the disputed categories of the library by direct negotiation with representatives of the National Museum of Canada.

J.A. Jeletzky:

1. Interim report on Cretaceous marine zones of Western Interior region of Canada compiled.

2. Preparation of final report on Mesozoic and Tertiary rocks and fossils of west coast Vancouver Island, British Columbia.

3. A second preliminary report on the Cretaceous and uppermost Jurassic rocks of Aklavik range, N.W.T. being prepared.

4. Paper on uppermost Marine Cretaceous rocks of Canada for International Geological Congress in Copenhagen.

5. Monographic description of Scaphites from the Cretaceous Bearpaw and equivalent formations.

6. Monographic study of Canadian Aucella.

D.C. McGregor:

1. Spores from Melville Island formation (Upper Devonian). Studies of this nature limited in the Arctic and this entirely new assemblage first small spore examination.

2. Combined study of micro- and macro-fossil plants from some rock units for the first time.

3. Preparation of the Eastern Canada Palaeobotanical Excursion itinerary for the forthcoming International Botanical Congress.

4. Development of a reference collection of plant microfossils.

D.J. McLaren:

1. Identification of faunas and preparation of stratigraphic information for final report Operation Mackenzie.

2. Description of new genera and species of Rhynchonellids from the Lower Waterways and Flume formations (Devonian) and their stratigraphic importance.

3. Preparation "Role of fossils in defining rocks units in the Devonian of Western and Arctic Canada", Symposium on Stratigraphic nomenclature, American Association of Petroleum Geologists.

4. Development of an Index collection of Devonian fossils.

A.W. Norris:

1. Stratigraphy and Palaeontology of pre-Middle Devonian and Middle Devonian of the upper Mackenzie basin.

2. Stratigraphy of the Devonian of Northeastern Alberta (Clearwater-Athabaska-Upper Slave rivers and Gypsum Cliffs-Vermilion Chutes, Peace River) report completed.

G.W. Sinclair:

1. Continuing studies on the Ordovician faunas and floras, and stratigraphy of the Ordovician sedimentary rocks of Canada.

2. Section representative at International Commission of Zoological Nomenclature London meeting.

3. Special assignment Library division.

E.T. Tozer:

1. Triassic faunas Queen Elizabeth Islands, Arctic.

F.J.E. Wagner:

1. Pleistocene of Vancouver Area, British Columbia manuscript completed.

2. Preparation of Lexicon of Stratigraphic Names of Canada under direction of T.E. Bolton.

WESTERN PETROLEUM AND NATURAL GAS OFFICE, CALGARY

R. T.D. Wickenden, in charge

During 1958 use of the facilities of the Calgary Office by the oil and gas industry continued to increase. There were 1, 907 visitors and publications to the value of $2, 283.51 were sold in the first 11 months. Most of the time there was a waiting list of persons who wished to study samples even though space in the Laboratory was used for this purpose.

The members of the Technical staff continued to do research on subsurface problems.

Dr. Helen R. Belyea continued studying the subsurface formations of Devonian age. Some of the results were prepared for publication as follows:

Devonian Formations Between Nordegg Area and Rimbey Meadowbrook Reef Chain Alberta.

This paper was prepared for the Eighth Annual Field Conference of the Alberta Society of Petroleum Geologists and published in the guide book for the conference.

At the request of the Billings Geological Society she prepared a paper entitled, Devonian Sediments in Southern Alberta and Correlations with Northwest Montana. This paper is in press and should be published soon.

A brief description of Devonian beds known as the Camrose tongue was published by Dr. Belyea in the April 1958 issue of the Journal of the Alberta Society of Petroleum Geologists.

A preliminary report on the Elk Point Group in Central and Southern Alberta was submitted to the Editor of the Geological Survey for publication.

Dr. Belyea also was a member of the Names Correlations Committee of the Alberta Society of Petroleum Geologists and was principal speaker at several of the stops on the A.S.P.G. field trip in the Nordegg area.

In the course of her study Dr. Belyea examined core from deep wells stored in or near Edmonton and in the vicinity of Calgary. She also made trips to the Nordegg area to examine outcrops to correlate the exposed section with the subsurface and be prepared for the talks she had to give on the field trip.

Mr. L.L. Price continued to study the Lower Cretaceous formations of Saskatchewan. A tentative manuscript for a report on this project was submitted and was returned to him for revision which required additional examination of cores and samples.

During the field season Mr. Price examined Lower Cretaceous sections near Swan River in Manitoba and studied cores stored in Winnipeg and Regina.

Dr. D.C. Pugh continued to study the sub-surface formations of N.E. British Columbia. He submitted a report on some of the Lower Cretaceous Formations, which is in the Editor's hands. Two more reports were submitted and returned to the author for corrections and revisions.

Dr. Pugh spent about 4 weeks in northeastern British Columbia studying and sampling cores from deep wells in the area.

Mr. I.M. Harris commenced preparing punch cards for wildcat information. The project is well underway and 1,200 cards of an estimated 6,000 have been completed. Mr. Harris also spent a few days examining the geology of the southern part of a 15 minute sheet in the Burnt Timber Creek area with the objective of starting to complete the area.

Members attended meetings of scientific organizations. Dr. Belyea attended the meetings and field trip of the Billings Geological Society and the field conference of the Alberta Society of Petroleum Geologists. Mr. Price attended the Second International Williston Basin Symposium in Regina, Mr. Harris represented the Survey at a meeting of the A.S.P.G. by giving the commentary on two reels of film taken on Operation Mackenzie and R.T.D. Wickenden attended the annual meetings of the A.A.P.G. and the A.S.P.G. field conference.

Miss Helen Lawson, outside of office hours, cooperated with the librarians of various oil companies and some members of the A.S.P.G. in assembling the information supplied for the bibliography of Alberta Geology by members of the A.S.P.G.

COAL RESEARCH SECTION, SYDNEY

P.A. Hacquebard, in charge

Coal Petrology

A. Study of Coking Coals

As part of the research program on the coking characteristics of Canadian coals, carried out in close cooperation with the Fuels Division of the Mines Branch, petrographic studies on coals from the Sydney coalfield, Nova Scotia, and the Crowsnest coalfield, Alberta were continued. These studies

consist of making detailed microscopic analyses of a large number of column samples, in order to examine the lateral and vertical variations in the petrographic composition of the coal seams in situ. As the petrographic composition of the coal is related to the quality of the resultant coke, this investigation may be considered as a resources study. It provides fundamental data on the composition of the coking coals present in the various coal areas.

However, since mined coal, and in particular screened coal, has a different composition than that of the seam in situ, detailed petrographic analyses of a series of screened sizes are also made. They show that the fine sizes, which are generally used for coke making, do not always contain the different petrographic components in the most suitable proportions. Data important for coal blending purposes, with the objective of improving the coke quality, are obtained with these studies.

During 1958, a study of ten column samples of the Harbour seam of the Sydney coalfield was completed by P.A. Hacquebard. The columns were taken from the five collieries that operate on this seam. Vertically, between roof and pavement, the petrographic composition of this seam varies considerably. Horizontally, between the different mines, no great variations were noted, when equal portions of the seam are compared. However, not all collieries mine the same part of the seam, and therefore different types of coal are produced, as for instance in Dominion No. 20 colliery, where the uppermost portion of the seam is not represented. In general, the upper half of the Harbour seam is high in inertinite and exinite (spores etc.), whereas the lower half is rich in vitrinite. This difference is also present in the screened coal, as was found with an analysis of nine screened sizes of Harbour coal from Dominion No. 26 colliery, completed in 1958. The larger sizes, sold on the domestic market, contain considerably more inertinite and exinite, than the finer sizes that are used as coking coals. The latter are very high in vitrinite. Since inertinite is more or less inert during the carbonization process, while vitrinite constitutes the reactive (high swelling) component, the relative distribution of these two groups of macerals is of great importance to the physical characteristics of the resultant coke. The Sydney metallurgical coke is at present made from coal that contains very little inertinite. It is therefore not surprising that its strength is not very great, because there are not enough strength giving inert components in the coal. Blending Sydney coking coals with lower volatile coals would help in this respect, but unfortunately such coals are not present in the Cape Breton coalfields. The petrographic investigation carried out so far shows that another source of coals, that may increase the strength of the Sydney coke, may be available in the larger screened sizes of Dominion No. 26 colliery, which at present are not used as coking coals. Coke tests of carefully prepared coals, controlled by petrographic analyses, and to be carried out by the Fuels Division in Ottawa, are planned as part of this program.

Studies, similar to those described above, are in progress on the coking coals from the Bellevue and Vicary Creek mines of West Canadian Collieries, in the Crowsnest field of Alberta. During the past year six

column samples and nine screened sizes of the Bellevue No. 1 seam have been examined by T.F. Birmingham, as well as one column from the new Vicary Creek mine, which was studied by K.J. Marsh. The results obtained so far, show that both vertically and horizontally the petrographic composition of the Bellevue No. 1 seam is more variable than that of the Harbour seam of the Sydney coalfield. The distribution pattern within the different screened sizes is likewise quite different. At present not enough data are available to present definite results. The seam of the Vicary Creek mine appears to be more constant in its petrographic composition between roof and pavement than the Bellevue No. 1 seam, and to contain a higher percentage of reactive components (vitrinite), at least on the basis of the one column studied to date.

During 1958 a research study on the effect of the petrographic composition on the swelling properties of the coal during carbonization was carried out. The results, described in a paper read at the International Coal Petrology Congress, held in September 1958 in Heerlen, Holland, are briefly as follows:

A quantitative comparison between the F.R.L. swelling index (as determined by the Fuel Research Laboratory of the Mines Branch) and the group macerals vitrinite, exinite and inertinite, shows that this index is related foremost to the amount of vitrinite. A precise correlation, however, is not represented. The reason for this is that vitrinite is not completely homogeneous, but consists of two constituents, namely collinite (devoid of cellular structure) and telinite (with structure). Quantitative analyses carried out on etched polished sections of ground coal (lucite pellets), revealed that a very substantial portion of vitrinite is represented by collinite. In non-etched sections a separation of vitrinite into collinite and telinite cannot be made, and accordingly only the total vitrinite is recorded. The study has shown that only telinite portion of the vitrinite is responsible for the swelling properties of coal during carbonization. A very good correlation between the F.R.L. swelling index and the percent telinite was found, in both the Harbour coal from the Sydney field (Carboniferous) and the Bellevue No. 1 coal from the Crowsnest area (Cretaceous). However, in the two coals examined, a different correlation is represented, which is caused by the difference in rank. The significance of this may be better understood when it is realized that only a relatively slight decrease in telinite content will cause a substantial decrease in the swelling indices of the Bellevue coal (medium volatile bituminous), but will not materially affect the indices of the Harbour coal (high volatile "A" bituminous). As the swelling indices are closely related to the physical properties of coke, this observation may be of considerable value for the determination of suitable blends of coking coals.

B. A.R. Cameron's Ph.D. Thesis Project on the Harbour Seam of the Sydney Coalfield.

This project, which was initiated in 1957, was continued this year. Microscopic studies of several column samples of the Harbour seam were made at the Pennsylvania State University and in Sydney, by employing thin sections of coal. Megascopic profiles were measured at regular intervals in the different mines by Cameron, assisted by K.J. Marsh, and a great number of additional samples of selected horizons were collected. At Penn. State, during

the winter of 1957 - '58 ash samples of different horizons were examined spectrographically, and a semi-quantitative analysis of the different elements present was made. The emphasis of this study is on lateral variations in the petrographic composition of the Harbour seam in relation to facies changes within the ancient peat bogs. The nature of the immediate roof rock is also considered, as well as the distribution of the ash contributing elements in the different types of coal. The results of this study will be given in Mr. Cameron's thesis, which he hopes to complete sometime during 1959.

Palynology

A. Study of Stratigraphic Ranges of Small Spore Genera in Upper Carboniferous Coals and Carbonaceous Shales of the Maritime Provinces

This investigation forms a part of the long range project that eventually will cover the entire Carboniferous succession in the Maritime Provinces. The objectives of this study are threefold, namely: 1. to find the stratigraphic ranges of the different small spore genera, 2. to determine the density variations of the genera in the stratigraphic column, 3. to establish, by means of spores, the stratigraphic position of those areas in the Maritimes that have yielded insufficient megafossils for a precise age assignment.

In connection with the Fourth International Congress on Carboniferous Stratigraphy and Geology, held in September 1958 in Heerlen, Holland, the first objective has been very actively pursued this year. As a result of this, the ranges of the small spore genera in the four groups that comprise the Upper Carboniferous of Eastern Canada (Canso, Riversdale, Cumberland and Pictou) has been established. For this, a total of 150 samples of coals and carbonaceous shales from different areas in Nova Scotia, New Brunswick and Newfoundland have been studied by M.S. Barss and J.R. Donaldson. This number includes 30 samples from the Mabou. area that were examined during 1956 and 1957, and 15 samples from the Minto - Chipman - Beersville area, referred to later in this report. The results obtained with this work to date are given in the spore paper presented at the Heerlen Congress by P.A. Hacquebard, and may be summarized as follows:

The presence of genera with restricted ranges permit a selection of certain spore combinations, that are used in zoning the Upper Carboniferous succession. Five spore divisions, four zones and four subzones are recognized. The limits of the spore divisions are in agreement with the six floral zones represented, and established by W.A. Bell. However, additional subzones not clearly marked by the mega-flora are also indicated, and include the "Howley Beds" of Newfoundland.

The beds contain the coals of Howley, St. Andrew's and South Branch, all in western Newfoundland. The spores show that they are younger than the Canso strata of the Pomquet River section of Nova Scotia, and field and spore evidence indicate that they underlie the Riversdale coals of the St. George's area of Newfoundland, as well as those of western Cape Breton Island. Equivalent strata in Nova Scotia have as yet not been found, but there is a possibility that the Canso strata that contain a Westphalian A arthropod fauna

(according to Copeland, 1952), may be the same age. The "Howley Beds" contain a Westphalian A spore assemblage. The name "Howley Beds" therefore, has at present only local significance. It is used for reference purposes, and not as a new stratigraphic unit, comparable in rank to Canso, Riversdale, etc. However, should later studies confirm Copeland's findings that the Canso group consists of two stratigraphic units, then it may be advisable to use separate terms to designate each unit. The more so, because the Mississippian - Pennsylvanian boundary occurs between these two parts of the Canso group. As is mentioned in the paper, the spores contained in the Canso section of the Pomquet River in Nova Scotia (near Antigonish) indicate that these Canso sediments are of Upper Mississippian (Chester) age. Spores of the type section of the Canso (on the Strait of Canso) have not yet been studied. This section is assigned by Copeland to the upper unit, and therefore could be of the same age as the 'Howley Beds" of Newfoundland.

The paper also points out that the spore distribution in the uppermost zones of the Pictou group show that a revision of the boundary between Westphalian C and D may be warranted, not only in the Maritimes but also in Europe. A detailed comparison with the Saar shows that the Westphalian D is represented not solely by the Ptychocarpus unitus zone (as is contended by Bell), but also includes the Linopteris obliqua zone. The division between C and D in Europe, based entirely on the megaflora is confusing, and can perhaps better be made by means of the microflora. Recent spore studies carried out in various European coalfields seem to indicate this.

The above investigation also provided valuable data for the third objective of the spore studies carried out for stratigraphic purposes. It was possible to indicate the stratigraphic position of the following areas of Carboniferous deposition, which were until now not precisely known. In descending stratigraphic order the locations of these deposits are listed below.

PICTOU GROUP

Ptychocarpus unitus zone
In New Brunswick: Beersville

Linopteris obliqua zone
In Nova Scotia: Stellarton
In Newfoundland: Riviere Blanche (near Stephenville)

Lonchopteris zone:
In Nova Scotia: Merigomish Island, Spicer Cover (Cumb. Co.)
In New Brunswick: Minto, Cody's, Dunsinane

CUMBERLAND GROUP

In Nova Scotia: Dewolf Brook (west of Parrsboro)

"HOWLEY BEDS"

In Newfoundland: Howley area, St. Andrews, South Branch

CANSO GROUP

In Nova Scotia: Pomquet River section, North Shore (Cape Breton).

The stratigraphic significance of these datings are as follows:

a) Minto and Beersville in New Brunswick, because it alters the present conception that the coals of both areas are of the same age. Although both are assigned to the Pictou group, the coal horizon at Beersville is considerably younger than the Minto coal seam. The two are separated by the entire Linopteris obliqua zone, which at present has not been located with any certainty in the area between Minto and Beersville. The Minto coal itself was assigned by W.A. Bell to the Linopteris obliqua zone, but the spores clearly show that it belongs to the Lonchopteris zone, and very likely to the upper part of this zone. It contains the same characteristic genera as the Tracey seam of the Sydney coalfield, which lies at the very top of the Lonchopteris zone.

b) Insufficient megafossils have been found in the shales associated with the coals at Stellarton. Therefore their stratigraphic position has been a matter of conjecture. Bell assumed these coals to lie in normal succession below the coals of the Thorburn district, which he dated as belonging to the Linopteris obliqua zone. T.B. Haites, on the other hand, assigned the Stellarton coals provisionally to the Cumberland group, and postulated that they are separated from the Thorburn coals by a disconformity. The spores show without any doubt that the Stellarton coals, at least as far down as the McGregor seam, belong to the Linopteris obliqua zone, and probably are in normal succession with the coals of Thorburn.

c) The assignment of the (thin) coal horizon on Riviere Blanche near Stephenville, Nfld., to the Linopteris obliqua zone of the Pictou group is significant, because it was entirely unknown that Upper Carboniferous sediments of this group occur in Newfoundland. Their geographic location in relation to the geosynclinal basin of the Gulf of St. Lawrence is also interesting, in that it shows the presence of upper Pennsylvanian (Pictou) sediments as far north as Stephenville, Nfld.

d) The dating of the coal present on Merigomish Island as lowermost Pictou (Lonchopteris zone) refutes Haites' correlation of the Thorburn coals with those that occur north of Fraser Mountain, and puts serious doubt on the existence of the disconformity mentioned under b).

e) The Upper Carboniferous sediments of the Cumberland coal basin, bordered in the north by the Joggins, River Hebert and Chignecto coalfields, on the west by the Springhill field and on the south by the Cobequid Mountains have all been placed (by Bell, Shaw, and others) in the Cumberland group. The presence at Spicer Cove (at extreme southeast part of the basin) of a section of lowermost Pictou(Lonchopteris zone) strata is therefore a very interesting discovery. Since the axis of the Athol syncline lies close to Spicer Cove, it is considered quite possible that more Pictou strata occur to the northwest of Spicer Cove in the region close to the synclinal axis. In fact, it may be possible that a large portion of Division 6d of map 337A (Springhill Sheet) prepared by Kerr, Jones and Bell (1935) may represent basal Pictou strata. More samples (if these can be obtained) are necessary to work out this problem.

f) The coal at Dunsinane in New Brunswick belongs to Gussow's Salisbury formation (1953), which he considers to be older than the Minto formation. The spores show that the Dunsinane and Minto coals are of the same age (Lonchopteris zone), and accordingly the Salisbury formation may be correlated with the Minto formation. The coal at Cody's may also be correlated with the Minto horizon, as it contains the same characteristic spores.

g) The coal at Dewolf Brook lies on the Cobequid Mountains east of Parrsboro. It is contained in a coarse conglomerate, that is probably of the same age as the Styles Brook conglomerate on the north side of the Cumberland basin (in Chignecto area), because the spores show the coal to be of Cumberland age. This dating gives concrete evidence of the presence of Cumberland strata on top of the (pre-Carboniferous) Cobequid Mountains. As regards the geologic history of this part of Nova Scotia, this may be considered important information, because it throws more light on the isostatic movements of the Cobequid complex.

h) The coals at Howley, St. Andrew's and South Branch of western Newfoundland have been assigned to the "Howley Beds". The significance of this result has already been dealt with previously on pages 5 and 6. The provisional stratigraphic term "Howley Beds" for the coal measures in the Howley area and equivalent strata has been introduced for the following reasons:

1) The spore assemblage noted in the six samples collected from Coal Brook and Aldery Brook in the area south of the village of Howley cannot be correlated with the spore assemblage present in the Riversdale coals of the St. George's coalfield, of which three samples were examined, nor with that present in the ten samples studied from the Riversdale coals of western Cape Breton Island. The latter includes a thin coal horizon just south of Margaree Harbour, which lies about 4,500 feet below the No. 5 Seam of Chimney Corner, and likely represents the earliest Riversdale coal known in Cape Breton Island. The youngest Riversdale coal, collected from the Boss Point formation in the Joggins area, likewise cannot be correlated with the Howley coals.

2) Although no correlation between the Howley and Riversdale coals can be made, the spore assemblage in both indicates a Westphalian A age, in terms of the European chronology. In American terms this means that both are of Pennsylvanian age. Accordingly, as was pointed out previously on page 6, the Howley coals are younger than the Canso deposits on Pomquet River, which are upper Mississippian in age.

3) The coals of the Howley area can readily be correlated with the coal horizon at South Branch, as well as with the horizon at St. Andrew's. The latter lies at the top, or just above the Searston Beds of the Codroy area, which Bell (1948) has provisionally correlated with the Canso group.

From above it is concluded that the "Howley Beds" occupy a Stratigraphic position that lies between the Riversdale and the Canso (of Pomquet River). It is for this reason that the new term was introduced.

i) The assignment of the Canso section on Pomquet River and North Shore, in Nova Scotia, to the Mississippian. Until recently the position of the Canso, either as basal Pennsylvanian or uppermost Mississippian was in doubt, and accordingly the Mississippian - Pennsylvanian boundary in the Maritimes could not be indicated with any certainty. The spore study shows that at least two sections of strata assigned to the Canso group are of Mississippian age. Of the Pomquet River section, which is about 6,000 feet thick, three samples obtained from the upper, middle and lower parts have been examined. The North Shore section is 375 feet thick and contains two layers of carbonaceous shale that have been studied for spores. However, as mentioned previously, other Canso sections may be basal Pennsylvanian (Westphalian A) as is contended by Copeland. Therefore considerably more work will have to be done to complete this project.

Regarding the second objective of the spore investigation carried out for stratigraphic purposes, mentioned on page 4, a considerable amount of work remains to be done. Spore counts have at present only been made of the Mabou, Minto-Chipman-Beersville, and in part of the Joggins-Springhill and Pictou coalfields. A determination of the spore density variations throughout the coal measures is necessary to obtain supplementary stratigraphic information. In many instances the observation that a particular genus is present is insufficient. The amount by which it occurs often varies between different stratigraphic units.

B. Spore Studies of Particular Coal Areas, carried out for Seam Correlation and Structural Purposes

1) Study of the Joggins-River Hebert-Chignecto and Springhill coalfields.

This investigation is carried out by J.R. Donaldson, and its objective is to verify the possibility of correlating the coal seams of these two areas of the Cumberland coal basin. Or, should no correlation exist, then the objective is to find the stratigraphic relationship.

For the purpose of finding the stratigraphic ranges of the different spore genera within the Cumberland group (carried out as part of project A, page 4 etc.) eleven seams were examined from the Joggins (etc.) area, and nine seams from the Springhill district.

Spore counts of eleven seams (comprising counts of 20 intervals) have been completed, and counts on another twenty seams are necessary to complete this project.

At present, the only result that can be reported is that the Cumberland group cannot be subdivided into different stratigraphic units on the basis of the generic spore distribution.

2) Study of the Pictou coalfield.

This study, which was commenced in 1957 was interrupted until October 1958, on account of the activities necessary for project A. Its objective is to find a structural interpretation of the Pictou coalfield supported by fossil evidence. At present there are two entirely different

views on the structural and stratigraphic relationships in this field, namely one by Bell (partly on fossil plants) and one by Haites (based in part on same plants). Bell interpreted the stratigraphy of this field as being one of continuous succession, which in descending order is as follows: Thorburn member, Coal Brook member, Albion member, Plymouth member, Westville member and Skinner Brook member, which together total about 12,000 feet, all of which he regarded as the Stellarton series, which is of Pictou age. Contrary to this, Haites placed only the Thorburn member in the Pictou group, and provisionally considered the other members as a part of the Cumberland group, the two being separated by a disconformity. The Albion member he regarded the same as the Westville member. This correlation is economically important, because it affects the remaining reserves of the Westville coals in the Stellarton district.

From the spore studies carried out to date (and again actively pursued since October) the following results regarding the above controversy can be reported.

a) Both the Thorburn and the Stellarton coals (Albion member) are of Pictou age (see page 7 b and 8 d).

b) The Stellarton coals are not the same, but are younger than the Westville coals. Accordingly, a substantial reserve of the Westville No. 1 (or Acadia) seam may be expected tounderlie the coals in the Stellarton district.

During 1958 M.S. Barss has studied the spore ranges from ten samples and has completed spore counts of five seams of the Pictou field. Counts and range studies of another thirty-seven samples are necessary to complete this project.

3) Study of the Minto-Chipman and Beersville coalfields, New Brunswick.

This study, which involved an examination of fifteen samples, collected from seven different coal horizons at various localities, was completed in 1957. A progress report, by Hacquebard and Barss was submitted in January 1958. It shows that it is possible to separate three formations, each containing coal horizons, by means of fossil spores. Several direct seam correlations were also made, which facilitated the field work carried out by the New Brunswick Mines Branch in the area east of Chipman.

As a result of the spore range study, mentioned under A, some changes are necessary in the age assignments of the coal bearing formations at Minto-Chipman and Beersville, that are mentioned in the report. These changes are the following:

a) In the report Bell's assignment of the Minto seam to the Linopteris obliqua zone was accepted. As was mentioned on page 7 a, the Minto seam is now placed in the Lonchopteris zone, because of the similarity with the spores contained in the Tracey seam of the Sydney coalfield.

b) The Beersville coal, although still considered as belonging to the Ptychocarpus unitus zone, may better be placed in the upper part of this zone, and not in the lower part, as was indicated in the report.

c) The correlation of the coals of the Sunbury Creek formation with the Linopteris obliqua zone, as shown in the report, was based solely on the evidence that they lie 150 feet above the Minto seam. Since the Minto seam is now regarded as belonging to the Lonchopteris zone, the position of the Sunbury Creek coals is in doubt. From the spore information available at present, it cannot be definitely said if these coals are lowermost Linopteris obliqua or uppermost Lonchopteris in age. It is hoped that several additional samples obtained during the summer of 1958 from the area between Chipman and Beersville, may provide a clue to solving this problem.

Other Activities

A. For Colloquium on Carboniferous Stratigraphy, held in conjunction with 4th. International Congress on Carboniferous Stratigraphy and Geology, Heerlen, 1958.

For this colloquium the late Professor W.J. Jongmans circulated six questions related to local and worldwide problems on the stratigraphy of the Carboniferous system. Several of these questions were quite involved, and an extensive literature survey was required to answer them. A report, to be published in the Congress Proceedings, and dealing with these six questions was made by Hacquebard, who also wrote a short article to accompany a large table showing the Carboniferous stratigraphy of the Maritime Provinces. In this table the lithology, fauna, flora and spore florules of the different stratigraphic units are indicated, as well as their presently accepted correlations with the divisions used in Europe and the United States.

In connection with the studies mentioned above, and for the spore range investigation, Hacquebard has constructed 31 stratigraphic sections (scale 1 inch equals 500 feet) of the different Carboniferous areas in Nova Scotia and Newfoundland. Sections of New Brunswick and Prince Edward Island still have to be drawn. At present, only draft copies of these sections have been made, but it is planned to group them together on a number of charts in a more permanent form, which will incorporate the stratigraphic results of the spore studies.

B. Activities outside Sydney

1) J.R. Donaldson spent three weeks in January 1958 at the Pennsylvania State University, where he carried out spore studies under Dr. Gerhard Kremp. The purpose of this visit was to learn more about the spore classification proposed by Potonie & Kremp, and to discuss certain problems encountered with our spore studies at Sydney with the co-author of this classification.

2) P.A. Hacquebard attended the First International Congress on Coal Petrology, and the Fourth International Congress on Carboniferous Stratigraphy

and Geology, both of which were held in Heerlen, Holland, in September 1958. He presented one paper to the Petrology Congress, and two papers to the Carboniferous Stratigraphy Congress, and also participated in the colloquium on Carboniferous stratigraphy which was held during the Congress.

3) Throughout the year P.A. Hacquebard and his associates visited the different coal areas of Cape Breton Island and the mainland of Nova Scotia to collect samples for the palynological investigations. Field trips for similar purposes were also made, in June to western Newfoundland, and in July to eastern New Brunswick. On the latter trip he was accompanied by Mr. John Hamilton of the Mines Branch of New Brunswick, who directed him to coal outcrops in the eastern part of this province.

LABORATORY ACTIVITIES

PALAEONTOLOGICAL LABORATORY STATISTICAL SUMMARY

NAME	SAW CUTS	THIN SECTIONS	POLISHED SECTIONS	RUBBER MOLDS	PLASTER CASTS	DISINTE-GRATES
Bolton, T.E.	70	65	--	--	--	--
Bell, W.A.	--	--	21	--	--	--
Copeland, M.J.	4	4	--	--	--	200
Cumming, L.M.	10	--	--	3	3	--
Frebold, H.	22	--	2	35	35	--
Harker, P.	115	120	5	10	10	--
Jeletzky, J.	4	--	--	18	18	--
McGregor, C.	10	10	--	--	--	--
McLaren, D.J.	310	283	15	68	136	--
Norris, A.W.	312	108	--	7	7	--
Sinclair, G.W.	22	17	5	--	--	--
Thorsteinsson, R.	63	46	2	--	--	--
Tozer, E.T.	27	--	--	63	137	--
Miss Wilson	12	26	5	20	20	--
Miss Wagner	--	--	--	18	36	--
Visitors	85	92	--	38	46	--
Universities	--	--	--	43	78	--
Total	1066	771	55	323	526	200

Boxes received during field season	224
School collections made up	20
Boxes shipped out during year	132

PUBLICATIONS IN SCIENTIFIC AND TECHNICAL JOURNALS

GEOLOGY OF FUELS SECTION

Jasper Alberta, A Source of the Foothills Eratics Train, by E.W. Mountjoy; Alberta Society of Petroleum Geologists, Vol. 6, No. 9, 1958, pp. 218-226.

Mississippian Stratigraphy of the Central Foothills and Eastern Ranges of the Nordegg Area, Alberta By W.B. Brady; Guide Book to 8th Annual Field Conference Alberta Society of Petroleum Geologists, 1958, pp. 51-63.

Pocono Paleocurrents in Pennsylvania and Maryland by B.R. Pelletier; Bull. Geological Society of America, Vol. 69, 1958, pp. 1033-1064.

Operation Mackenzie: By R.J.W. Douglas; Canadian Oil and Gas Industries, Vol. 11, 1958, pp. 51-57; Canadian Mining Journal, Vol. 79, 1958, pp. 64-70.

Canadian Operation "Mackenzie", 1957 by R.J.W. Douglas; Polar Record, Vol. 9, 1958, pp. 144-146.

Mississippian Succession in Mount Head Area, Alberta by R.J.W. Douglas and P. Harker (as submitted by Harker).

STRATIGRAPHIC PALAEONTOLOGY SECTION

Redescription of Ctenobolbina clavigera (Jones) 1891 from the Middle Ordovician of Ottawa, Canada, by Murray J. Copeland. J. Pal. 32-1: 236-238, 1958.

Pre-Carboniferous Faunas, Northern and Central New Brunswick, by L.M. Cumming. Abstr., Bull. Geol. Soc. Amer. 69-12-2: 1958

Stratigraphy and Correlation of the Jurassic in the Canadian Rocky Mountains and Alberta Foothills, by Hans Frebold. "Jurassic and Carboniferous of Western Canada", Am. Assoc. Petrol. Geol., pp. 10-26, 1958

Mississippian Succession in Mount Head Area, Alberta, by R.J. Douglas and P. Harker. "Jurassic and Carboniferous of Western Canada", Am. Assoc. Petrol. Geol. pp. 177-189. 1958.

Megafaunal Zones in the Alberta Mississippian and Permian, by P. Harker and G.C. Raasch. "Jurassic and Carboniferous of Western Canada", Am. Assoc. Petrol. Geol., pp. 216-231. 1958.

The Devonian-Mississippian Boundary in the Alberta Rocky Mountains, by P. Harker and D.J. McLaren. "Jurassic and Carboniferous of Western Canada", Am. Assoc. Petrol. Geol., pp. 244-259, 1958.

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Die Jungere Oberkreide (Oberconiac bis Maestricht) Südwestrusslands und ihr Vergleich mit der Nordwest and Westeuropos, by J.A. Jeletzky. Beihefte zum Geologischen Jahrbuch, Heft 33:1-144. 1958.

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Common Devonian Fossils from the Alberta Rocky Mountains, by D.J. McLaren. Guidebook Eighth Annual Field Conference, Alta. Soc. Petrol. Geol., pp. 193-203. 1958

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New Name for an Ordovician Shale in Manitoba, by G. Winston Sinclair and Edward I. Leith. J. Pal. 32-1: pp. 243-244. 1958.

Age of the Ordovician Cobourg "Formation", by G. Winston Sinclair. Abstr., Bull. Geol. Soc. Amer. 69-12-2: 1958.

Occurrence of Fish in the Ordovician of Canada, by G. Winston Sinclair. Abstr., Bull. Geol. Soc. Amer. 69-12-2: 1958.

Triassic Faunas from the Queen Elizabeth Islands, Arctic Canada, by E.T. Tozer. Abstr., Bull. Geol. Soc. Amer. 69-12-2: 1958.

Unusual Pleistocene Fossils from Southeastern Ontario, by Frances J.E. Wagner, Trans. Roy. Soc. Can., 3rd ser., sec. 4, 51: 5-11, 1957. 1958.

CALGARY OFFICE

Designation of Type Section, Camrose Tongue, Upper Devonian, Alberta, by Helen R. Belyea, Jour. Alta. Soc. Petrol. Geol. 6-3: 105-110. 1958.

Devonian Formations Between Nordegg Area and Rimby-Meadowbrook Reef Chain, Alberta, by Helen R. Belyea, 8th. Ann. Field Conference, Alta. Soc. Petrol. Geol. 75-106. 1958.

SYDNEY OFFICE

The following publications, although dated in 1957, did not come out in print until early in 1958, and are not listed in the 1957 Annual Report of the Department of Mines and Technical Surveys.

Hacquebard, P.A., 1957: Plant spores in coal from the Horton group (Mississippian) of Nova Scotia. - Micropalaeontology, vol. 3, no. 4, pp. 301-324.

Submitted and approved for publication are the following papers, that likely will appear in print in 1959.

Hacquebard, P.A.: Palynological Studies of some Upper and Lower Carboniferous strata in Nova Scotia. Part I: The Mabou coal area. - M.S. submitted for publication in the Proceedings of the Third Coal Conference, held at Crystal Cliffs, N.S. in June 1956.

Hacquebard, P.A.. Value of a quantitative separation of the maceral vitrinite into its constituents telinite and collinite for the petrography of coking coals. - M.S. submitted for publication in the Proceedings of the 4th Carboniferous Congress, Heerlen, Holland, September 1958.

Hacquebard, P.A.. Barss, M.S. and Donaldson, J.R.: Distribution and stratigraphic significance of small spore genera in the Upper Carboniferous of the Maritime Provinces of Canada. - M.S. etc., as above.

Hacquebard, P.A.: A Summary of Carboniferous stratigraphy and palaeontology of the Maritime Provinces of Canada. - M.S. etc., as above.

Hacquebard, P.A.: Canadian contribution for Colloquium on Carboniferous Stratigraphy, held in conjunction with the 4th International Congress on Carboniferous Stratigraphy and Geology, Heerlen, Holland, September 15-20, 1958. Report etc., as above
Report with outside circulation, but not for publication.

Hacquebard, P.A., and Barss, M.S., 1958: Progress report on a spore study of the coal deposits in the Minto, Chipman and Beersville areas of New Brunswick.

MINERALOGY DIVISION

S.C. Robinson, Chief

INTRODUCTION

The following report has been compiled from reports submitted by heads of the chemical analysis, geochemistry, isotope geology, mineralogy and petrology sections. While Dr. Rose was seconded to the Mineral Deposits Division, work of his section was handled by the mineralogy section, and pending decision on duties of Dr. Rose, it is recommended that this arrangement be continued. Reports of the Section heads are appended.

FIELD ACTIVITIES

Northwest Territories

57-28. C.H. Smith made a brief reconnaissance of a basic-ultrabasic complex on the Coppermine River preliminary to undertaking a detailed study.

Yukon Territory

53-5. R.W. Boyle continued laboratory studies on ores of the Mayo camp in preparation for completion of a memoir. These deposits are unique

in Canada because weathering and supergene enrichment are preserved. As a result it is possible to study the geochemical changes involved. Mineralogy is also unique in Canada and already one new mineral (Hawleyite) has been described.

British Columbia

57-27. J.E. Reesor commenced detailed studies of Nelson and Valhalla granite intrusions in parts of the Burton and Passmore map-areas. These studies are part of a general investigation of types, genesis and related features of granites in Canada. Results of this year's work have demonstrated unusual field relations in a dome of granites, quartzites, gneisses and migmatites whose significance requires further valuation in the field and laboratory.

57-28. C.H. Smith made a reconnaissance of several ultrabasic bodies in the Cordillera of British Columbia and the Yukon.

Alberta and Saskatchewan

58-18. E.M. Cameron initiated a broad study of the geochemistry of sandstones by field work in the Foothills of the Rockies and in the Cyprus Hills. A collection of 400 samples was made as the basis of intensive laboratory studies which will provide information on conditions of formation of sandstones, their provenance, subsequent diagenesis etc; data which should be useful in petroleum geology and ground-water investigations.

Ontario

54-31. A brief trip to the Bancroft area to obtain additional samples was made. Studies of uranium ores and rocks from the area are continuing with assistance of a seasonal employee. Results indicate that uranium and thorium were not derived from enclosing host rocks but were introduced from a deeper source. Correlation by age determination indicates a genetic relationship to granites in the area.

Ontario and Quebec

C.H.R. Gauthier collected over 10 tons of rocks and minerals from 48 localities in Ontario and Quebec. This material is used to prepare suites for sale to the public. He also collected 200 pounds of display specimens.

Quebec

58-36. E.R. Rose commenced a study of the petrology and mineralogy of the iron-titanium deposits in anorthosite bodies of the Grenville sub-province. It is hoped that this study will provide information on the zoning and structure of the anorthosite bodies and the relation of the titaniferous iron deposits to them. These deposits comprise very large tonnages of iron minerals, approaching ore grade.

New Brunswick

57-22. This study of the geochemistry of the Bathurst - Newcastle base metal camp was commenced with a brief reconnaissance in 1957 and continued in part of 1958 by Dr. Boyle in association with Dr. Roy, a post doctorate fellow in mineralogy, and with Professor Kalliokoski who is working on the geothermometry of the deposits by the Küllerüd method.

Nova Scotia

56-28. R.H.C. Holman completed the geochemical reconnaissance of the mainland of Nova Scotia by analysing stream waters and stream sediments for Cu, Pb, and Zu. Maps showing lines similar to contours but enclosing areas in which streams have equal metal content, are being used to present results of this work. This new type of presentation not only permits ready recognition of anomalously high areas, but also brings out the relation of these anomalies to the bed-rock geology. Results of this reconnaissance have indicated several areas in which significantly high anomalies exist and thus provide a valuable supplement to the geological mapping of the Province.

OFFICE AND LABORATORY ACTIVITIES

ANALYTICAL CHEMISTRY SECTION

This section includes the rock and mineral analysis laboratories, the spectrographic laboratory and the laboratory for analysis of radioactive materials. During this year Mrs. M. McGahey resigned and was replaced by Mr. K.G. Hoops and Mr. V. Romeny joined the section. Mr. O.C. Wickremasinghe, a Colombo Plan student at McMaster University, spent three months in the section to study methods of rock analysis.

As a result of modifications to rapid methods of rock analysis, it was possible for the first time, to supply rock analyses to a field officer during the same field season in which they were collected.

New methods were developed for: determination of small amounts of uranium in zircon; chlorine, fluorine, strontium and manganese in silicates; continuous extraction of acid-soluble constituents from rocks; conversion of sulphates to sulphides for isotope analysis; and extensive development work was done on Versene titration methods for calcium and magnesium.

Compilation of data of geochemistry of Canadian rocks and minerals (C.P. 121) was continued by two seasonal assistants during the summer.

The following is a summary of analytical work completed by the section in 1958:

Complete rock analyses	131
Partial analyses	201
Special analyses	21
Total determinations involved	4049
Preparations of lead tetramethyl	114
Preparations for thoron line etc.	160
Qualitative spectrographic analyses	199
Semiquantitative " "	928
Quantitative " "	680
Total spectrographic exposures	4624

MINERALOGY SECTION

Good progress was made in compilation of data for publication of a catalogue, of X-ray powder diffraction patterns of minerals which are on file in the X-ray laboratory. (O.P. 15).

A seasonal assistant in collaboration with R.J. Traill started work on revision of memoir 74, "A List of Canadian Mineral Occurrences". Cooperation of the Mineralogical Association of Canada in this project has been promised. (C.P. 160).

For the past two years, D.D. Hogarth has been employed as a seasonal technical officer to do research on uranium-niobium minerals. This work was completed for the betafite and pyrochlore series during 1958 and will be presented as a Ph.D. thesis to McGill University. M.V.N. Murthy a post doctorate fellow, completed his study of zircons in granites as suitable chronometers of geological age in March and is completing final draft of a bulletin in India. Dr. Supriya Roy, a post doctorate fellow joined the section in March to undertake a micrographic study of the ores of the Bathurst-Newcastle camp. This work in part supplements that of R.W. Boyle in 57-22.

Service work continued to dominate activities of the section: a summary follows:

1. X-ray mineral identifications	1819
2. X-ray spectrographic analyses	112
3. X-ray diffractometer analyses	78
4. Mineral concentrates separated	515
5. Samples crushed and sized for analysis	298

Mineral separations involved the following operations:

Crushing, grinding and sizing	460
Super panner separations	35
Frantz isodynamic separations	750
Carpco magnetic separations	250
Heavy liquid separations	385
Other separations	55

Mr. Fabry examined 2, 316 rock and mineral samples received by mail during the year, and a substantial additional number for persons who brought them to the laboratory.

ISOTOPE GEOLOGY SECTION

Good progress was made during the year on studies involving isotopic analyses of sulphur, lead, magnesium and argon, (O.P.'s 28, 62, 71, 98, 116 and 144).

Complete mechanical and electrical plans for a second mass spectrometer were drawn by R.K. Wanless and the intricate tube assembly, magnets and stand were completed by the Maintenance Section of the Mines Branch. All other equipment has been purchased and assembly requires only completion of the contract for the electronic circuits. It is anticipated that this mass spectrometer will be tested, but not operated, before the move to the new building.

Plans for the radiocarbon dating laboratory were completed and the counting equipment is being designed and built by the Radioactivity Division of the Mines Branch. All equipment for conversion of samples to CO_2 has been ordered ready for assembly in the new building.

Isotopic analyses of sulphur from Devonian petroleum horizons, from ores and rocks of the Yellowknife camp and from the Sullivan camp have been made but have not yet been assessed.

Isotopic ratios of lead (O.P. 98) from all parts of the Sullivan mine and from some neighbouring properties are remarkably constant, whereas lead isotope ratios from other neighbouring properties differ significantly. Work on this project is nearly complete and a preliminary paper has been published.

A second argon extraction line was completed and put into operation by N.J. Snelling, a post doctorate fellow. Difficulties encountered in extraction and purification of argon have been largely eliminated and work is now proceeding on a routine basis. Calibration work on K/A ages has been successfully completed, research on conformity of K/A ages of different rocks and minerals of geological equivalent age, by N.J. Snelling, is well advanced and routine determination of micas has been started.

Preliminary work on measurement of magnesium isotope ratios, using a simple type of solid source arrangement was not entirely satisfactory but did indicate a significant variation in Mg^{24}/Mg^{26} ratios in a wide range of samples. This program will be actively implemented when the second mass spectrometer with its improved sources is available.

The following is a summary of work done:

Extractions and purifications of argon	48
Extractions " " " sulphur	130
Mass spectrometer analyses of sulphur	89
" " " " lead	20
" " " " argon	127
" " " " magnesium	16

PETROLOGY SECTION

A small petrography laboratory was established in the late summer and two seasonal T.O.'s have been retained through the winter to study thin sections of ultrabasic rocks, to examine mineral concentrates used

in the age program, to provide precise identification of plagioclase feldspars, to make petrographic studies of meteorites and samples submitted by other branches of government etc.

Preliminary petrographic and mineralogical work on the Abee meteorite was finished and a report in manuscript has been written. The catalogue of meteorites in the collections of the Geological Survey has been consolidated and brought up to date. Systematic collections representing rocks of 32 field areas were catalogued and comprise 15,500 specimens.

Petrographic studies were made of seven suites of rocks.

30 precise determinations of plagioclase feldspars were reported.

GEOCHEMISTRY SECTION

R. H. C. Holman in collaboration with Mrs. Gilbert has almost completed laboratory work on peat, soils, rocks and vegetation collected from a copper swamp near Sackville, N.B. Copper content of parts of this swamp is 6% and as high as 25% in the dried material. This work is being done in collaboration with Dr. R.E. Beschel of the Department of Biology and Bacteriology, Mount Allison University.

Good progress has been made by Mrs. Gilbert in compilation of a handbook of simple methods of geochemical analysis that provide consistent and sensitive results for certain elements. Most of these methods are adaptable for use in the field.

As usual most of the work was devoted to analysis of samples from the field.

Number of samples	3,595
Total number of determinations	9,763
Determinations of specific gravity	136

This volume of analyses was done by Mrs. Gilbert with the assistance of two seasonal assistants. In addition chemical supplies were ordered and packed for the field parties, standards were prepared, and some training provided to field assistants.

Some progress was made in developing more sensitive tests for copper and molybdenum. Many tests for various metals, employing new reagents are being reported in the literature and it is hoped to test the applicability of these to field use when additional staff is available.

COLLECTIONS FOR SALE TO PUBLIC

Increase in demand for these collections and specimens in 1958, over figures for 1957, was 17%. Despite employment of one seasonal employee throughout the year and two additional seasonal employees in the summer, delay in shipping orders has periodically been as long as 2 1/2 months. For those using collections for teaching, this may be a serious handicap.

	Specimens	Collections
Ontario	82,477	2,301
British Columbia	54,568	1,556
Alberta	25,870	736
Quebec	15,049	437
Manitoba	14,744	406
Saskatchewan	5,644	160
Yukon	3,604	103
Nova Scotia	3,003	77
New Brunswick	2,197	39
Sold in Ottawa	11,271	329
P.E.I., N.W.T., Nfld.	3,924	109
	222,351	6,253

In addition 50 large sets containing a total of 6,000 specimens were shipped.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to all who contributed specimens, and in particular to: Mr. E.G. Ballachy, Manager, Quemont Mines Corpn; Mr. S.A.J. Hopper, Manager, Golden Manitou Mines; Mr. J.B. Steele, Manager, Quartz Crystals Mines Ltd.; Mr. J. Symon, Manager, Huntingdon Fluorspar Mines Ltd.

For supplies of argon-38 used as spike material in the potassium-argon dating program, gratitude is expressed to the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and to Atomic Energy of Canada Ltd.

PUBLICATIONS IN SCIENTIFIC AND TECHNICAL JOURNALS

A geochemical reconnaissance of part of Nova Scotia, by R.H.C. Holman and R.W. Boyle. Northern Miner, March 6, 1958, p. 262 et seq.

Geology of the Bathurst-Newcastle mineral district, New Brunswick, by C.H. Smith and R. Skinner. Trans. C.I.M. LXI, pp. 78-83.

Lead isotope studies of the Sullivan and other deposits in the East Kootenay disyrict, southeastern British Columbia. Trans. Amer. Geophys. Union, Vol. 39, No. 3, p. 535 et seq.

An application of multivariate variance analysis to mineralogical variation, Preissac-Lacorne batholith, Abitibi county, Quebec, by K.R. Dawson. Can. Mineralogist, Vol. 6, part 2, pp. 222-233.

The composition and crystallography of niocalite, by E.H. Nickel, J.F. Rowland and J.A. Maxwell, Can. Mineralogist, Vol. 6, part 2, pp. 264-272.

Possible loss of sodium and potassium during fusion of plagioclase feldspars, by K.R. Dawson and J.A. Maxwell. Can. Mineralogist, Vol. 6, part 2, pp. 288-289.

A Canadian occurrence of fairchildite and buetschliite, by K.R. Dawson and Ann. Sabina. Can. Mineralogist, Vol. 6, part 2, pp. 290-291.

Technique for optical determination of iron-bearing dolomites, by J.E. Howell and K.R. Dawson. Can. Mineralogist, Vol. 6, part 2, pp. 292-293.

The compilation of chemical analyses of Canadian rocks and minerals, by J.A. Maxwell, K.R. Dawson and Margaret E. Tomilson. Abstract, Fourth Western Regional Conference, Chemical Institute of Canada, Sept. 4-6.

Electroanalytical chemistry, by J.A. Maxwell. Chemistry in Canada, Vol. 10, No. 1, pp. 38-39.

Uranium deposits of the Bancroft region, Ontario, by S.C. Robinson and D.F. Hewitt. In the 2nd. International Conference on the Peaceful Uses of Atomic Energy, Geneva 1958.

A genetic classification of Canadian uranium deposits, by S.C. Robinson. Can. Mineralogist, vol. 6, part 2, pp. 174-190.

Types and ore reserves of Canadian radioactive deposits, by J.W. Griffith, A.H. Lang, S.C. Robinson, S.M. Roscoe and H.R. Steacy. In the 2nd International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958.

REPORTS OF UNITS

ANALYTICAL CHEMISTRY SECTION

by J.A. Maxwell

A. Rock and mineral Analysis Laboratory (O.P.77)

	Type			
	Complete	Partial	Special	Total
Samples on hand, Jan. 1/58	27	20	25	72
Samples received, 1958	216	50	55	321
	243	70	80	393
Samples completed, 1958	131	59	21	211
Samples on hand, Jan. 1/59	112	11	59	182
Analyses reported	131	59	21	211
Supporting analyses made	90	120	3	213
Total	221	179	24	424

	Type			
	Complete	Partial	Special	Total
Determinations involved in analyses reported	1823	152	117	2092
Determinations involved in supporting analyses	1494	154	6	1654
	3317	306	123	3764
'Rapid method' Analyses on hand, Jan. 1/58	26	0		
'Rapid method' Analyses received, 1958	172	15		
	198	15		
'Rapid method' Analyses completed, 1958	117	15		
'Rapid method' Analyses on hand, Jan. 1/59	81	0		

B. Radioactive Minerals Chemical Laboratory (O.P. 28)

	Samples Processed	Chemical Preparations	Analytical Determinations
Rocks dissolved for thoron line	137	137	--
Lead tetramethyl preparations	114	114	--
Potassium in silicates	53	--	53
Minor constituents in rocks	74	--	212
Others	38	23	20
	416	274	285

C. Spectrographic Laboratory (O.P. 16)

Samples on hand, Jan. 1/1958	144
Samples received, 1958	909
Total	1053

	Qual.	Semi-quant.	Quant.	Total
Analyses reported	199	928	680	1807

	Analytical	Development	Total
Exposures made	2223	2401	4624

SUMMARY

	Chem.	Spec.	Total
Samples carried over and received, 1958	809	1053	1862
Analyses made	709	1807	2516
Chemical Preparations made	274	----	----
Determinations involved	4323	----	4323
Spectrographic Exposures made	---	4624	4624

The analytical laboratories had on hand in 1958 a total of 1862 samples for analysis. The total number of analyses made is 2516, and that of chemical preparations made is 274, involving 4323 determinations and 4624 spectrographic exposures.

General

The work of the Section has involved the complete and partial chemical and spectrographic analyses of rocks, minerals, ores, soils, brines and waters submitted by Survey officers to supply data of field problems, and the analytical and preparative chemistry required for the age determination and isotope study programs, mineralogical studies of radioactive minerals and geochemical studies of uranium, thorium and related elements.

New and special projects undertaken by the Section in 1958 are as follows:

1. The Rapid Methods of Analysis were put into regular laboratory use and 117 complete analyses were made. Extensive development work was done on the Versene titration methods for calcium and magnesium.

2. Extensive work was done on Blind River samples for Dr. Roscoe, involving preparation of samples for thoron line work, and trace element analyses.

3. Revision of all spectrographic methods, other than qualitative, has been completed, and a general semiquantitative method established.

4. Soil and brine analyses were made for the first time.

5. New methods were developed and applied to the determination of small amounts of uranium in zircon; chlorine, strontium, fluorine and manganese in silicates; the continuous extraction of acid-soluble constituents from crushed rocks; the conversion of sulfates to sulfides for mass spectrometric analysis.

6. For the first time, analyses of samples sent from the field were sent to the Survey officer before he had left the field.

7. The compilation work connected with O.P.121 (Compilation of Canadian Rock and Mineral Analyses) was continued during the summer months with the help of Miss Margaret Tomilson and Miss Dorothy Pocock.

8. Mrs. M. McGahey left the Rock and Mineral Analyses Laboratory and was replaced by Mr. K.G. Hoops. Mr. U. Romeny joined the staff of the Radioactive Minerals Chemical Laboratory. Mr. O.C. Wickremasinghe, a Colombo Plan student at McMaster University, spent three months in the above laboratory in order to study our methods.

MINERALOGY SECTION

by R.J. Traill

Good progress was made on the compilation of data for publication of a catalogue of X-ray diffraction patterns of minerals which are on file in the X-ray Laboratory.

Work began on a second major compilation project, revision of Memoir 74 and publication of an up-to-date list of (O.P.160) Canadian mineral occurrences complete with analytical data.

A two-year research study of pyrochlore and betafite minerals was completed during the past summer. The results of this study will be embodied in a Ph.D. thesis to be presented at McGill University by D.D. Hogarth.

Dr. Supriya Roy joined the Mineralogy Section in March on a Post-doctorate Fellowship and began an ore micrographic study of the copper ore deposits in the Bathurst area, New Brunswick.

Provision of service work to geologists of the Survey and the public in general continues to dominate the activities of the Mineralogy Section. A summary of services performed follows:

(1). The X-ray Laboratory completed 1819 mineral identifications, 112 X-ray spectrographic analyses and 78 X-ray diffractometer analyses.

(2). A total of 515 mineral concentrates were separated, and 298 rock samples were crushed, in the Mineral Preparation and Separation Laboratories. The separating work included the following numbers of operations:

Crushing, grinding, sizing	460
Superpanner separations	35
Frantz separations	750
Carpco separations	250
Heavy Liquid separations	385
Other Operations	55

(3) As a service to the public, a total of 2316 mineral and rock samples were examined and the results of these examinations were communicated to the senders in 353 letters. A large number of additional samples were examined and identified for persons who made personal visits to our laboratories.

ISOTOPE GEOLOGY SECTION

by R.K. Wanless

The laboratory has continued studies on problems involving sulphur, lead, argon and magnesium isotopes during 1958. In addition work has gone ahead on the assembly of a new solid source mass spectrometer. The original plan called for completion of the new instrument by the time the Survey moved to its new quarters in 1959 and it would appear now that this will be realized. Two argon extraction lines have been set up in the laboratory at 541 Sussex Street and the processing of argon samples for age studies is being carried on in a routine manner. A radio-carbon dating laboratory has been planned and equipped from this year's estimates. The majority of the necessary apparatus is now stored in the Survey quarters at 541 Sussex Street. Electronic components required to provide automatic operation of the counting equipment have been ordered.

Sulphur Isotopes: O.P.62; O.P.71; O.P.144

A total of 130 sulphur samples were converted to SO_2 for mass spectrometric analysis and 89 mass spectrometric analyses were carried out.

The samples represent a series of projects involving studies of the isotope chemistry of sulphur in rocks and ore deposits and isotope studies of sulphur in Canadian petroleum deposits. A detailed investigation of the sulphur isotopes at Yellowknife, N.W.T., is now complete and the results will be assessed early in 1959. Several interesting trends have been observed in this study of various sulphide minerals selected from all geological formations of the area.

A large number of sulphide and sulphate specimens from Devonian producing horizons in Alberta as well as oil samples from producing wells have been analysed mass spectrometrically. It has been observed that the sulphide sulphur ratios are relatively constant within formations but that the ratios vary widely in intermediate transitions zones. This fact indicates that the sulphur isotope ratios may be valuable in stratigraphic correlation and with this thought in mind collections were made from neighbouring Devonian regions. Further work in this field of study must await the mass spectrometric analysis of the remaining specimens on hand.

Sulphur isotope ratios have been determined on galena specimens from the Sullivan Mine in S.E. British Columbia and are to be considered in conjunction with the lead isotope study of the orebody.

Although results are not as yet available a study of the sulphur isotope distribution in a series of samples (25) from the Blind River area of Ontario has been started. Analysis of these samples is scheduled for early 1959.

Lead Isotopes: O.P. 98

Galena samples supplied by the Consolidated Mining and Smelting Co., from the Sullivan Mine in S.E. British Columbia have been analysed mass spectrometrically. In addition Dr. G.B. Leech has supplied a number of specimens from neighbouring smaller vein type deposits found in rocks of the Purcell formation. The Sullivan samples, representing all phases of the orebody, have been found to possess an extremely constant lead isotopic ratio with the exception of some of the later ore which appears to have an excess of radiogenic lead. The average lead isotope ratio indicates that the ore was separated from its uranium and thorium parent isotopes about 1250 M.Y. ago but not necessarily deposited in its present location at that time. In order to help resolve this point potassium argon age determinations are being carried out on biotite separated from dykes cutting the orebody. This phase of the study is nearing completion.

A paper giving the preliminary results of this study was presented at the Annual Meeting of the American Geophysical Union in Washington, May 5, 1958. (1). The final results should be ready for publication in the spring of 1959.

Argon Isotopes

Two argon extraction lines have now been set up in the laboratories at 541 Sussex Street. One of these lines is currently used by a post-doctorate fellow on a special project and will be available for routine age work on the completion of this project in the fall of 1959.

A great many problems associated with the extraction procedures have been solved and both lines are now equipped with titanium furnaces for gas purification and special diffusion pumps to facilitate the movement of the extracted gas samples. The current output of the equipment is about two per week per line or about 150 argon extractions per year.

In addition to the vacuum assembly a small induction heater has been assembled and placed in operation and argon-38 has been extracted from irradiated capsules supplied by Atomic Energy of Canada Ltd. This material which has an argon 38 composition of 92% (compared with a natural composition of .07%) is used as an isotopic 'spike' in the age determination procedure.

The argon work was considered in three phases: 1) calibration - by comparing K/A ages of micas with Pb/U ages of uraninites from the same pegmatitic occurrences: 2) determination of the age of micas from all regions of a large granitic body and 3) the routine determination of the age of micaceous materials and the subdivision of Canadian Precambrian areas. The results of phase 1 were most gratifying. The check results were on the whole very good and indicated the second and third phases could be commenced with

reasonable assurance of success. Phase 2 is now being studied by the post-doctorate fellow referred to above and preliminary work on phase 3 has started. To date 48 extractions have been carried out. Thirty-six of these are samples from phases 1 and 3 while 12 phase 2 samples have been processed.

Magnesium Isotopes: O.P.116

Preliminary work was carried out using a very simple type of solid source arrangement. While the results were not the best there does appear to be some variation in the Mg^{24}/Mg^{26} ratio in natural occurrences. This is a new field and presents very interesting possibilities in the study of dolomites, serpentines, olivines, asbestos etc. Sample collection and preparation has gone ahead in anticipation of further studies in this field when the new solid source instrument becomes operative.

Radiocarbon Laboratory

Preparations have been made for the establishment of a C^{14} dating laboratory in the new building. A special room is to be provided in the sub-basement where advantage may be taken of the excellent shielding provided by the 8 floors of concrete in the new building. All equipment required for the conversion of sample material to CO_2 for counting has been ordered and stored. Electronic equipment required to place the counting equipment on a 24 hour operational basis is now on order.

New Mass Spectrometer

Very good progress has been made on the design, construction and assembly of our second mass spectrometer. This instrument, which is a refined and improved version of our current instrument, is to be equipped with a special solid source assembly that will permit the analysis of microgram quantities of sample material and with an electron multiplier.

Early in 1958 the mechanical drawings were complete and construction of the magnet and analyser tube assembly was started by the Maintenance Section of the Mines Branch. The work has been carried out in a most efficient manner. This phase of the work was completed in September and the equipment was transferred to the Museum Building. Details of the electronic circuits were completed in October and the contract for assembly placed early in December. The units are scheduled for delivery before March 15th, 1959.

If time permits preliminary testing will be carried out in the Museum but the instrument will not be in operation before the laboratories are established, in the new building.

(1) Lead Isotope Studies of the Sullivan and other Deposits in the East Kootenay District, Southeastern British Columbia. R.K. Wanless and G.B. Leech, Transactions of the American Geophysical Union, vol. 39, No. 3, p. 535, 1958.

PETROLOGY SECTION

by K.R. Dawson

The petrology section has responsibility for the petrographic collections which now contain in excess of 1,500 specimens representing 32 four mile map areas. The fusion technique for the identification of plagioclase feldspars has been developed and a total of 30 determinations have been made. Petrographic studies include a suite of wallrock specimens, and a specimen from a sandstone carving. A small petrographic laboratory has been in operation for 3 months.

GEOCHEMISTRY SECTION

Geochemical Research

by R.W. Boyle

During 1958 research in geochemical prospecting was carried out in two field areas in Canada and field parties commenced work on two projects, one on the geochemistry of sandstones and the other on the geochemistry of the zinc-lead-copper deposits of Bathurst, New Brunswick. In addition research on the chemistry of ore genesis, isotope geology, and geochemical prospecting was continued. New geochemical laboratories are nearing completion and will be occupied early in 1959.

Under the supervision of R.H.C. Holman, 9 men carried out geochemical prospecting research in the Province of Nova Scotia. Stream sediment and water, in the area northwest of a line drawn from Truro to New Glasgow was tested during the summer for zinc, lead, and copper.

The zinc content of the stream sediments was found to be anomalously high within the Cobequid Mountains between Parrsboro and Pictou. Within this anomalous area, high local lead anomalies were found: At Lakelands, north of Parrsboro; centred on Newton Lake, which drains into Economy River; and centred on Totten Lake, which drains into Folly River. The significance of these anomalies is now being assessed. This field work completes the geochemical reconnaissance of the mainland part of Nova Scotia. Publications issued on the project (1, 2) are given in the references.

R.H.C. Holman completed a detailed geochemical survey of a copper swamp near Upper Sackville, New Brunswick. Peat, soils, rocks and vegetation were sampled to determine the materials in which the copper is concentrated. The *pH* and *eH* (oxidation potential) of water, soils, and peats were determined to establish the conditions of precipitation of copper. The geochemical study is being done in conjunction with Dr. R.E. Beschel of the Department of Biology and Bacteriology, Mount Allison University, Sackville New Brunswick. It is hoped that the results of this research will add materially to our knowledge of copper in the exogene and biologic cycles. Publication of the research will appear in the near future.

E.M. Cameron commenced a broad study of the geochemistry of sandstones. Field work was done in Western Canada, particularly in the Foothills of Alberta. Laboratory examination and analysis of the samples is presently underway. It is hoped that this study will provide much information on the conditions of formation of sandstones, diagenetic processes, etc., data which should be useful in petroleum geology and groundwater studies.

R.W. Boyle commenced a geochemical study of the zinc-lead-copper deposits of the Bathurst-Newcastle area, New Brunswick. This study will include an integrated geological and geochemical investigation of the distribution of lead, zinc, copper, silver, iron and sulphur in the deposits and their host rocks, and in the soils, waters, and vegetation. A geochemical study of the formation of gossans and zones of secondary enrichment is also projected. Parts of the project are well under way. Dr. S. Roy, a post-doctorate fellow from Jadavpur University, Calcutta, India, is completing a detailed microscopic investigation of the mineralogy of the ores and the paragenesis of the metallic and gangue minerals. Professor J. Kalliokoski of Princeton University spent a month in the field examining the deposits and collecting samples preparatory to testing the applicability of the Kullerud method (3) of geothermometry using sphalerite.

R.K. Wanless and R.W. Boyle have completed a detailed investigation of the isotope geology of sulphur in the rocks and gold-quartz deposits of the Yellowknife area. Publication of the results is projected for 1959. G.B. Leech and R.K. Wanless carried out a detailed investigation of the lead-isotopic distribution in the Sullivan Mine and neighbouring deposits in South-eastern British Columbia. An outline of this investigation has been published (4). Dr. Wanless has also continued research on the isotope geology of sulphur in petroleum and on various aspects of geochronology.

M.A. Gilbert and R.H.C. Holman have continued their laboratory research on methods of field and laboratory analyses, particularly with a view to introducing automation both in the field and laboratory.

The new building for the Geological Survey of Canada will be completed and occupied early in 1959. This building contains an extensive suite of laboratories for the pursuance of all types of geochemical work. In addition to normal analytical laboratories special laboratories for high temperature - high pressure research, radio-tracer work, and various types of low temperature syntheses will come into use. A novel feature is a laboratory greenhouse in which it is hoped that controlled experiments will give much needed data on the biogeochemistry of many elements. Such experiments should greatly enhance and stimulate biogeochemical prospecting and give much information on the part that organisms play in the concentration of metals during sedimentation processes as well as during the oxidation and enrichment of ore-bodies.

Geochemical Laboratory

by M.A. Gilbert

During the past year 3,595 samples involving a total of 9,763 separate determinations were received by the laboratory for analysis. In addition, 136

specific gravity determinations were made on rock samples (using a Kraus Tolly balance) for R. W. Boyle. (The chemicals and equipment required for R. H. C. Holman's field party of 9 were ordered and assembled).

Two student assistants, Miss Patricia Millar and Miss Valerie Montgomery, were employed in the laboratory during the summer. Mr. Edgar Allen (field assistant) spent a brief period in the laboratory receiving intensified training in the analytical procedures to be used in Nova Scotia.

Routine Analyses of Samples from Nova Scotia

This project was continued for a second year and the samples were analysed in the same way as those collected the previous field season (1957). During the summer and early autumn approximately 2, 296 samples were analysed for copper, lead and zinc. The routine analyses for the Nova Scotia project (NS-1 and NS-2) have now been completed involving a total of 4, 896 samples which required 14, 296 separate determinations.

The carbon tetrachloride used in this work was recovered.

Copper Swamp Samples from Sackville

A further 350 samples were analysed for copper and all samples in Rand have now been completed.

Samples received from Outside the Mineralogy Division

284 soils were submitted for copper, lead and zinc determinations by Dr. Sikha from McGill University.

Research and Development Work

Some time was spent developing a sensitive test for the determination of copper in water. The results appeared encouraging, but the method has yet to be tested on field samples.

Several analytical procedures published in the scientific literature, reviewed each week, appear as if they might be readily adapted into suitable trace analytical methods for geological samples; however, owing to the lack of a permanent assistant, no time is available to investigate these possibilities.

The writer is currently engaged in compiling a paper series covering the analytical procedures used in this laboratory.

Summary of Analyses

A. Work Completed

(1) For Mineralogy Division

Project	Field Geologist	Type of Sample	Metals Analysed	No. of Samples	No. of Determinations
	S.C. Robinson	Rock	Cu, Pb, Zn, Mo	70	280
Nova Scotia	R.W. Boyle	Sediment & Soil	Cu, Pb, Zn	160*	480
" "	" "	Rock	Cu, Pb, Zn	120	360
Keno Hill	" "	Peat	Cu, Pb, Zn	6	18
" "	" "	Miscellaneous	Cu, Pb, Zn	70	210
" "	" "	Rock	Cu, Pb, Zn	230	690
" "	" "	Water	Cu, Pb, Zn	4	12
" "	" "	Soil	Cu, Pb, Zn	4	12
Sackville	R.H.C. Holman	Bog & Moss	Cu	330	330
"	" "	Soil	Cu	20*	20
Nova Scotia	" "	Stream Sediment & Soil	Cu, Pb, Zn	2,000	6,000
" "	" "	"	Cu, Zn	200*	400
" "	" "	"	Pb	96*	96
Totals				3,310	8,908

(2) Outside Mineralogy Division

	Meagher	Stream Sediment	Cu, Pb, Zn	1	3
	Sikha	Soil	Cu, Pb, Zn	284	852
Totals				285	855

B. Work to be completed

(1) For Mineralogy Division

Project	Field Geologist	Type of Sample	Metals to be Analysed	No. of Samples	No. of Determinations
	S.C. Robinson	Rock	Cu, Pb, Zn, Mo	15	60
	R.W. Boyle	Rock	Cu, Pb, Zn	416	1,248
Totals				431	1,308

Summary of Analyses (cont'd)

(2) Outside Mineralogy Division.

New Brunswick	J.L. Davies	Rock	Cu, Pb, Zn	164	492
Totals				164	492

* Samples required sieving.

MINERAL COLLECTION AND DISTRIBUTION

by C.H.R. Gauthier

Collection

List of the material collected and delivered to the division from various localities:

Name	Locality	Weight
Actinolite	Elzevir Tp., Ont.	600 lbs.
Amphibolite	Mayo Tp., Ont.	400 lbs.
Andesite	Duprat Tp., Que.	500 lbs.
Apatite	Templeton Tp., Que.	300 lbs.
Apatite crystals	Huddersfield Tp., Que.	100 lbs.
Arsenopyrite	Marmora Tp., Ont.	300 lbs.
Barite	Buckingham Tp., Que.	100 lbs.
Beryl crystals	Quadeville, Ont.	100 lbs.
Chalcopyrite	Dalquier Tp., Que.	500 lbs.
Dolomite crystalline	Portage du Fort, Que.	600 lbs.
Ellsworthite	Hybla, Ont.	400 lbs.
Feldspar (albite)	Villeneuve Tp., Que.	400 lbs.
Feldspar (amazonite)	Cameron Tp., Ont.	100 lbs.
Feldspar (microcline)	Bathurst Tp., Ont.	400 lbs.
Feldspar (perthite)	N. Burgess Tp., Ont.	400 lbs.
Fluorite	Madoc, Ont.	400 lbs.
Garnet (grossularite)	Wakefield Tp., Que.	50 lbs
Garnet (almandite)	Dana Tp., Ont.	1200 lbs.
Granite	Staynerville, Que.	800 lbs.
Graphite	Black Donald, Ont.	1000 lbs.
Hornblende	Bathurst Tp., Ont.	200 lbs.
Lepidolite	Lacorne Tp., Que.	200 lbs.
Limestone	Hull, Que.	1000 lbs.
Limestone crystalline	Bancroft, Ont.	900 lbs.
Magnetite	Mayo Tp., Ont.	500 lbs.
Mica (biotite)	Cantley, Que.	700 lbs.
Mica (phlogopite)	Templeton Tp., Que.	200 lbs.
Olivine in Calcite	Pigelow Tp., Que.	300 lbs.
Porphyry (quartz)	Rouyn Tp., Que.	800 lbs.
Quartz (massive)	Quadeville, Ont.	1000 lbs.

Name	Locality	Weight
Quartz (rose)	Quadeville, Ont.	200 lbs.
Quartz crystals	Lyndhurst Tp., Ont.	200 lbs.
Rhyolite	Landrienne, Que.	400 lbs.
Rhyolite (porphyry)	Madoc Tp., Ont.	400 lbs.
Sandstone (Nepean)	March Tp., Ont.	1000 lbs.
Sandstone (white)	St. Canut, Que.	500 lbs.
Schist (mica)	Wilberforce Tp., Ont.	400 lbs.
Serpentine	Denholm Tp., Que.	500 lbs.
Sphalerite	Bourlamaque Tp., Que.	300 lbs.
Spinel in Calcite	Aylwin Tp. Que.	100 lbs.
Spodumene crystals (chips)	Lacorne Tp., Que.	200 lbs.
Syenite (red)	Grenville Tp., Que.	700 lbs.
Tourmaline crystals (black)	Villeneuve Tp. Que.	100 lbs.
Tourmaline (colored)	Wakefield Tp., Que.	200 lbs.

In addition arrangements were made to have some calcopyrite, galena, niccolite, smaltite and sphalerite from the following mines:

Golden Manitou Mines
East Sullivan Mines
Silver Miller Mines
Agnico Mines Limited

Museum Specimens

A beautiful grouping of fluorite crystals weighing 37 lbs. was given by Mr. J. Symon of Madoc, Ontario.

Twelve garnets approximately 6" in diameter were collected in Dana Tp., Ontario.

A block of blue scapolite weighing 22 lbs. was brought from Pontefract Tp., Que.

A specimen of barite weighing 14 lbs. was located at Buckingham 21-IV, Que.

Acknowledgments

Valuable assistance or materials were given by the following persons:

Mr. E.G. Ballachy, Mgr.,
Quemont Mines Corp., Noranda, Que.

Mr. S.A.J. Hopper, Mgr.,
Golden Manitou Mines, Val D'Or, Que.

Mr. J.B. Steele, Mgr.,
Quartz Crystals Mines Ltd., Lyndhurst, Ont.

Mr. J. Symon, Mgr.,
Huntingdon Fluorspar Mines Ltd., Madoc.

Distribution

Our statistics this year show an increase of 34, 343 specimens over the 1957 output.

The following list compared to last year's production gives the amount of specimens and collections sent to various provinces in Canada:

	1957		1958	
	Specimens	Collections	Specimens	Collections
Ontario	56, 039	1, 581	82, 447	2, 301
British Columbia	44, 279	I, 229	54, 568	1, 556
Alberta	37, 128	1, 058	25, 870	736
Quebec	10, 163	307	15, 049	437
Manitoba	2, 590	73	14, 774	406
Saskatchewan	7, 705	219	5, 644	160
P.E.I.-N.W.T.				
Nfld - Labrador	1, 701	48	3, 924	109
Yukon	10, 721	302	3, 604	103
Nova Scotia	4, 010	117	3, 003	77
New Brunswick	1, 787	52	2, 197	39
Office	11, 885	349	11, 271	329
	188, 008	5, 335	222, 351	6, 253

We also shipped during the year 1958 fifty large ($25.00) collections, representing an additional 6, 000 specimens.

Standing orders on hand amount to 192 collections, or 6, 820 specimens.

MINERAL DEPOSITS DIVISION

A. H. Lang, Chief

FIELD ACTIVITIES

Geology of Radioactive Deposits, Blind River Area, Ontario, by S. M. Roscoe

54-30. As the Blind River area is now the leading uranium-producing district of Canada and perhaps the most significant in the world, and as it contains much thorium as well, much importance is attached to this detailed and many-sided study begun in 1954. The small amount of field work required for a comprehensive--although not exhaustive--report was finished in 1958, and most of the year was devoted to microscopic studies and other office work. The full report, to augment preliminary ones already published, is scheduled for completion in the spring or early summer of 1959. A supplementary doctorate-thesis study on one phase of the subject, undertaken by P. J. Pienaar under Roscoe's supervision, is completed and the thesis has been written.

Study of Beach and Other Placer Deposits in Canada, by C.R. McLeod

57-30. This work was undertaken mainly to test the possibilities of finding valuable minerals other than gold in sands and placer deposits; and, if so, to try to provide information on how prospecting and appraisal for such deposits might be done to best advantage. Research of this kind is largely geological. Field work begun the previous year in Nova Scotia and New Brunswick was continued in 1958. The results so far have not indicated deposits of probable importance, but the studies are considered to have been well worth while because even negative information will be useful to prospectors and companies. A report on the results to date is about half prepared and will be finished by next spring.

Studies for Publications in the Economic Geology Series

Much of the field work of the division was devoted to studies connected with the Economic Geology Series, which comprises Canada-wide reports on specific metals or other topics. The results of local studies in economic geology are not issued in this series. Reports in the Economic Geology Series contain comprehensive, although condensed, data on deposits, including generalizations on mode of occurrence and geological considerations regarding prospecting, exploration, and appraisal; descriptions of principal areas and deposits; and tables of geological data on minor occurrences. They are based both on field studies and on published and unpublished information, one of their features being the collating, weighing, and condensing of data that are widely scattered, out of print, or unpublished. As many deposits as possible, however, are studied at first hand, selections being based partly on apparent economic importance and partly on supposed unusual features. Country-wide studies and reviews of this kind commonly indicate and bring into focus problems requiring more detailed, local research by the division. Reports in the Economic Geology Series are in demand because they often contain all the information required, and when this is not the case they furnish a foundation and references to more detailed data if available. Work was done on five of these projects, as follows:

Canadian Deposits of of Uranium and Thorium, by A.H. Lang, J.W. Griffith, and H.R. Steacy.

48-6 and O.P.91. Field studies for a second edition of this report, which is out of print, were completed by a small amount of field work done by Griffith. About two-thirds of the manuscript was prepared by the end of the year. The remaining work is to be done mainly by Lang, who can do it only as other duties permit.

Lithium Deposits of Canada, by R. Mulligan

53-14. The manuscript for this report was completed in August.

Beryllium Deposits of Canada, by R. Mulligan

53-14. Some information for this study was obtained in former years incidentally to studies of niobium and lithium deposits. As beryllium deposits are in considerable demand studies specifically on them were begun in August; part or all of another season's field work will be required before a comprehensive report can be prepared.

Iron Deposits of Canada, by G.A. Gross

57-29. Studies of iron deposits were continued, mainly in Ontario and Quebec, particular attention being paid to problems of origin and the natural transformation of low-grade iron-formation to ore. The field work of 1957 and 1958 is believed to represent about half of that required to permit publication of a comprehensive report.

Molybdenum Deposits of Canada, by F.M. Vokes.

58-35. Selected molybdenum deposits were examined in Quebec, Ontario, and British Columbia. Although this work is not completed in as much detail as would be desirable, it is believed to be enough for a useful report, which must suffice because of the resignation of Vokes. He has agreed to prepare a report in his own time, and expects to complete it in 1959.

PROJECTS OUTSTANDING FROM PREVIOUS YEARS

Study of Occurrences of Heavy Rare Earths in Ontario and Quebec, by E.R. Rose

57-14. A report on this project, for which field work was done in 1957, was prepared except for the results of analyses being made outside the division. These were delayed because of technical difficulties. This officer was on loan to the division for this project.

Chromite Deposits of Canada, by H.A. Quinn

51-11. This officer was loaned to the division for a time in 1957 to complete field work for this project, but the report has not been written.

51-19. Mica Deposits of Canada, by J.W. Hoadley (resigned). This report was forwarded in 1956? but has not yet been published.

51-16. Tungsten Deposits of Canada, by H.W. Little (Post-Precambrian Division). This report was forwarded in 1956 but has not yet been published.

OFFICE ACTIVITIES

METALLOGENIC MAPS OP 125

Publication of series of 'metallogenic' maps was begun in 1958. This is a new departure for the Geological Survey, and one that has seldom been

attempted in other countries except for small local areas. Each map shows the distribution in Canada of known deposits (or areas containing many deposits) of a particular metal or two closely related metals, subdivided according to main geological classes of deposits. Comparisons with regional geological features can be made by placing one of the maps, which are printed on transparent paper, over the geological map of Canada. Comparisons of the distributions of two or three metals can be made by superimposing appropriate maps.

These maps are intended mainly as preliminary steps in research on, and the illustration of, metallogenic provinces--that is, geological regions that are characterized by deposits of one or more metals. In addition, the maps are useful to those prospectors who cannot interpret other geological literature for themselves, and to companies and others who desire to know where prospects are situated. Compilation of a composite map showing the main features of the distribution of all major metals and the more important minor ones is planned, after sufficient individual maps have been prepared.

Emphasis was given to this project because additional knowledge of metallogenic provinces would be of great assistance in the selection of a region for prospecting, which is one of the first considerations of prospectors and their backers. Also, the Geological Survey has agreed to supply a metallogenic map for Iron in Canada, and generalized data on the metallogeny of all metals in Canada, for a world-wide project being sponsored by the International Geological Congress. Our own project and our contribution to the world compilation are progressing, as two maps have been published, one is nearly ready for printing, and several others are compiled or partly so.

Status of Project at End of 1958

Metal	Compiled by	Status
Beryllium	F.M. Vokes	Published
Uranium	A.H. Lang	Published
Molybdenum	F.M. Vokes	Draughting nearing completion
Niobium	F.M. Vokes	Compiled
Iron & Titanium	G.A. Gross	Compiled
Lithium	R. Mulligan	Compiled
Tin	D.R. Whitmore	Compiled
Mercury	D.R. Whitmore	Compiled
Nickel & Cobalt	A.G. Johnston	Compilation half completed
Vanadium	D.G. Bowler	Compilation half completed
Lead & Zinc	D.R. Whitmore	Compilation begun
Gold (placer part)	C.R. McLeod	Compilation begun
Platinum	C.R. McLeod	Compilation begun

CONFIDENTIAL INVENTORY OF CANADIAN DEPOSITS OF URANIUM AND THORIUM OP 3

As agent for the Atomic Energy Control Board the division continued to receive and file reports of radioactive discoveries and work done on properties, to digest these for the confidential inventory which is revised annually, and to advise companies and prospectors. Although the number of new discoveries declined, much work was done at certain properties. Completion of the inventory was delayed by resignation of the typist and the obtaining and training of a replacement for this special typing task, but the work was completed in July.

ECONOMIC GEOLOGY FILES OP 2

The Economic Geology Files contain geological reports on specific Canadian deposits, extracted from Geological Survey and Provincial reports, selected papers from scientific and technical journals, and non-confidential unpublished reports. They are useful in providing foundations for research projects and for other purposes, and are open to company officials and competent prospectors. Much more progress was made during 1958 in bringing these files up to date than in the past several years, because of a change in personnel. Johnston is devoting an average of one hour a day to selecting and codifying material for inclusion, and the clerk and typist are doing the remainder of the work as other duties permit. All Geological Survey and most Provincial material in print is now extracted and placed in temporary files. Much final filing and indexing remain to be done; because of the move it will be impracticable to do this until afterwards. These files are expected to be in fair condition by the end of next year, but much work will remain to be done, particularly cross-referencing and adding out-of-print material.

LABORATORY ACTIVITIES

OP 3 (in part) The sample-preparation and radiometric laboratories carried out 296 ordinary radiometric assays, 76 radiometric assays for uranium, 176 radiometric assays for thorium, 15 identifications of radioactive minerals in prospectors' samples, and 58 complex mineral separations on fine-grained samples. Although some work was done for prospectors, under the special duties assumed for the Atomic Energy Control Board, most was in connection with divisional research projects, particularly that dealing with research on the Blind River deposits. Some of the mineral separations were particularly difficult, involving picking under a microscope small grains from mineral concentrates, this requiring up to 40 man-days per sample. All the work of these laboratories in support of the Blind River project was completed by the end of the year. In 1959 it is proposed to give priority to mineral separations and other laboratory work in connection with the placer research project.

O.P. 134. Progress was made in the investigation of samples collected by Griffith from a uraninite deposit in the Sudbury region, which may throw light on the origin of the Blind River ores.

PUBLICATIONS IN SCIENTIFIC AND TECHNICAL JOURNALS

OP 96. Two papers published by the United Nations in connection with the Second International Conference on Peaceful Uses of Atomic Energy were:

Types and Ore Reserves of Canadian Radioactive Deposits, by J.W. Griffith, A.H. Lang, S.C. Robinson, S.M. Roscoe, and H.R. Steacy.
On the Geology and Radioactive Deposits of Blind River Region, by S.M. Roscoe and H.R. Steacy.

48-6. A paper entitled "On the Distribution of Canadian Uranium Deposits", by A.H. Lang was published in the C.I.M. Bulletin for May 1958. This paper serves to introduce and supplement the metallogenic map for uranium.

COMMITTEES AND SOCIETIES

Steacy served on a committee within the Geological Survey to select and supervise the preparation of exhibits to be placed in the new building.

Whitmore acted on a committee within the Geological Survey to screen and establish priorities for requests for stable isotopic studies to be made by the mass spectrometer laboratory, such as measurements of the ratios of sulphur isotopes in connection with sulphide mineral deposits in Canada.

OP 96. Lang served on a committee sponsored by the Department of External Affairs, charged with arranging the Canadian contribution to the Second United Nations Conference on Peaceful Uses of Atomic Energy. This involved six meetings in Ottawa and Chalk River and much correspondence and scrutinizing and editing of papers. Papers offered were screened, others were suggested and solicited, and exhibits were planned. Because of the need of obtaining at first hand the most authentic information on future demands for uranium and thorium, and on the resources of other countries, Lang attended this conference and gave the paper on types of deposits listed above.

OP 96. Lang was the Geological Survey representative on the Departmental Roads Appraisal Committee established to assist in planning the large road-building programme sponsored by the Canadian Government. Four meetings were attended and considerable office work and consultations with geologists familiar with particular areas were required. The committee recommended some of the projects submitted, recommended re-routing or cancellation of others, and suggested some additional roads. The projects involve expenditures of approximately $250,000,000.

CP 117. Lang continued to act as a member of the sub-committee on metallic mineral deposits of the National Advisory Committee on Research in Geological Sciences. This work includes an undertaking to review all Canadian research projects on geology of mineral deposits, but because a thorough review was made and published in 1957 only general attention was given in 1958.

OP 46. By request of a committee of the Royal Society of Canada Lang prepared, with R.W. Douglas of the Fuels and Stratigraphic Geology division, a paper on mineral deposits and fuels in Northwestern Canada for a symposium now in press. Considerable time was spent by Lang and Steacy on plans for the new building and in supervising the packing of collections and samples in preparation for the move. Steacy also devoted time to classifying the collection of representative ores of Canadian mineral deposits, and the systematic collection of radioactive minerals which is in his charge because of the long association of this division with radioactive minerals.

PERSONNEL

At the beginning of the year the staff of the division, consisted of 4 geologists (1 temporary), 1 engineer (geological), 5 technical officers (1 winter seasonal), 1 clerk, 1 typist, 1 assistant technician, and the divisional chief. Another seasonal technical officer was employed in the laboratory during the summer. The temporary geologist, engineer, and typist resigned. Another geologist and typist were added. The temporary geologist resigned after a permanent position had been assigned; this position was lost. The engineer was not replaced pending negotiations to try to exchange this position for that of a geologist. Thus at the end of the year the net staff was one less than at the beginning.

A few more geologists are badly needed to cope with the most pressing projects and the demands for information.

GEOPHYSICS DIVISION

L.W. Morley, Chief

INTRODUCTION

There has been a considerable expansion of the Geophysics Division in the last year. Two well-qualified Ph.D.s and one geophysicist with ten years' experience in petroleum geophysics have been added to the staff. The division is not active in the following types of work:

I.	Field Surveys and Interpretation	Airborne magnetometer and scintillometer Seismic surveys
II.	Research	Magnetic rock properties Palaeomagnetism Magnetic resonances Gamma radiation from and adsorption in rocks

Individual reports of activities from each of the officers in the division are submitted herewith. Recommendations for future work have been added to each report and while it is realized by all concerned that there is little hope of being able to carry out even a small percentage of the suggested projects, it is nevertheless considered worthwhile formally asking the officers concerned for their ideas so that no exceptionally worthwhile projects which are reasonably within reach will be overlooked.

The following items represent some of the highlights of the year's work.

FIELD ACTIVITIES

AIRBORNE MAGNETOMETER SURVEYS

The old Canso aircraft which had been operated since 1950 by the department for aeromagnetic surveys was returned to the Air Force. In its place an Aero Commander 680 was leased from Commander Aviation and the Geological Survey magnetometer was installed. Due to the higher speed and lower cost of operation, a record number of line miles were flown (87, 931). The cost to the department was reduced from $2.66 per line mile with the Canso to $1.23 with the new aircraft.

Decca Navigation

For the first time on this continent the Decca Navigational System was used to control an aeromagnetic survey over the Bay of Fundy and the Gulf of St. Lawrence. The existing Maritimes network was used so that it was only necessary to install a Decca receiver in the aircraft. This work also represented the Geological Survey's first venture into the realm of submarine geology. The work is important both because of the interest in petroleum in Prince Edward Island and because of the theoretical importance of knowing how the geology of New Brunswick and Nova Scotia ties into the geology of Newfoundland

The area covered over the Gulf of St. Lawrence lies south of a line joining Cape Gaspe and Cape North in Cape Breton and includes the Magdalen Islands and the east half of Chaleur Bay.

In addition to the two sea areas, all the remaining land areas of New Brunswick and Nova Scotia which had not been surveyed were completed. This included in large part the Carboniferous basin of New Brunswick.

Recommendations for Future Work

A recommendation has already been put forward that the Federal and Provincial Governments share in the cost of obtaining complete aeromagnetic coverage in the northern parts of the provinces over the Shield areas. This was put forward as a remedy to the uneconomic, haphazard way in which this work is presently being done, with the hope that much of it would be completed before a great deal of geologic mapping has been done.

It is further recommended here that such surveys be combined with AFMAG surveys in order that the geological faults can also be detected and mapped in advance of geological mapping.

SEISMIC SURVEYS

Mr. Claude Gauvreau, a technician with the Geophysics Division, aided by one student assistant, operated the new MD-1 hammer seismic refraction equipment to determine depth of overburden in places suggested by Mr. Sanford and Mr. Pollitt in southwestern Ontario and south of Montreal.

It was found that depths of overburden were readily obtained to within about 10 per cent accuracy up to depth of 75 feet. Beyond that depth, both the operation and interpretation became more difficult. It was possible in some locations to detect two layers within the overburden.

OFFICE ACTIVITIES

AEROMAGNETIC

Aeromagnetic-Geologic-Correlation

Dr. A.S. MacLaren published a short summary of the results of his geologic-aeromagnetic correlation work in the Eastern Townships in the Canadian Mining Journal. From an analysis of magnetic susceptibility determinations of various rock types, it was concluded that susceptibilities of andesites, basalts, gabbros and serpentines in the area were not only extremely variable (from 20×10^{-6} to $10,000 \times 10^{-6}$) but showed modes which were so close as to make the rocks indistinguishable on the basis of their susceptibilities.

Dr. MacLaren prepared marginal notes for one of a new series of aeromagnetic composite maps to be published by the Geological Survey at a scale of 4 miles to the inch. It is the Boyd Lake Sheet No. 65E. To simplify these maps, only the 100 gamma contours will be shown. The different contour levels will be represented by five shades ranging from a deep violet colour through decreasing intensities of carmine to white. Where information is available, the rock types causing the anomalies will be listed in the notes as well as a general interpretation of the magnetic data.

Aeromagnetic Compilation

Approximately eighty-five contoured manuscripts were submitted for drafting during 1958 covering areas in the Northwest Territories, Northern Manitoba and the Maritime Provinces.

Future aeromagnetic surveys in Canada will be hampered by the lack of sufficiently accurate base maps. Trouble was experienced with poor base maps in Northern Manitoba so that compilation had to be delayed in some areas until base maps become available.

The automatic compiling machine has been satisfactorily put to use.

Aeromagnetic Interpretation over Sedimentary Areas

Dr. Garland of the University of Alberta assisted the Geological Survey by developing a mathematicl method for removing 'regional' from aeromagnetic data and trained Miss Bower of the Geophysics staff in this technique and in methods of accomplishing it using an electronic computer. A large area surrounding the Tar Sands area in northern Alberta was chosen as a test project. Dr. Garland and Miss Bower prepared a paper on the results of this work to be delivered at the Fifth World Petroleum Congress in June 1959.

Mr. Hall, a Ph.D. student at the University of British Columbia was supported during last summer in his work on the interpretation of the aeromagnetic data in the Isle a la Crosse area of Saskatchewan. In addition to the geologic interpretation of these data using air photos as an aid, he improved on mathematical methods for calculating directions of polarization of anomalous magnetic masses. This latter work will be important in palaeomagnetic interpretation.

PALAEOMAGNETIC AND MAGNETIC ROCK PROPERTY STUDIES

Mr. Du Bois succeeded in collecting about 420 oriented rock samples suitable for palaeomagnetic study. Two hundred of these were collected from Proterozoic rocks in the Lake Superior region. A number of formations in this area were found to be magnetically stable and as a result some interesting speculations were made regarding their ages. He is presently preparing a paper on this. Another 200 samples were collected from the Devonian, Carboniferous and Triassic of New Brunswick, Gaspe and Nova Scotia. These samples have not yet been measured but should help to confirm 'pole positions' previously determined for these eras.

Mr. Larochelle, working on reversely polarized rocks from the Monteregian Hills in the Eastern Townships, has succeeded in doing two important things in connection with palaeomagnetism. Firstly, he has made a Curie Point meter which is capable of determining the Curie point or points of ferromagnetic minerals contained in rock samples. This is important because he can now determine whether or not the rock sample contains ferromagnetic minerals with more than one Curie point which might cause it to possess the property of magnetic self-reversal. Secondly, he has been able to successfully apply the technique of 'magnetic washing' to magnetically unstable rock samples in such a way as to determine the direction of polarization of the stable component. Using this technique, many igneous and metamorphic rocks, which were heretofore regarded as too unstable for palaeomagnetic purposes, now fall within the scope of the method.

The Yamaska Mountain rocks, using this technique, were found to be polarized in such a direction as would suggest their age to be Cretaceous. To be sure of this statement, it would be necessary to have supporting evidence as to the location of the 'Cretaceous pole' for North America.

MAGNETIC RESONANCES

Dr. Wesemeyer has been conducting investigations in high and low field paramagnetic and nuclear magnetic resonances. Since most of his time has been spent on a confidential project, there is not much to report in the way of experimental work on the other projects.

The high field work will be directed towards rock analysis while the low field work will find more application in geophysics. The confidential project is concerned with low field nuclear and paramagnetic resonance. A magnet is on order for the high-field research.

GAMMA RADIATION FROM ROCKS

Much work over the past 10 years has been done on total flux gamma radiation surveys but little attempt had been made to separate the effects due to uranium, thorium and potassium. Dr. Gregory since joining the staff in September, has been studying existing data with a view to trying to differentiate these effects and has devised a method for so doing.

His study points to the fact that future work should include the study of gamma ray spectra from rocks as a means of determining the relative proportions of these radioelements.

REPORTS OF UNITS

AIRBORNE MAGNETOMETER SURVEY

by K.H. Owens

An aeromagnetic survey was made over those parts of New Brunswick, Nova Scotia, and Prince Edward Island that had not been previously flown, and parts of the Bay of Fundy and Gulf of St. Lawrence. For convenience the area was divided into three parts--land and the two water areas. The flight altitude was 1,000 feet above the surface and the overland spacing interval was half a mile. Flight lines over the water were flown on Decca lanes as Decca Navigational aids were used, and therefore the spacing was generally greater than the 1/2 mile interval.

The land areas of New Brunswick and Nova Scotia, the Bay of Fundy from the U.S. border is 67°W as far south as 44°N, and the New Brunswick-Nova Scotia coast, and the Gulf of St. Lawrence from New Brunswick-Gaspe to Newfoundland-Cape Breton Island between the coasts of Nova Scotia and New Brunswick to 48°N. On the west side of this area, lines were flown north to Anticosti Island and most of the Island is covered as far north as 49°30'. Between the east tip of Anticosti and Port au Port Peninsula, a pair of lines at varying intervals were flown. Prince Edward and the Magdalen Islands were covered on this portion of the survey. For convenience, and to cut down deadhead flying, three bases were used: Saint John, N.B., Moncton, N.B., and New Glasgow, N.S.

Some lines were flown across the Gaspe Peninsula but the area was not completed.

A total of 748:25 hours was flown, including ferry time to and from Ottawa, for 87,931 line miles.

The aircraft used for this season's work was an Aero Commander Super 680 with an all up weight of 7,000 pounds. It was leased by the Department from Commander Aviation Limited and flown by Spartan Air Services Limited. The survey data were obtained by Geological Survey airborne magnetometer equipment and operated by Survey personnel. A crew of three (pilot, navigator and operator) was carried on all flights. With this crew plus equipment, the aircraft was operated at the maximum allowable weight.

The aircraft performed in a very satisfactory manner and unserviceabilities were kept at a minimum. The major complaint of the compilation section seems to be in the camera, as it is not gyro stabilized; also, possibly due to the film speed used, plotting of line crossings proves difficult.

In future operations, using the same type of aircraft, the areas to be flown should be even blocks to cut down deadhead flying, with the lines no more than 210 miles long, with the average ferry to the start of the line not more than twenty minutes, as the average speed on line over the land seemed to work out at about 160 miles per hour. This will allow for a six hour flight.

The magnetometer compartment should be redesigned to give the operator more comfort as his position now is very cramped for a six hour trip. One or two other small changes should be made for the comfort of the crew.

The aircraft now is at its maximum weight (Super 680) and if additional equipment is to be carried in the future, the weight of the present Survey equipment will have to be cut, which means a new type and lighter magnetometer and recorder. Most of the trouble encountered last year was in the L.N. Recorder which seems to be very sensitive to dampness. Also a new type of radio altimeter should be obtained as the one we have been using for the past ten years has reached its limits.

INSTRUMENTATION AND ELECTRONICS

By L.S. Collett

The building of the spinner-type of magnetometer for palaeomagnetic studies has been continuing. The coils are made and mounted, the electronic circuitry has been worked out and most of it has been constructed. An Air compressor has been purchased and installed; a means has yet to be devised to keep the spinner turning at constant velocity.

Work has been dropped for the while on the nuclear resonance technique for detecting the proton in ground water due to pressure of other projects.

The seismic work using the MD-1 refraction hammer equipment was organized and supervised. Projects carried out were in S.W. Ontario, Chateauguay district south of Montreal and the Ottawa area. The compilation has been checked by George Hobson and a paper is being written by Hobson and myself on this work to show the limitations and uses of this portable equipment.

Radio communication equipment has taken up a good deal of my time, this fall on looking into the best types of equipment suitable for the use by the Geological Survey. Organization and planning for maintenance and service in the future has also taken considerable thought and time throughout the year. Mr. Knapp has been spending most of his time on maintenance.

A week during August was spent at the request of the Ontario Government in observing the seismic test work that was carried out by Canadian Kewanee Cil Company in Lake Erie. The experience gained here on water seismic technique should be most useful if the Survey plans to do any waterborne seismic work in the future.

Some time has been spent on the "All Purpose" seismic equipment in becoming familiar with its electronic characteristics and associated equipment so as to be able to advise and help to make a decision in the final selection of this equipment. A visit was made to the Texas Instrument and S.I.E. plants in Houston to see this equipment.

General Recommendations for future Work

A study of radio frequency adsorption in rocks as a function of applied magnetic field is an investigation which enters into a number of geophysical applications. After I finish my present commitments, I would recommend that I commence this line of investigation.

A study of adsorption of seismic waves in rocks as a function of frequency and distance to my knowledge has not been consistently carried out probably because of lack of suitable equipment such as transducers.

There is an accelerometer on the market now which can detect a minimum acceleration of .03 g. At this acceleration the output is 1.2 mv. Frequence response is from 2 cps. to 4 Kc and linearity is good to 1 per cent.

With very little extra equipment and time, some information on this phenomena could easily be obtained using the seismic equipment and magnetic recording apparatus which we are purchasing.

AEROMAGNETIC-GEOLOGIC CORRELATION

By A.S. MacLaren

1. Work on Eastern Townships memoir on aeromagnetic-geological correlation, including write-up on 26 of 31 map sheets, occupied the major portion of my time.

2. A paper on Aeromagnetic-Geologic Correlation for presentation at the Prospectors and Developers Association Meeting was prepared. It was published in the Canadian Mining Journal.

3. A composite aeromagnetic-geologic correlation map 4 miles = 1 inch of Boyd Lake with marginal notes was prepared for publication. This is the first of a new series of 4 mile maps.

4. Consulting work with various geologists including Drs. Douglas, Wright, Fahrig, Anderson and Riley, on the interpretation of airborne magnetometer surveys occupied considerable time.

Recommendations for Future Work

1. Southwestern Nova Scotia: We have magnetic data which are at variance with mapped geology. If too much overburden is present, the Nova Scotia Government might agree to diamond drilling anomalous areas covered by drift. Dr. Boyle reports there is a possibility of Sn and Mo in pegmatites associated with local granite bodies. In this area geochemistry, geology and geophysics could be correlated, including collection of oriented granite samples for palaeomagnetic study.

2. Grenville: Study of special magnetic anomalies which are not explained by present mapping. Study of orientation of remanent magnetization in the youngest of the Grenville rocks to see if their directions are similar to the Keweenawan.

3. Checking rock types in the Chibougamau to Val D'Cr areas for correlation in 4-mile aeromagnetic work.

AEROMAGNETIC COMPILATION

By Edward E. Ready

The arrival of the New Year found the compilation section well on its way to completing half of the 1956 Manitoba Project. Base maps made from uncontrolled mosaics were used for the western portion of the project due to inaccuracy of those available. These base maps later proved to be just as inaccurate due to errors in photographic reproduction and the drawing of projection lines. These errors also made it quite difficult to tie into the adjoining 1957 area which was in progress at this time. Due to the pressure to complete the 1956 Manitoba project, 1955 Northwest Territories was previously set aside after being seventy-five per cent completed. Compilation was resumed around the end of February. Four sheets flown in 1953 in the northeast corner of Alberta were also in progress. Work on these four projects was carried on into February when compilation of the southern half of the 1950 Northwest Territories Buffalo Lake area was resumed. This area lay dormant for several years while waiting for decent base map coverage. Again our only alternative was to plot on uncontrolled mosaics and transfer the flight lines to a blow-up of an eight mile map. This worked out fairly well and tied into the northern half of the area without too much trouble.

The middle of February saw the arrival of the airborne compiler after weeks of trials and tests at Computing Devices of Canada. This machine when given a fair trial, should speed up production by at least four times. It combines four steps into one when transcribing data from chart to map and it also excels in transferring film crossings to the chart. Minor maintenance and unfamiliarity with the compiler slowed progress at first but lately it has been idle due to the lack of accurate base maps for the 1957 Manitoba area. Progress continued on all areas through the month of March, except 1956 Manitoba.

The end of March initiated the compilation of 2 miles = 1 inch Decca maps for the Bay of Fundy area. This involved a tedious process of plotting Decca Navigational lanes from tables received from Hydrographic Survey. Great pains were taken to plot these lanes accurately but again inaccurate maps with regard to projections and detailed topographic features caused the scrapping of the two mile maps, after checking some of the records from the field. The whole area was later replotted on a scale of 1:50,000 maps with more satisfying results. This scale should also serve much better for interpretation work. After the two mile maps for the Bay of Fundy were completed, similar maps were compiled for the Gulf of St. Lawrence in time for the first of August, when the field crew were scheduled to start flying that area.

The 1955 Northwest project was carried through from March until completed at the end of July. Manitoba 1956 was worked on until completed in November. Manitoba 1957 progressed until the end of June when pressure from other projects and the lack of accurate maps caused

its lay-away. Northwest Territories 1950 was continued through May and June, lay dormant until the end of August but was resumed through November and is still in progress.

As sufficient records were received from the field, New Brunswick, Nova Scotia and the Bay of Fundy projects began to take shape during the month of July and are still being compiled. The joyful part of the Maritime Provinces area is that it is ninety-nine per cent covered by published maps.

Since New Brunswick 1956 is almost completely surrounded by 1958 flying, it was decided to put out a revised edition of the 1956 area due to badly positioned base lines, inaccurate plotting and the great change in contouring to make the two areas tie in properly. Also other errors were corrected in the process, so the revision of this project is certainly not a wasted effort.

The Moisie River Area was obtained from Jalore Mining Company during the summer. Along with all flight records we received uncontrolled mosaics with the flight lines already plotted. These flight lines are now being transferred to 1 mile = 1 inch blue line maps on which we will compile the information.

Approximately eighty-five contoured sheets will have been submitted to the drafting room for publication by the end of December 1958, It is hoped that this number may be increased to an average of ten sheets a month during the next calendar year.

Regarding general recommendations for the future, it is likely that the method of compilation will remain the same under similar circumstances. It is recommended that we do not employ summer students because of the length of time it takes to familiarize them with the compilation routine and constant supervision they require. Instead, it is suggested that three more employees be hired to the permanent staff.

The major difficulty in compilation has been the lack of large scale accurate map coverage for areas flown, except of course for 1958. With good maps, better flight coverage and faster plotting will result. Other minor difficulties might be overcome if a closer liaison between field crew and compilation staff could be maintained. Maybe when we are all under one roof, everyone will have a better opportunity to see "how the other half lives".

AEROMAGNETIC INTERPRETATION

By Margaret Bower

During the year 1958, further work has been done in the interpretation of aeromagnetic maps.

In the Saint John, New Brunswick test area, both the methods of second derivatives and downward continuation were applied, and the results compared.

The flights made across the Rocky Mountains from Lethbridge to Vancouver Island were correlated with the known geology.

In May, a major project was commenced in conjunction with the University of Alberta to interpret the results of the large area of Northern Alberta which has been covered by the airborne magnetometer. The purpose of this project was to explore the Precambrian basement by various geophysical means. The availability of a digital computer made it possible to use new methods of interpretation which formerly could not be attempted. Depth calculations and recent well drilling information helped to determine more accurately the Precambrian basement contours. In addition, certain apparent structural features in the basement show a definite correlation with known structure in exposed basement areas to the northeast. A report on this project has been prepared by Dr. Garland of the University of Alberta, and will be given at the Fifth World Petroleum Congress next spring. A copy of this paper is attached.

It is thought that the methods used in the Alberta project may be useful in other places, particularly in the Continental Shelf area in the Maritimes, which was recently flown.

Summer Work at Dept. of Physics, University of British Columbia

By D.H. Hall

1. Interpretation and research on quantitative methods of interprtation of aeromagnetic maps, and on applications of this, combined with photo-geology, to two test areas.

2. The areas: (a) Texada Island, B.C. (b) 73-N, O, J, Northern Saskatchewan (See accompanying sketch map)

3. Procedure adopted: (Texada Island)

On Texada Island, the 1/2 mile/inch aeromagnetic map AM-57-3, issued by the British Columbia Department of Mines, as well as the original tapes and flight records (borrowed from the B.C. Dept. of Mines) were used; magnetic trends were separated out, graded according to magnitude and plotted on a separate map. These were correlated with the fracture pattern observed on stereoscopic study of aerial photographs of the area, and appeared to reveal interesting information on faulting on the island. Quantitative calculations from the anomalies, of amount of throw and type of polarization along some of the fault zones were made, and the whole interpretation was compared with known geology and location of ore deposits from information supplied by the Department of Mines.

4. Major results of the study: (Texada Island)

This was a test both of the ability of aeromagnetic surveys in revealing geological information and of the ability of aeromagnetic surveys to give results in mountainous areas. The consistency of the results shows that the survey was successful on both these counts. The faulting pattern revealed by the airphoto-aeromagnetic trend analysis combination, and confirmed by quantitative calculations, is tentatively outlined as a result of the summer's work.

5. Recommendations for future work: (Texada Island)

The indications, at the stage the work was carried to, are that a major faulting pattern is revealed in the magnetic results, and that the movements on it are such that if confirmed, would have important bearing on predicting extensions of the magnetite-bearing zones of the northern part of the island. If sufficient ground work were done--perhaps by other methods: electromagnetic, gravity, and ground magnetometer--to confirm and suggest new ideas about one part of the aeromagnetic interpretation--the whole interpretation could be very much strengthened, and possibly produce an excellent case history for aeromagnetic interpretation, as well as provide geologically important information about this area which is important economically to B.C. Texada is a good test area in many ways, also for testing the use of topographic corrections. The relief is high (up to 2,000 feet), but not too high, and is well mapped, and a good many of the mountains are composed of highly polarized formations. The chart method of Henderson and Zietz (Geophysics V. 22, 1957) might be applied, and the equations I have developed for my thesis might be used to extend these charts to cover possible anomalous directions of polarization.

6. Procedure adopted (Saskatchewan area):

This area was chosen because in an earlier study of the structure of the Precambrian north and east of this area, which I did in 1950 (Master's thesis, University of Toronto), certain interesting structural trends were found to disappear beneath the Palaeozoic cover in the general vicinity of the area studied this summer. When the magnetics for the area became available after that time, it appeared worthwhile to resume structural research in the area, using the magnetics to extend these trends beneath the Palaeozoics. Magnetic trends were carefully analyzed and taken off the aeromagnetic maps on to overlays, and a qualitative division made dividing these into zones of differing magnetic properties. As these showed great similarity to the trends observed on the photos over the Precambrian part, work was begun with new vertical photos to fill in the trends in the Precambrian between the point where there was a gap in the 1950 work, and where the aeromagnetic maps overlap into the Shield. Quantitative reductions of some anomalies was begun in order to determine the magnetic properties of some of these zones.

7. Major results of the study: (Saskatchewan area)

A preliminary plot of magnetic trends and suggested displacements of these was made for the area. Airphoto study of the fracturing pattern in the adjacent Precambrian was begun, to link up the magnetic trends to the airphoto

trends plotted over a larger area (up to Reindeer Lake) in 1950, and the initial stage of quantitative calculation to determine magnetic properties from the anomalies was begun.

8. Recommendations for future work: (Saskatchewan area)

The identification of these trends would contribute to geological knowledge in Saskatchewan, and add to knowledge about the ability of aeromagnetics to reflect geological conditions. Completion of the airphoto study (being done here this winter - in rough form at least) would be very important, and the further testing of quantitative calculations would also be important. My thesis work indicates that direction of polarization as well as depth, average polarization, etc., of rocks can be found from the aeromagnetic anomalies. This confirms previous work in Australia (Sutton and Mumme, Australian Journal of Physics, 1957) and in Russia (Mikov, 1953). The anomalies of this area are well suited for this type of analysis. (This is about the point to which my quantitative work got this year - I have no definite results on this yet). If Dr. Garland's (and Miss Bower's) trials of determining regional base level are successful, this type of analysis would provide data on which the polarization calculations could be done with great accuracy, and the area would be a worth while test area for this.

PALAEOMAGNETIC INVESTIGATIONS

By P.M. Du Bois

About two hundred samples were collected from the Lake Superior region for palaeomagnetic measurements. The results for these rocks are now complete and reveal some interesting features. The Logan sills were found to be reversely polarized with steep upward dips, while many of the diabase dykes which are petrologically very similar to the sills are normally polarized with moderate dips to the west. Certain of the dykes are known to cut some of the sills and therefore are younger than the sills. The magnetization of the dykes is very similar to that of the Keweenawan lavas of northern Michigan, and the two formations are very probably contemporaneous.

Samples were also collected from the Duluth gabbro, and its magnetization was found to be close to that of the lavas.

The lavas at Mamainse Point, north of Sault Ste. Marie, also have a magnetization identical to that of the Michigan lavas, but lavas from nearby Alona Bay were found to be reversely magnetized and to give a pole position not significantly different from that of the Logan sills. Therefore, there is the possibility of the existence of two separate periods of igneous activity both characterized by extrusion and intrusion in the Lake Superior basin.

The sandstones of the St. Mary's river valley have a magnetization similar to some Upper Keweenawan sandstones of Wisconsin and Michigan and probably should be correlated with them rather than with the Lower Cambrian.

Another 200 samples were collected from the Devonian, Carboniferous and Triassic of New Brunswick, Gaspe Peninsula and Nova Scotia. These samples have not been measured yet.

About 20 samples from the Grenville province of Ontario and Quebec have been measured. They are generally reversely polarized and cause strong and sharp negative aeromagnetic anomalies. They give a pole position quite close to those measured for the Upper Keweenawan. Therefore, if the reversely polarized gneisses, syenite gneisses and pyroxenites were magnetized during the last Grenville orogeny, which has been well dated at 1050 m.y., the Upper Keweenawan would have been laid down at about the same time. This is a satisfactory conclusion since the Middle Keweenawan has recently been dated at 1120 m.y.

Pole positions have now been obtained for a period of late Precambrian time running from 800 to 1300 million years approximately. The gap, however, between the very latest Keweenawan and the Lower Cambrian should be sampled. The problem is to know where rocks, which could fill in this gap, are to be found, but it is possible that the post-Grenville intrusions would be useful, and it is here suggested that they should be sampled in the future.

MAGNETIC ROCK PROPERTY AND PALAEOMAGNETIC INVESTIGATIONS

By Andre Larochelle

Since the beginning of this fiscal year, I have completed the building, preliminary testing and calibration of a Curie Point meter. This instrument was constructed for the purpose of investigating the cause of reverse magnetic polarization of oriented rock specimens from Yamaska and Brome mountains in the Eastern Townships. The Curie points of some of the above specimens were determined.

The soft component of magnetization of the above specimens was partly removed by means of an alternating magnetic field, the specimens lying in a constant field equal but opposite to the ambient earth's field. After this operation, referred to as "Magnetic Washing", the magnetizations were remeasured and the operation was repeated until no change in magnetization resulted from it. The final result was that from an original scatter in the magnetization directions of the Yamaska and Brome rocks, a reasonable clustering was achieved. A statistical analysis of the magnetization directions was done and the results were interpreted from a palaeomagnetic point of view by comparing the mean directions of magnetization of these rocks and that of dated rocks from other places in North America. An account of this work is now completed in the form of a thesis and it is planned to summarize the latter into the form of a bulletin or paper.

Recommendations for Future Work

Future plans are to continue with this type of work on specimens of anorthosite bearing hematite and ilmenite. For this study it might be desirable to construct other pieces of equipment such as a coercimeter, a

saturation magnetometer, a thermomagnetic separator and possibly other types of magnetic washing apparata. Another project would be the sampling of some granite batholiths (known to be magnetic) from the Eastern Townships. Age determinations of these have been made by Dr. R.K. Wanless of this Survey. It would be interesting to compare age estimates obtained from the magnetization data with the data obtained by radiogenic methods. If interesting results come out of this work, it might be advisable to extend it later to other intrusive rocks from other parts of the country. Finally, it is hoped that sometime in the future, the results obtained by the magnetic properties measuring devices be correlated with chemical analyses, X-ray work and other tools used in the mineralogy laboratory. It is too early yet to design a long range program of research in those lines but there is certainly a minimum of two years' work in the fulfilment of the above mentioned projects.

MAGNETIC RESONANCE INVESTIGATIONS

By H. Wesemeyer

I started to work for the Geological Survey in March 1958 with a general study on possible applications of magnetic resonances to geology.

OP 146 - For the office project OP 146, "development of magnetic resonance apparatus for laboratory chemical analysis", preliminary studies and tests were carried out on several rock samples. An extensive theoretical study of the subject was required because of the complexity of the magnetic resonance phenomenon in rocks. On account of the difficulties involved in this project a trip was made to competent research organizations in the United States to gather information (See report on this trip May 5-13, 1958).

For the simplification of this report magnetic resonances are classified into two main regions, namely: I - electronic paramagnetic resonance; and II - nuclear magnetic resonance.

I - The method of electronic paramagnetic resonance has been successfully tested on several rock samples (See the report: "Preliminary report on paramagnetic resonances in rocks", 28 August 1958). This method is good for the detection of traces of paramagnetic ions in rocks and soils and thus should be of use in geochemical problems.

II - The method of nuclear magnetic resonance should be good for the detection of elements which are present in rocks in a larger than 'trace' concentrations. Since a suitable spectrograph for nuclear magnetic resonances to carry out experiments was not available in Ottawa, it was decided to build a simple spectrometer of good average sensitivity. Equipment available in the University of Ottawa was used for the construction. On this spectrometer some experiments were made on samples of known composition. These tests, although not yet carried out on rock samples, indicate that the method is feasible for the detection of elements.

It is planned to build a very sensitive nuclear magnetic resonance spectrometer as well as a very sensitive paramagnetic resonance spectrometer.

CP 157 - My work on CP 146 was soon interrupted (August '58) by a classified project CP 157 which occupied myself entirely till the end of this year.

OP 147 - "Electron spin resonance at very low fields". Here only theoretical studies have been done and a part of their results are being used in the classified project CP 157.

Future work in 1959:

The work on CP 157 will take preference over all other projects.

The preliminary work on CP 147 will proceed parallel to CP 157.

CP 146 - The construction of a very sensitive paramagnetic resonance spectrometer is planned. Tests on rock samples will continue.

On the nuclear magnetic resonance spectrometer at the University of Ottawa further experiments will be done.

Preliminary Report on Paramagnetic Resonances in Rock Samples

Introduction:

Paramagnetic resonance is a very sensitive method of detecting paramagnetic ions, i.e. ions of elements belonging to a transition group in the Periodic Table. Paramagnetic resonance can differentiate between different kinds of ions and also allows the determination of the concentration of detected paramagnetic ions in a sample.

However, an analysis by means of paramagnetic resonance is not quite as straight forward as one may think. The observed paramagnetic resonance spectrum from rocks and soils which usually contain many different kinds of paramagnetic ions, ferromagnetic and anti-ferromagnetic domains, can be complicated in structure and numerous in resonance lines. Moreover, due to the influence of the crystalline electric field, the positions of these lines in magnetic field depend strongly on the crystal structure and on the relative orientation of the crystal axes to the external magnetic field. Line shapes and positions will be different for single crystals and for polycrystalline samples like rocks.

Fortunately, the hyperfine structure of the spectrum of a paramagnetic ion depends very little on the crystalline electric field and perturbations arising from this are of second and higher order. Roughly speaking, the hyperfine structure of the spectrum of a paramagnetic ion is to a first approximation independent of the crystal structure of the sample and is a "label" of this ion. It is relatively easy to pick out the hyperfine structure in a spectrum of a paramagnetic ion as test experiments on rock samples have shown.

The hyperfine structure of the spectra of some ions of the iron group will now be described here:

Mn++, (Mn^{55}) nuclear spin I = 5/2, shows for any fine structure line an isotropic splitting into 6 hyperfine components which are equally spaced and are of almost equal intensity. Between these 6 lines there are weak components of an anisotropic hyperfine splitting which depend on the various orientations of crystallites with respect to the external magnetic field. Mn++ can be detected at room temperature.

Cu++ (Cu^{63}, Cu^{65}), nuclear spin I = 3/2, shows 4 equally spaced and equally intense hyperfine lines. The spacings and ratios of intensities are sometimes disturbed by second order effects from the nuclear electric quadrupole moment, which effect will decrease at a shorter wave length than 3 cm. of the microwave radiation. In spite of the second order effects, the hyperfine splitting here is still a characteristic indicator of Cu++. Cu++ can be detected at room temperature.

Co++ (Co^{59}), nuclear spin I = 7/2, shows eight equally spaced and equally intense hyperfine structure lines. Co++ can only be detected below 77°K.

V++ (V^{51}), nuclear spin I = 7/2, also shows eight lines, but these are of different intensity, the centre lines being four times as intense as the outer ones. This phenomenon is due to the fact that the hyperfine interaction is almost as strong as the spin-orbit coupling in the paramagnetic ion. The complexity of this spectrum is so characteristic that it can be used as an indicator for V++. V++ can be detected at room temperature.

Further investigations will follow, whether the fine structure of the spectrum is sufficient enough to detect certain ions. There are, for instance, Gd+++, Eu++, and Mo+++++ which can easily be detected at room temperature. Most of the paramagnetic ions can only be detected at temperatures below the temperature of liquid air.

Tests on Rock Samples

In order to investigate the feasibility of paramagnetic resonance technique for detection of traces of paramagnetic elements in rocks, several different rock samples have been tested. The samples were selected for traces of Mn and shaped into a convenient size to fit into a microwave cavity resonator. Then they were sent to the California Research Corporation who offered to run them through their paramagnetic resonance spectrograph which has only a medium sensitivity. The samples were cylinders of 7 mm. diameter and 25 mm. length.

The following table shows the tested samples, their approximate abundance in Mn (as far as a chemical analysis can tell), whether a signal from Mn has been detected and the signal to noise ratio. Paramagnetic resonance can only detect Mn++. If Mn is not in this valency, the detection method fails.

Sample	Concentration of Mn	Detected Mn++	Signal to Noise Ratio
Porphyry	0.02%	Yes	60/1
Gabbro	0.1%	No	---
Pink Marble (Tate Georgia)	low(1%)	Yes	50/1
Reddish granite	0.04%	No	---
Colitic limestone	low	Yes	80/1
Brown sandstone	low	Yes	50/1
$CaCO_3$ crystal	low	Yes	100/1

The detected signals are recorded on a chart and can be inspected any time in my office in the Auditorium Building. The records, which are ozalids sent from the California Research Corporation, are so pale that they cannot be copied a second time.

In case of porphyry, where the approximate concentration of Mn++ is known, we can optimistically conclude that two parts in 10^5 can be detected. If a double modulation high sensitivity spectrograph were used, less than two parts in 10^6 could be detected.

More tests will be carried out and a report on them will follow in the near future.

Preparations have been made to use nuclear magnetic resonance techniques for chemical analysis too. A report on experiments with nuclear magnetic resonances will soon be written.

Report on Trip to United States

The purpose of my trip to the United States, May 5-13, was to learn the latest developments in magnetic resonance techniques which are to be used for the Geological Survey.

I met the following persons:

Prof. Dr. M. Bloom	University of British Columbia, Vancouver
Prof. Dr. Uehling Mr. H. Mahon Prof. Dr. H.G. Dehmelt	University of Washington, Seattle
Prof. Dr. G.E. Pake Prof. Dr. Herzog Mr. C. Greeve	Stanford University, Palo Alto

Dr. M. Packard
Dr. H.E. Weaver
Mr. R. Rempel — Varian Associates, Palo Alto

Dr. R.R. Unterberger — California Research Corporation, La Habra, Calif.

The results of the discussions are classified into the following subjects:

1) Rock analysis by means of nuclear magnetic resonance and high sensitive nuclear magnetic resonance techniques.

2) Rock analysis by means of paramagnetic resonance technique and high sensitive paramagnetic resonance techniques.

3) Miscellanies

4) Magnetometry at very low fields

1) Rock analysis by means of n.m.r. and high sensitive n.m.r. techniques

The matter was discussed with Prof. Dr. Uehling, Prof. Dr. M. Bloom, Mr. H. Mahon, Dr. Unterberger, Prof. Dr. G.E. Pake, Dr. Herzog, and Dr. M. Packard. Relaxation processes in n.m.r. and the role they play in polycrystalline rocks on the signal strength of n.m.r. were considered. The relaxation processes mainly depend on the distributed paramagnetic impurities in the samples and consequently for each particular resonance signal an optimum power level of the radio frequency radiation has to be used.

We found that the sensitive Pound-Knight spectrometer which is only fairly sensitive under optimum load and optimum r.f. power level, is not able to handle various power levels as required for my problems. The so-called "crossed-coil" spectrometer, developed by Bloch and Hansen, is suitable to handle almost any power level and also offers a high sensitivity over a wide range of r.f. power levels.

In most geochemical problems only traces of elements, say concentrations below 1 per cent, are of interest. This necessitates the development of an extremely sensitive n.m.r. spectrometer.

Dr. H.E. Weaver from the Varian Associates has developed such a sensitive "crossed-coil" spectrometer, which utilizes two paddles for the compensation of the magnetic leakage field between the coils. He recommends a tuned cascoded preamplifier following the pick-up coil. I could inspect his crossed-coil probe which is now on the market.

No detailed analysis of rock samples was available, because nobody seemed to have been much interested in it.

I left some cylindrically shaped rock samples which were especially selected for certain concentrations of certain elements, with Prof. M. Bloom at U.B.C. for investigation by means of n.m.r.

2) Rock analysis by means of e.p.r. (electron paramagnetic resonance)

This method is by a factor 1000 more sensitive than n.m.r. and has widely been applied in detecting elements of the transition groups when in the paramagnetic state. Dr. Unterberger of the California Research Corporation showed me his spectra charts of several rock samples which he has investigated in his e.p.r. machine. On those charts, traces of paramagnetic ions are detected with a good signal to noise ratio. He supplied me with copies of those charts, and also offered to run my samples through his machine until my machine is in operation. He is mainly interested in the detection of transition group ions and free radicals in crude oil. He operates a fairly simple X-band bridge type spectrometer with low frequence magnetic sweep and narrow band operation.

With Mr. R. Rempel of the Varian Associates, I discussed the advantages of high magnetic field modulation in e.p.r. and his investigations of an optimum modulation frequency. He found the latter to be 100 k/cycles. Various other problems as for instance induced microphonics into the waveguide system at this modulation were pointed out, and mechanical means were considered to avoid vibrations of the walls of the cavity resonator.

3) Miscellanies

Dr. Bell of the Varian Associates has carried out some research on the magnetic absorption of radio frequencey power between 1 and 5 M/cycles. Characteristic absorption curves via an a.c. magnetic field were found for each kind of rock. The absorption curves are reproducible in their shape for the same kind of rock even if from different sources, and thus could be used in field work for quick identification of samples. Research on this subject is going on, and its physics is not yet properly understood. The Department of Geophysics of Stanford University has also started to work in this field (Mr. G. Greeve).

4. Magnetometry at very low fields

A discussion with Dr. Dehmelt, Associate Professor of Physics at the University of Washington in Seattle, showed that it is feasible to use the electron-spin resonance for measuring the earth's magnetic field.

The problem of obtaining a narrow electron paramagnetic resonance line was solved by creating an electron paramagnetic system with long relaxation times. Dr. Dehmelt uses the spins of unpaired valence electrons of alkaline metals for the orientation of the alkaline atoms. They are aligned in the earth's magnetic field simply by optical pumping, i.e. by using circularly polarized radiation of the correct frequency of the visible light to excite the atoms into a substate of the Zeeman levels. At right angles to the earth's field a magnetic radio frequency radiation of the correct frequency to

cause allowed transitions between the sublevels, i.e, paramagnetic resonance, is applied which distrubs the orientation of the atoms causing a decrease of the intensity of the transmitted pumping radiation through the vapor. The frequency of the paramagnetic resonance is linearly dependent on the earth's magnetic field.

This optical detection of magnetic resonance, being essentially a spectroscopic method, is suitable for continuous operation, and can be used for measuring the earth's magnetic field to an accuracy of about 1 in 50,000.

When I met Dr. Dehmelt he was carrying out an experiment with Rb-vapor in a different fashion than the method mentioned above. He polarized thermal electrons by exchange collisions with orientated Rb-atoms which in turn were polarized by optical pumping. The gyromagnetic spin resonance of the electrons causes an additional intensity modulation on the pumping radiation whose detection allowed a determination of the Lande factor of a free electron spin.

Use of Nuclear spin relaxation times

According to Dr. Unterberger, the proton spin relaxation times can be used for the detection of petroleum and differentiation between different kinds of oils and water. From the decay times of the signals of free precessing protons in the earth's magnetic field the relaxation times can be calculated.

GAMMA RADIATION SURVEY TECHNIQUES

By A.F. Gregory

Since joining the Geophysics Division in September 1958, the writer has been investigating the potential use of airborne scintillation counters in assisting geological mapping.

Total flux data gathered in the combined aeromagnetic and aeroradiometric surveys in the Arctic Archipelago were analysed. A regional interpretation technique was developed which allows extrapolation of known geology under conditions of favourable activity contrast. The data suggest that analysis of energy spectra would provide more useful information than total flux measurements alone and such data might allow definition of source character.

A paper on this interpretation has been completed and the manuscript is in preparation.

Future investigations which might be considered include:

1. A laboratory study of the source emission spectra as modified by self-attenuation and relative proportions of radioelements in the source. "In situ" source spectra determinations may be feasible and might be useful in stratigraphic correlation.

2. A controlled study of the energy spectra with increasing multiple scatter for the three important natural spectra (Ra, Th and K_{40}).

3. A study of the changes in diurnal atmospheric and cosmic gamma flux.

4. Application of above studies to natural source and actual survey conditions.

GEOLOGICAL CARTOGRAPHY

A.E. Hale, Superintendant of Cartography

Maps prepared by the Geological Cartography Unit and published during the year comprised 18 multicoloured geological maps (including 3 reprints), 27 maps of the preliminary geological series, 88 blue-line maps of the aeromagnetic series, and 5 maps to accompany water supply papers. In addition, 188 maps and scientific figure drawings were drafted for reproduction by photolithography or by zinc-cut process for illustrating memoirs, bulletins, reports, and papers. (For complete list of maps published see Departmental Annual Report).

Miscellaneous drafting consisted of 62 items comprising 236 pieces, including drafting figure illustrations for scientific papers, colouring lantern slides, map-mounting, and other general drafting services.

At the end of the year, 1 multicoloured geological map and 2 figure illustrations were in the hands of the Queen's Printer for lithography; 2 multicoloured geological maps, 1 preliminary geological map, and 3 figure illustrations were at the Surveys and Mapping Branch for printing. Work was in progress on 18 multicoloured geological maps, 10 maps of the preliminary geological series, 13 maps of the aeromagnetic series, and 56 figure illustrations.

The following reproduction process work was completed.

Mapping camera

Film negatives (up to 30" x 30")	1,970

Contact processes

Films	729
Sensitized linen prints	106

Ferro-prussiate blue-line impressions	262
Vandyke prints	3,517
Copyflex prints	3,369
Blue-line map prints	54,716
Photostat impressions	8,047
Mimeograph impressions	990,849

Negative retouching

Film negatives	355
Paper negatives	90

Typesetting

Map names, were set-up and printed for all maps and figure illustrations being drafted. Postcards, envelopes etc. printed totalled 302,800 impressions of 74 items.

In 1958 the staff was increased by the addition of one Draftsman Grade 3, one Draftsman Grade 1, two Student Draftsmen, one Junior Office Equipment Operator, and one Clerk Grade 3. One Litho Learner resigned.

The present strength of the Unit is fifty-one (51) including two vacant positions.

During the year a concentrated effort was made to reduce the backlog of final geological maps, as indicated by the work progress statistics. Preliminary geological maps and aeromagnetic maps were given immediate attention on being received in the Unit. A start was made on the reorganization of the geological manuscript filing system. Considerable time was spent in planning the Unit's requirements of accommodation and equipment in the new building. The new 40" x 48" mapping camera has been received and is awaiting installation. Discussions were carried on with officers of the Department of Public Printing and Stationery relative to the setting up of a departmental printing unit in the new Geological Survey Building. Under this plan priority will be given to the printing of multicoloured figure illustrations for Geological Survey memoirs, bulletins, and reports.

The drafting of final geological maps by an outside firm was introduced on a trial basis with the letting of a contract for production of the Victoria-Vancouver eight-mile sheet, still in progress.

ADMINISTRATIVE SERVICES

STATISTICAL REPORT OF THE LIBRARY OF THE GEOLOGICAL SURVEY OF CANADA

Miss N.I. Wills, Librarian

Acquisitions

Books and pamphlets acquired by purchase	489
Canadian periodicals	1565
Canadian government publications	4010
British and foreign government publications	3642
Proceedings, transactions and bulletins of societies	4093
British and foreign periodicals	8302
Total	22,901

Other data

Periodicals and annuals subscriptions	365
Recorded loans, books, pamphlets and periodicals	37896
Interlibrary and occasional loans	3941
Publications borrowed from other libraries	656
Maps and charts received before sorting for disposal	3423
Maps and charts loaned	522
Cards added to general catalogue	22751
Cards added to map catalogue	385
Volumes accessioned	1294
Letters and cards received	4614
Letters and cards sent (including a large percentage of overdues)	8561
Items catalogued including books, pamphlets, microfilms, monographs and analytical entries	5287
Volumes bound	600

STATISTICAL REPORT OF DISTRIBUTION OFFICE

by L.B. Leafloor

Requests for publications received	18,118
Acknowledgements	6,570
Publications sent out in compliance with personal and written requests	134,830
Visitors	669

During the year we received and made available for distribution:-

Memoirs	6
Economic Geology Series	1
Geological Survey Bulletins	7
Paper Series	10
Geological Maps (final)	8
Mineral Oil maps	3
Metallogenic Maps	2
Preliminary Maps	17
Aeromagnetic Maps	88
Special Reports	3
Annual Report	1
Water Supply Paper	4

PHOTOGRAPHIC SECTION

by E.C. Elliott

As the Survey expands into its numerous fields, it becomes necessary for the Photographic Section to develop new methods and techniques to procure the necessary photographs for illustrations and study purposes.

In the past year we have had to branch out into the micro fossil field. This study proved to be a problem for, under the existing equipment that we had, it was impossible for us to produce photographic prints of good quality. After visiting different photographic units in the City and trying out their equipment with no appreciable results, it was requested that I be permitted to attend a one day meeting of scientific photographers held in Albandy, New York. This problem was discussed at some length there, but the results were negligible. From reviewing a new type of illumination and camera on display at the meeting, I decided, upon my return, to do some further experiments. The results were quite startling, so the necessary illumination and camera were purchased and another problem had been solved.

Time was granted to me to attend the Biological Photographers Association meeting held in Washington D.C. The thought behind this request was to have an opportunity of attending a scientific photographic meeting and also to visit the Geological Survey. The visit to the survey proved quite disappointing as they are not under one central grouping like we are. The photographers work as individuals for a small group of scientists, and as a result, they are more or less individualists in a very narrow field, also, the equipment, with the exception of the map reproduction unit, is very antiquated and, as a result the work has to suffer.

It was my good fortune to have been invited out to the Walter Reed Research Development to visit their different photographic units. Here a very modern set of scientific photographic units are in operation which are similar to our own organization where every unit works in a variety of scientific fields in one particular branch of science, namely, medical, biology, nuclear physics, etc.

From this visit I gained a vast knowledge of modern equipment, as the people that I met were very cooperative and helpful in answering and discussing the merits and faults of the different pieces of equipment and materials. This visit alone was of value because it changed my thinking on a number of items of equipment both in the saving of money, and adaptability for our own work.

This year with the addition of Decca to the airborne magnetometer it added more work and responsibility to the photographer in the field. A 16 m.m. movie camera was installed in the air craft to photograph the deccaometers at intervals. This necessitated him to work extra long hours at times, as there was one third more film processed this year than in previous years.

With the addition of colour film supplied to the field parties, it has now become necessary for us to make a certain number of colour duplicates from transparencies under very adverse working conditions as we are not equipped

at present with water temperature controls, which is a must for proper colour tone reproductions. This unfavourable condition will be overcome with the move to the new building, it will also be necessary to purchase a 35 m.m. film camera to do this type of work.

This past summer a move was made from room no. 28 to room no. 8 of one of our dark rooms. This held up part of our printing production more than three months, and as a consequence, there is a back log of work in this particular branch.

In all other branches of our work we have been going forward and I am very happy to report that at the end of the year we will be able to show a substantial increase in work production.

RESEARCH GRANTS TO CANADIAN UNIVERSITIES 1958-59

by J.F. Henderson

Grants-in-aid from funds provided by Parliament for the support and stimulation of geological research in Canadian universities totalled $50,000 in 1958, an increase of $10,000 over 1957. The grants were made to ten universities in support of twenty-five research projects. These grants are awarded with the advice of the National Advisory Committee on Research in the Geological Sciences. For the amounts of the individual grants and descriptions of the projects they support, the reader is referred to the Eighth Annual Report of the National Advisory Committee on Research in the Geological Sciences 1957-58, Appendices I and II.

Thirty-eight research projects in twelve universities are currently (December, 1958) being supported; thirty other projects have been completed. Since 1951 when the grants were initiated more than seventy papers have been published in scientific journals recording the results from projects supported by the grants.

Grants-in-aid were first provided in 1951 on the recommendation of the National Advisory Committee on Research in the Geological Sciences. At that time the universities were doing little geological research of any kind mainly because they had neither the necessary equipment, the graduate students, nor the technical assistants to carry it out. Most graduates in geology wishing to carry on graduate work to the doctorate level went to universities in the United States. In 1951 when the grants were initiated $10,000 was provided and that year there were just about enough worthwhile applications to use this sum of money, - a testimony to the insignificant amount of research then being carried on. But each year the number of applications has increased and at the same time the quality and excellence of the projects have improved. In the current year (1958) with $50,000 provided, there were forty applications requesting almost $100,000 and most of the projects were well worth supporting. The best that could be done

with the money available was to support twenty-five of the forty--most in only part of the amount asked for. Because a number of worthwhile projects could not be supported at all and grants for others were reduced to much below the amounts requested, the National Advisory Committee on Research in the Geological Sciences on the basis of whose recommendations the grants are awarded, has asked that the amount provided be increased in 1959 to $75,000 (since reduced to $50,000 by Treasury Board).

There can be little doubt that the grants are accomplishing their purpose in stimulating and improving the quality of geological research in our universities. Not only have they helped to provide much needed equipment, but they have enabled the more brilliant students to pursue their graduate studies and research in Canada rather than in the United States. Doubtless also, by providing a more attractive and stimulating environment for the professorial staffs of our universities, they are helping to keep the better research men from seeking more remunerative occupations in industry, or in universities in the United States.

At the same time increased opportunities and facilities for research are attracting additional support from other sources. Thus at Queen's University the Department of Geological Sciences has received a grant of $20,000 from the Atkinson Charitable Foundation for the purchase of mineralogical equipment. The technical assistants to operate the equipment are being provided in part by our grants-in aid. A research project in geochemical prospecting at McGill University has been supported to the extent of $10,000 by a mining company; the original research on this project was supported by our grants. Likewise at the University of British Columbia research in biogeochemical prospecting, supported by our grants, has received substantial additional financial help from mining companies, and one technique developed by this research has been given direct credit for the discovery of a large copper orebody in British Columbia. A project initiated this year at the University of Manitoba on the distribution of certain metals in silicate and sulphide phases is being supported in nearly equal financial part by a mining company. At the University of Toronto, research on the determination of the age of minerals, which has been supported by our grants since 1951, received in 1957 a grant of $15,000 from a mining company. The University of Alberta, in 1955 initiated research on methods of determining the age of rocks with the support of our grants. The University has recently received a grant of $20,000 from the National Research Council for the construction of a mass spectrometer to be used jointly for research by the Department of Geology on this project and by the Department of Physics.

It has been and will continue to be the role of the universities to pioneer new and less tried fields of research. Effective research results mainly from personal ingenuity. For this reason it is desirable that many people with different viewpoints and considerable freedom work on fundamental problems, rather than a few under centralized control. Support of geological research in our universities offers a means of attaining this end. From our university laboratories will originate many of the new techniques to serve in the increasingly difficult search for, and utilization of our mineral deposits. It is therefore most important that such university research, until recently largely neglected in the geological sciences in Canada, be fostered and encouraged by means such as our grants-in-aid.

APPENDIX I

Geological Survey of Canada

Staff List, December 31, 1958

Director's Office

1 Director
Harrison, J.M.

1 Admin. Off. 5
Daly, W.P.

1 Secretary to Executive
Arscott, Mrs. M.M.

2 Clerk 2
Lemay, Miss M.C.C.
McNabb, Mrs. S.W.A.

2 Clerical Assistants
Jean, Miss R.
O'Connell, Miss I.A.

1 Chief Special Projects
Stockwell, C.H.

1 Chief Geologist
Lord, C.S.

1 Clerk 4
Derry, Miss G.E.

1 Tech. Off. 5
Steeves, S.M.

1 Clerk
Cloutier, M.L.

Geological Manuscripts

1 Sr. Geologist
Rice, H.M.A.

1 Geologist 4
Brown, I.C.

1 Geologist 3
Wright, J.F.

1 Clerk 3
Mahoney, Mrs. L.E.

ADMINISTRATIVE SERVICES

Accounts

1 Admin. Off. 1
Besserer, L.E.

1 Admin. Asst.
Cameron, D.L.

1 Clerk
McNaught, Mrs. M.E.

Files

1 Clerk 3
Gooch, W.B.

1 Clerk
Potvin, Miss L.J.

Geological Information

1 Superv. Clerk
Leafloor, L.H.

1 Clerk 4
Touchette, J.L.

2 Clerk 3
Coutu, F.V.
Phillips, E.A. (Lortie, L.H. Clerk)

2 Clerk
Higgs, Mrs. M.M.
Routhier, J.G.

1 Typist
Lathem, Mrs. L.A.

Stationery & Off. Supplies

1 Clerk 4
Raymond, J.E.

1 Storeman 1
Charlebois, G.J.

Stationery & Off. Supplies (cont'd)

2 Clerk 2
Castle, D.
Henderson, Mrs. V.

1 Labourer
Cayer, H.H.

Library

1 Librarian 5
Wills, Miss N.I.

1 Librarian 3
Shanks, E.R.

1 Librarian 2
Whitney, Mrs. L.E.

1 Clerk 3
Stewart, Miss T.G.

1 Asst. Tech. 3
Fisher, A.

1 Typist
Patterson, Miss E.L.

Photographic

1 Technician 4
Elliott, E.C.

4 Technician 1
Cooke, F.J.
Kempt, J.W.
Stafford, W.G.
Thorpe, E.

2 Assistant Technician 3
Stockill, F.R.
White, Miss J.I.

Stenographic Pool

1 Clerk 4
McKinley, Miss E.M.

1 Clerk 3
Partington, Mrs. G.

Stenographic Pool (cont'd)

2 Typist 3
Casey, Mrs. M.
Thomas, Mrs. F.C.

2 Typist 2
Millar, Miss M.
Shurben, Mrs. P.K.

3 Typist
Blackburn, Miss M.B.
Gavan, Miss J.E.
Kiefl, Miss M.C.

2 Stenographer 2
Matheson, Miss M.A.
Olson, Miss M.E.A.

1 Stenographer
Nugent, Miss G.M.

Lapidary

1 Technician 2
Hay, H.W.

1 Asst. Tech. 3
Whitehead, A.E.

1 Asst. Tech. 2
McEwan, W.O.

1 Asst. Tech. 1
Lacoste, F.

Carpenter Shop

1 Carpenter
Carey, E.L.

GEOLOGICAL CARTOGRAPHY

1 Supt. of Cartography
Hale, A.E.

1 Clerk 3
Nakamoto, Mrs. S.

Map Editing, Work Planning, and Map Revisions

1 Tech. Off. 5
Daughtry, G.S.

1 Tech. Off. 4
Williams, L.A.

Stand. & Prelim. Geol. Maps

1 Super. Dr. 3
Nunn, E.P.

1 Super. Dr. 2
Gardham, F.J.

8 Draft. 3
Bernard, M.
Debain, P.
Dumbrell, E.A.
Edwards, B.
Finn, H.J.
Gagnon, J.G.E.
Leader, R.E.
Rockburne, K.G.

6 Draft. 2
Barbary, G.J.
Daugherty, R.F.
Guibord, J.L.
Howe, K.G.
Mainville, B.
Raddatz, Miss M.A.

Geophysical Maps, Figure Illustrations, Special Projects

1 Super. Dr. 3
McNeil, C.E.

1 Super. Dr. 2
Babcock, L.W.

1 Draft. 3
Smart, A.D.

5 Draft. 2
Eaton, R.C.
Hayne, M.F.
Heyendal, H.A.
Lavigne, G.H.
Walter, D.J.

Geophysical Maps, Figure Illustrations, Special Projects (cont'd)

6 Draft. 1
Hill, R.
King, J.A.
Romhild, R.C.
Tanguay, W.Y.
Thomson, J.W.
White, G.N.

7 Student Draft.
Bartlett, E.G.
Bergeron, J.J.
Cright, D.E.
Desrochers, R.F.
Heney, F.J.
Vermette, W.P.
Whitman, G.S.

Reproduction Processes

1 Tech. 2
Connell, C.

Map Photography

2 Tech. 1
Buck, N.E.
Williams, J.B.F.

1 Asst. Tech. 2
Sidock, K.S.

Printing

2 Asst. (Litho or Photo) 1
Foshay, G.N.
Major, A.C.

2 Jr. Off. Eq. Oper.
Coderre, H.A.
Latreille, G.L.M.

PRECAMBRIAN DIVISION

1 Chief of Division
Fortier, Y.C.

1 Sr. Geologist
Henderson, J.F.

1 Clerk 3
Wragg, Miss C.E.

Eastern Canadian Shield

1 Sr. Geologist
Duffell, S.

3 Geologist 3
Fahrig, W.F.
Frarey, M.J.
Eade, K.E.

1 Geologist 2
Roach, R.A.

2 Tech. Off. 3
Baragar, W.R.A.
Heywood, W.W.

Western Canadian Shield

1 Sr. Geol.
Wright, G.M.

2 Geologist 4
Quinn, H.A.
Tremblay, L.P.

3 Geologist 3
Bell, C.K.
Fraser, J.A.
Taylor, F.C.

1 Geologist 2
Kretz, R.

Arctic Islands

2 Geologist 3
Blackadar, R.G.
Thorsteinsson, R.

1 Geol. 2
Christie, R.L.

2 Tech. Off. 3
Davison, W.L.
Jackson, G.D.

Yellowknife Office

1 Geologist 3
McGlynn, J.C.

1 Clerk
Brennock, Miss P.

POST-PRECAMBRIAN DIVISION

1 Chief of Division
Weeks, L.J.

1 Clerk 3
Paquette, Mrs. A.M.

Cordilleran Region

1 Sr. Geologist
Bostock, H.S.

4 Geologist 4
Leech, G.B.
Little, H.W.
Muller, J.E.
Roots, E.F.

6 Geologist 3
Gabrielse, H.
Green, L.H.
Roddick, J.A.
Souther, J.G.
Tipper, H.W.
Wheeler, J.O.

Appalachian Region

6 Geologist 3
Anderson, F.D.
Jenness, S.E.
Neale, E.R.W.
Poole, W.H.
Riley, G.C.
Stevenson, I.M.

2 Tech. Off. 3
Kelley, D.C.
McCartney, W.D.

Pleistocene, Groundwater and Engineering Geology

1 Sr. Geologist
Prest, V.K.

Pleistocene Geology

1 Geologist 4
Stalker, A.M.

Pleistocene Geology (cont'd)

6 Geologist 3
Craig, B.G.
Fyles, J.G.
Gadd, N.R.
Henderson, E.P.
Lee, H.A.
Terasmae, J.

1 Tech. Off. 3
Hughes, C.L.

1 Technician 1
Field, D.E.

Groundwater & Engineering Geology

1 Tech. Off. 8
Owen, E.B.

2 Tech. Off. 5
Hall, E.
Pollitt, E.I.K.

4 Tech. Off. 3
Bostock, Miss J.
Brandon, L.V.
Charron, J.E.
Toth, A.M.

1 Technician 1
Pearce, R.G.

British Columbia Office

1 Sr. Geologist
Armstrong, J.E.

1 Tech. Off. 5
Halstead, E.C.

1 Stenographer 3
Marble, Mrs. A.

1 Stenographer
Lee, Mrs. E.M.

Whitehorse Office

1 Geologist 3
Skinner, R.

FUELS AND STRATIGRAPHY DIVISION

1 Chief of Division
Caley, J.F.

2 Tech. Off. 3
Howie, R.D.
MacLean, B.

1 Clerk 3
Dougherty, Miss H.M.

Stratigraphic Palaeontology

1 Sr. Geologist
Frebold, H.W.

4 Geologist 4
Harker, P.
Jeletzky, J.A.
McLaren, D.J.
Tozer, E.T.

6 Geologist 3
Bolton, T.E.
Copeland, M.J.
Cumming, L.M.
Norris, A.W.
Sinclair, G.W.
Wagner, Miss F.J.E.

1 Geologist 2
McGregor, D.C.

1 Tech. 2
Botte, B.J.

1 Tech. 1
Callahan, J.J.

1 Asst. Tech. 1
Matte, J.E.A.

1 Stenographer 3
Stafford, Miss A.E.

1 Typist 2
Shields, Mrs. L.

Geology of Fuels

1 Sr. Geologist
Douglas, R.J.W.

1 Geologist 4
Irish, E.J.W.

2 Geologist 3
Liberty, B.A.
Norris, D.K.

3 Geologist 2
Pelletier, B.R.
Price, R.A.
Stott, D.F.

1 Tech. Cff. 6
Latour, B.A.

1 Tech. Cff. 5
Sanford, B.V.

1 Tech. Cff. 3
Brady, W.B.

1 Technician 2
Lalonde, J.M.A.

2 Asst. Tech. 2
Bova, P.
Seguin, R.J.G.

2 Asst. Tech. 1
Erdody, P.
Remillard, G.

Western Plains Cffice

1 Sr. Geologist
Wickenden, R.T.D.

1 Geologist 4
Belyea, Miss H.R.

1 Geologist 3
Pugh, D.C.

1 Tech. Cff. 5
Price, L.L.

Western Plains Cffice (cont'd)

1 Tech. Cff. 2
Harris, I.M.

1 Asst. Tech. 2
Balfour, A.F.

1 Clerk 3
Lawson, Miss H.F.

1 Typist
George, Mrs. M.E.

Sydney Coal Research Lab.

1 Sr. Geologist
Macquebard, P.A.

2 Tech. Cff. 4
Birmingham, T.F.
Donaldson, J.R.

1 Tech. Cff. 3
Cameron, A.R.

1 Technician 2
Barss, M.S.

1 Clerk 2
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1 Clerk 3
Burns, Miss E.M.

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1 Geologist 4
Mulligan, R.

2 Geologist 3
Gross, G.A.
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1 Tech. Off. 1
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1 Tech. Off. 4
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1 Tech. Off. 3
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1 Tech. Off. 2
Trask, Miss C.J.

1 Technician 1
Paris, J.C.

1 Asst. Tech. 1
Cormier, R.

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1 Geologist 3
Rose, E.R.

1 Technician 2
Gauthier, C.H.R.

1 Asst. Tech. 3
Vaux, M.

1 Asst. Tech. 2
Lacroix, A.

1 Museum Helper
Turpin, J.

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1 Geologist 4
Boyle, R.W.

1 Geologist 3
Holman, R.H.C.

1 Geologist 2
Cameron, E.M.

1 Chemist 2
Gilbert, Mrs. M.A.

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Reesor, J.E.
Smith, C.K.

1 Geologist 3
Dawson, K.R.

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Maxwell, J.A.

2 Chemist 3
Abbey, S.
Champ, W.H.

1 Chemist 1
Courville, S.

1 Technician 3
White, W.F.

1 Technician 1
Ter Haar Romeny, W.Y.

1 Asst. Tech. 3
Bender, G.

1 Asst. Tech. 2
Malone, J.P.

1 Asst. Tech. 1
Hoops, K.G.

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Purkiss, Miss E.F.

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MacLaren, A.S.

1 Geologist 2
Gregory, A.F.

Geophysical Interpretation (cont'd)

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1 Technician 1
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1 Tech. Off. 4
Du Bois, P.M.

1 Technician 1
Black, R.F.

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1 Tech. Off. 4
Owens, K.H.

3 Technician 2
Essex, F. (Navig.)
Houlihan, J.P. (Mag. Op.)
Sawatzky, P. (Mag. Op.)

1 Technician 1
Eisener, K.G. (Mag. Op.)

Compilation Section

1 Technician 2
Ready, E.E.

Compilation Section (cont'd)

2 Map Compiler & Computer 3
Chretien, Miss M.B.
Langlois, R.J.

2 Map Compiler & Computer 2
Dods, S.D.
Dregas, Miss T.C.M.

2 Map Compiler
Haley, E.L.
Zieman, F.W.

3 Asst. Tech. 3
Derouin, E.J.
Leblanc, Mrs. M.K.
Reveler, D.A.

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Geological Survey of Canada

Information Circular No. 2

FIELD WORK, 1958

by

C.S. Lord

Chief Geologist

Ottawa

December 1958

FIELD WORK, 1958

The following notes describe briefly, by provinces, the seventy-six field projects undertaken by the Geological Survey of Canada during 1958, indicate progress made, and briefly summarize some of the results. The main purpose of most Geological Survey field work is to obtain basic data concerning the geology of Canada. These data, when assembled, interpreted, and published as appropriate maps and reports, guide those engaged in the search for and development of metallic and non-metallic mineral deposits, fuels, and construction materials. From time to time, however, as an incidental product of the field work, geological features or mineral occurrences are noted that may be of immediate or direct economic interest. Some of these warrant prompt release, in advance of the Survey's more formal Preliminary Series reports. A few such economic items are included in the following notes.

The field projects described involve the study and mapping of bedrock geology, unless otherwise specified.

All statements concerning the results of field work are subject to confirmation by office and laboratory study, and by publication by the officer concerned through Geological Survey or other media.

Map-areas are designated according to the National Topographic System in effect up to and including 1957.

DISTRICT OF FRANKLIN

R.G. Blackadar mapped the following areas at Cape Dorset, on the southern coast of Baffin Island, for publication on the scale of 1 inch to 1 mile: 36 C SE¼, and the west half of 36 B SW¼. The areas are underlain by Grenville-type rocks. These are mainly gneisses, but include substantial bands of metamorphosed quartzite, marble, and schist. The trends of these sedimentary bands change from west in the northwest corner of the mapped area, to southeast at the east boundary of the mapped area.

In addition, a few traverses were completed in the Hobart Island (36 A) and White Bear Bay (35 P) map-areas, also on the southern coast of Baffin Island.

R.L. Christie, attached to Defence Research Board's Operation Hazen for logistical and administrative purposes, continued his geological reconnaissance in the Hazen Lake district, in northern Ellesmere Island. The reconnaissance included the area between Markham Inlet and Hazen Lake, the ice cap for about 70 miles west of Hazen Lake, the region between Alert and Hazen Lake, Judge Daly Promontory, and

territory in the vicinity of Discovery Harbour (Fort Conger).

The strata trend northeasterly. The oldest and most widespread rocks are the early Palaeozoic or older strata of the Cape Rawson group. These are mainly slate, sandstone, quartzite, and greywacke, and underlie the region between Archer Fiord and Hazen Lake, and some of the mountains north of that lake. Moderately inclined Permo-Carboniferous strata, comprising sandstone, limestone, arkose, and chert-pebble conglomerate, underlie much of the United States Range. Adjacent to Hazen Lake is a gently folded group of sandstone, shale, and coal beds from which were collected fossils of Permo-Carboniferous, probable Triassic, and probable Cenozoic age. Steeply to moderately inclined limestone, sandstone, quartzite, slate, and phyllite, of probable Palaeozoic age, underlie most of Judge Daly Promontory. Partly consolidated sandstone, shale, and coal underlie small areas on Judge Daly Promontory and near Fort Conger, and contain fossil leaves and tree trunks that indicate a probable Cenozoic age.

In addition to the coal occurrences noted in Information Circular No. 1, a bed of Tertiary coal at least 20 feet thick is exposed for a length of about 1,000 feet along a creek canyon near Fort Conger. This coal was used as fuel by explorers wintering at Fort Conger in 1875-76 and in 1882-83. Amber occurs as nodules in coal outcropping on Hazen Lake, and was noted on beaches at the east end of the lake. Carnelian, or pale yellow chalcedony, occurs as residual pebbles or nodules on the surface of a small basalt conglomerate deposit about 40 miles northeast of Hazen Lake.

R. Thorsteinsson and E.T. Tozer completed the mapping of Melville, Brock, Borden, Mackenzie King, and Prince Patrick Islands, and in doing so mapped about 20,000 square miles in sufficient detail for publication at 1 inch to 8 miles. The party comprised only the two geologists, and a pilot, and had full-time use of a Piper Super Cub supplied by Bradley Air Services of Carp, Ontario. The aircraft was used for moving camps, and by the geologists for traversing. The landing gear was fitted with large low pressure tires and with this equipment little difficulty was experienced in landing at about 300 different unprepared localities. The base of operations was a food and fuel cache established on eastern Melville Island in 1955 by the Geological Survey's Operation Franklin.

The strata range in age from Lower Ordovician (and possibly older) to Tertiary, all systems except the Mississippian being represented. A substantial unconformity occurs beneath the Pennsylvanian, and a lesser discordance beneath the Permian.

Ordovician and Silurian rocks are confined to Melville Island, where they occur in the Canrobert Hills,

the McCormick Inlet area, and the Weatherall Bay area. Substantial facies differences occur: the Ordovician-Silurian section of the Canrobert Hills is mainly graptolitic shale; that of McCormick Inlet area includes both carbonate and graptolitic facies; and the Silurian rocks of Weatherall Bay area are almost exclusively carbonate.

Brock, Borden, and Mackenzie King Islands expose the northwest limb of the Sverdrup basin with a section from Triassic to Cretaceous that dips regionally to the southeast.

Beaufort sands and gravels, of Pleistocene or Late Tertiary age, occupy the northwestern parts of Prince Patrick Island, Brock Island, and Borden Island.

DISTRICT OF MACKENZIE

J.A. Fraser completed geological mapping of Fort Enterprise (86 A) map-area. The results of 1957 field work in this map-area have been published[1].

The 1958 work disclosed mainly massive and gneissic granitic rocks in the northwest corner of the map-area, and schist and gneiss in the northeast corner as might be expected from Map 16-1958.

In addition, preparations were made for helicopter-supported Operation Coppermine, planned for 1959. Caches of aviation fuel were established at Sawmill Bay and Coppermine, and an aerial reconnaissance was made of part of the Operation area to select camp sites and for other purposes.

F.C. Taylor was assigned to complete the reconnaissance geological mapping of the only outstanding map-areas within the Precambrian Shield of southeastern District of Mackenzie (75 A, the southeast half of 75 F, 75 G, and the west half of 75 H). The project area was completed for publication on the scale of 1 inch to 4 miles except for a central north-south strip comprising about one-third of 75 A, and except for the extreme southeast corner of that map-area.

The mapped area is underlain almost entirely by gneisses. The oldest rocks are biotite and hornblende paragneisses. These form scattered bodies totalling about one-quarter of the mapped area. These rocks, particularly in

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[1] Fraser, J.A.: Fort Enterprise, Northwest Territories; Geol. Surv., Canada, Map 16-1958 (1958).

75 A, G, and H, include highly metamorphosed magnetite iron formation. However, no important concentrations of magnetite were noted. Granitic rocks, mainly gneissic, underlie nearly three-quarters of the mapped area. Sedimentary rocks of the Nonacho group underlie minor areas in 75 F, and in the west part of 75 G, but were not noted elsewhere. Some of the granite is younger than the Nonacho strata. Gossans derived from pyrite are common in the paragneisses.

J.V. Ross, of the Department of Geology and Geography, University of British Columbia, commenced and completed the geological study and mapping of the west half of Mesa Lake (86 B/14 W½) map-area. This map-area was chosen for mapping because it was thought that it would provide further information on the relations between the Yellowknife group and Snare group of rocks[1]. Field work failed to indicate a stratigraphic break between the metamorphosed Yellowknife rocks in the east and the metamorphosed rocks, previously assigned to the Snare group, in the west; and suggests that the metamorphic rocks of this map-area, previously assigned to two different age groups are, in fact, of the same age, differing only in facies.

R.D. Lawrence, a seasonal party chief now at University of Toronto, commenced and completed field work within Rodriques Lake (86 B/13 E½) map-area. It is not expected that this project will add much to data previously published[2].

DISTRICT OF MACKENZIE, AND YUKON

J.A. Jeletzky continued his study of the stratigraphy and palaeontology of Cretaceous and uppermost Jurassic strata southwest of the Mackenzie River delta. The project was commenced in 1955, but no field work done on it during the summers of 1956 and 1957. A preliminary report[3] concerning the 1955 field work has been published.

Most of the 1958 field season was spent on the eastern flank of the Richardson Mountains, in Northwest Territories, between the latitudes of Aklavik and Fort McPherson. In addition, a few days were spent studying strata

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1 Lord, C.S., and Wilson, J.T.: Ingray Lake, District of Mackenzie, Northwest Territories; Geol. Surv., Canada, Map 697A (1942).

2 Lord, C.S., and Wilson, J.T.: op. cit.

3 Jeletzky, J.A.: Uppermost Jurassic and Cretaceous Rocks of Aklavik Range, Northeastern Richardson Mountains, Northwest Territories; Geol. Surv., Canada, Paper 58-2 (1958).

on parts of the Porcupine River between the mouths of the Bell and Driftwood Rivers, in Yukon; and another few days studying strata in an area including the junction of Porcupine and East Porcupine Rivers, Yukon.

On the east flank of the Richardson Mountains a detailed study was made of more than 5,000 feet of strata comprising an essentially complete succession of marine Lower Cretaceous and uppermost Jurassic strata. All units were found to be fossiliferous. Coal seams were mapped at about the middle of the Lower Cretaceous section, and these are correlated with those mined at Moose Channel northwest of Aklavik. The Lower Cretaceous strata are unconformably overlain by more than 550 feet of Upper Cretaceous marine rocks.

On the Porcupine River between the mouths of Bell and Driftwood Rivers strata were examined that had been mapped previously as Cretaceous[1]. They were found to comprise about 900 feet of fossiliferous marine Permian rocks unconformably overlain by more than 2,500 feet of mostly marine, fossiliferous Jurassic strata, in turn overlain by a thick non-fossiliferous conglomerate of an unknown but presumably late Jurassic or early Cretaceous age.

Near the junction of Porcupine and East Porcupine Rivers, late Lower Cretaceous fossils were found in the middle part of several thousand feet of sandstone and shale which, insofar as known, is otherwise unfossiliferous.

DISTRICT OF KEEWATIN

G.D. Jackson commenced the geological study and mapping of Belcher Islands (33 M, 34 D), and completed field work within the eastern quarter of this project area.

YUKON

L.H. Green commenced a preliminary reconnaissance of the following map-areas in west-central Yukon in anticipation of a helicopter-assisted project in this vicinity in the near future: 116 A, B, C E½, F E½, G, and H. Data were obtained from all map-areas except 116 A. Although the stratigraphic data obtained will facilitate the contemplated helicopter-assisted reconnaissance they do not warrant a preliminary report at this stage.

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1 McConnell, R.G.: Report on Exploration in the Yukon and Mackenzie Basins, N.W.T.; Geol. Surv., Canada, Ann. Rept., vol. IV, 1888-89, pt. D, p. 123.

J.A. Roddick and J.O. Wheeler made a preliminary geological reconnaissance of 105 F, G, J, K, and part of B, all in southeastern Yukon. It is anticipated that a helicopter-supported geological reconnaissance of these map-areas, to be known as Operation Pelly, will be undertaken in 1959. The 1958 preliminary reconnaissance, supported by a Piper Super Cub, obtained in a relatively inexpensive manner much key geological data that will aid in planning Operation Pelly and enable it to be conducted at maximum efficiency. Dr. Roddick was responsible for the reconnaissance north and northeast of the Finlayson Lake-Pelly River valley, whereas Dr. Wheeler was responsible for the field work to the south and southwest. The results, because of their preliminary and scattered nature, do not warrant a preliminary map or report.

BRITISH COLUMBIA

E.F. Roots completed field work required to fill in gaps and to solve critical geological problems outstanding from Operation Stikine (1956)[1] within Bowser Lake (104 A), Spatsizi (104 H), and Dease Lake (104 J) map-areas. Similar work outstanding from Operation Stikine within Iskut River (104 B) and Telegraph Creek (104 G) map-areas is the responsibility of J.G. Souther; and within Cry Lake (104 I) map-area, of H. Gabrielse.

Part of the season was spent in a study of the limits, stratigraphy, and structure of a large area of marine and continental clastic sedimentary rocks that underlies most of the Skeena Mountains and Nass Basin. These rocks appear to form the largest single sedimentary basin, uncomplicated by igneous activity, in the western Cordillera. The central part of the basin contains several thousand feet of Upper Triassic and Lower Cretaceous sediments which are in part intensely contorted and dislocated, and in places have suffered low-grade metamorphism. The basin is surrounded by rocks of varied lithology including considerable thicknesses of limestone, of Early Mesozoic and Late Palaeozoic age, some of which are less deformed than the younger rocks within the basin. The recognition of this basin during the mapping done by Operation Stikine lead to speculation as to its potential for petroleum deposits. The mapping done in 1958 confirmed the possibility that the intensity of deformation of the interior of the basin may decrease with

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1 Roots, E.F., and Others: Stikine River Area, Cassiar District British Columbia; Geol. Surv., Canada, Map 9-1957 (1957).

depth, thereby increasing its attractiveness to those engaged in the search for oil and gas.

Asbestos was noted in Dease Lake (104 J) map-area 4 miles east of the south bay of Tachilta Lakes, 2½ miles west of Tuya River. This locality is approximately 35 miles up Tuya River valley from the Dease Lake-Telegraph Creek road, and at latitude 58°36', longitude 130°51'. Cross fibre veins of fibrous chrysotile occur on the northwest end of a hill of serpentinized peridotite. Veins wider than one-eighth inch appear to be spaced at least one to every square yard, and in several places are found several to each square foot, across two or three hundred yards of outcrop. Many of the veins have a central parting, but clean ½-inch fibre is abundant. The longest fibre noted was about 1¼ inches in length. Veins of green non-flexible fibrous serpentine, and of massive pale bluish grey and green serpentine are also present, and are cut by the veins of chrysotile. The ultramafic body in which the veins occur is about 3 miles long and ½ mile wide. This body was crossed by a single traverse only, and nothing is known of its asbestos content elsewhere.

J.G. Souther completed field work outstanding from Operation Stikine (1956) in Iskut River (104 B) map-area, except that about a week's work with a ski-wheel equipped aircraft is still required in and about an ice field adjacent to the central part of the north boundary[1].

In addition, he made a geological reconnaissance of Sumdum (104 F) map-area and the southern half of Tulsequah (104 K) map-area. Although additional field work is required to bring this reconnaissance up to 4-mile standard, the study of Sumdum map-area is sufficiently advanced to warrant publication of a preliminary map now being prepared. The western part of these map-areas is underlain by Coast Range granitic intrusions. The eastern part is underlain mainly by Permian, Triassic, and Jurassic sedimentary and volcanic rocks.

Abundant molybdenite was noted in hand specimens from a pink quartz monzonite stock on the eastern boundary of Sumdum (104 F) map-area 4½ miles north of Barrington River. In addition, specimens of pink quartz monzonite, well mineralized with molybdenite, were found 4 miles west of the north end of Chutine Lake. These were in the medial moraine of a glacier that flows easterly into the north end of the lake.

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[1] Roots, E.F., and Others: Stikine River Area, Cassiar District, British Columbia; Geol. Surv., Canada, Map 9-1957 (1957).

H. Gabrielse continued stratigraphic studies and preliminary geological reconnaissance of Kechika (94 L) and Rabbitt River (94 M) map-areas. This work, barely started in 1957, is intended as reconnaissance in preparation for future helicopter-assisted mapping for publication on the scale of 1 inch to 4 miles. Most of the northwest quarter of Kechika map-area west of the Rocky Mountain trench, and the southwest quarter of Rabbitt River map-area west of the trench and south of Turnagain River and Sandpile Creek, were mapped to about 4-mile standard. In addition, some reconnaissance was done in the southwest quarter of Kechika map-area. The 1958 work does, nevertheless, contain various gaps better completed at a later date with the aid of a helicopter, and the release of a preliminary geological map is not warranted at this stage.

The area mapped is underlain by tightly folded sedimentary strata ranging in age from Precambrian to Mississippian, and by granitic rocks of the Cassiar batholith. Fluorite was noted in Kechika map-area in a greenstone body about 10 miles east-northeast up a creek that flows into Dall River 2 miles north of Dall Lake. The greenstone is brecciated and contains amphibole, biotite, and epidote. Veinlets cutting the greenstone contain carbonate and dark purple fluorite. The extent of the fluorite-bearing rock is not known. Rocks intruded by the greenstone have been altered to fine-grained, cherty hornfels. Similar contact metamorphic rocks were noted several miles northwest of the fluorite-bearing greenstone.

H.W. Tipper completed the geological study and mapping of Quesnel (93 B) map-area except that part lying northeast of Quesnel River and a small area around the town of Quesnel. Both these uncompleted parts are in the northeast corner.

With the above exceptions, the northern two-thirds of the map-area was mapped in 1958. This part contains scattered minor areas of Cache Creek strata. Granitic rocks outcrop at and around Granite Mountain east of Fraser River. Similar granitic rocks outcrop west of Fraser River at the head of Deserters Creek, and as an elongated body extending 12 miles north-northeasterly from the junction of Narcosli Creek and Ramsey Creek. Otherwise, most of the area mapped during 1958 is underlain by Tertiary volcanic and sedimentary rocks, comprising three assemblages separated by two angular unconformities. A small area of post-Pleistocene basalt, breccia, and volcanic ash, outcrops 6 miles west of Nazco Indian Village, in the northwestern part of the map-area.

Pliocene or Miocene sedimentary rocks, here and there with diatomite, occur in Fraser Valley between Quesnel and Macalister. Several previously unrecorded occurrences of diatomite were noted near Buck Ridge, one of which is at least 25 feet thick.

H.W. Little commenced the revision of previous 4-mile geological mapping within Kettle River West Half (82 E W½) map-area[1]. Field work required for this revision was completed except in that part of the map-area lying north of latitude 49°50'.

Rocks shown as "Shuswap Complex" on Map 538A were remapped in accordance with the current concept that the term "Shuswap" should be restricted to rocks of pre-Permian age. Intrusions included in the "Shuswap Complex" of Map 538A were remapped as Mesozoic Nelson or Valhalla intrusions, or as Cenozoic Coryell intrusions, to correspond with the map-units used in the map-area immediately to the east[2]. The stratigraphy of the Tertiary volcanic and sedimentary rocks was found to require substantial revision. Undeformed Miocene (?) basalts were recognized for the first time. Major northerly-trending faults were noted near the east boundary of the map-area in Conkle Creek valley, and at various points between Carmi and the junction of Mission and Pearson Creeks.

H.H. Bostock, a post-graduate geology student now at the University of Wisconsin, commenced the geological study and mapping of Squamish (92 G W½) map-area, under the direct supervision of Dr. J.E. Armstrong. Field work was seriously hampered by circumstances beyond Mr. Bostock's control, including forest fire hazard. However, the mapping of much or all of the shoreline of Howe Sound, Salmon Arm, and Seechelt Inlet and vicinity, was completed, and substantial work done inland from Britannia Beach.

J.G. Fyles completed the field study and mapping of the surficial deposits of the lowland parts of the east coast of Vancouver Island between the towns of Cumberland and Campbell River (lowland parts of 92 F/10, 11, 13, and 14, and K/3, 4).

In addition, he commenced and completed a reconnaissance of the surficial deposits of the lowlands and islands of Strait of Georgia between Sooke on Vancouver Island and Howe Sound on the mainland. The main purpose of this project was to obtain a better understanding of the pre-Vashon stratigraphy and geological history of the Georgia Basin.

J.E. Reesor continued his studies of granitic rocks. He devoted the 1958 field season to detailed studies within

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1 Cairnes, C.E.: Kettle River (West Half), British Columbia; Geol. Surv., Canada, Map 538A (1940).

2 Little, H.W.: Kettle River (East Half), British Columbia; Geol. Surv., Canada, Map 6-1957.

the southeast quarter of Burton (82 F/13) map-area and the northeastern eighth of Passmore (82 F/12) map-area. This work included mapping, on the scale of 2 inches to 1 mile, of an area about 12 miles long and 7 miles wide. It is anticipated that field studies will be continued in the same region in 1959.

The area studied has a relief of several thousand feet, and is mainly above timberline and otherwise well exposed. The rocks appear to occupy an elongated dome in the centre of which erosion has exposed the oldest unit, mainly quartzite. Overlying the quartzite, in sharp contact with it, and presumably intrusive into it, is hornblende and biotite porphyritic gneissic granite (Nelson intrusions, Unit 12, Map 3-1956)[1]. The gneissic granite grades upward into fine- to very coarse-grained, heterogeneous, biotite and leucogranite (Valhalla Intrusions, Unit 13, Map 3-1956). The combined "stratigraphic" thickness of the gneiss and granite is between 2,000 and 3,000 feet. The granite grades upward into migmatite and paragneiss (Unit 10C, Map 3-1956). Work to date has involved detailed studies of the strata in order to establish field relations, and appropriate sampling for laboratory and office investigations, all intended to contribute to an overall comprehensive study of the mode of emplacement, origin, and other features of the granitic and associated rocks.

B.R. Pelletier and W.B. Brady commenced and completed field work within Tetsa River (94 K/9) map-area. All strata are folded along northwesterly trending axes. The southwestern two-thirds of the map-area is underlain mainly by Triassic sandstones and siltstones; except that Palaeozoic strata outcrop in two structurally "high" belts, the main one of which crosses the Alaska Highway and extends northwesterly across the north boundary of the map-area; and except that the overlying Lower Cretaceous strata outcrop in troughs that become progressively more abundant towards the northeast. The northeastern third of the map-area is underlain mainly by Lower Cretaceous formations. The Triassic strata thin from west to east, and sedimentary features indicate that they were deposited from easterly flowing waters.

BRITISH COLUMBIA AND ALBERTA

R.A. Price commenced the geological study and mapping, for publication on the scale of 1 inch to 4 miles, of Fernie East Half (82 G E½) map-area. Field work was

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[1] Little, H.W.: Nelson (West Half), Kootenay and Similkameen Districts, British Columbia; Geol. Surv., Canada, Map 3-1956 (1957).

completed within part of 82 G/1, all of 82 G/2 E½, and part of 82 G/10.

The map-area contains an exceptionally complete stratigraphic section, the strata ranging in age from the Precambrian Waterton formation, to the Kishenehn formation of Eocene and Oligocene age. Many minor intrusions of trachyte and syenite were mapped, mainly in northern part of 82 G/2 E½. These range up to 3 miles in length, and are of late Mesozoic or younger age. Several windows of Upper Cretaceous rocks were mapped within the Precambrian strata of the Lewis thrust sheet. One of these, in British Columbia, is at the headwaters of Howell and Harvey creeks, in 82 G/2 E½. It suggests that the minimum horizontal displacement of the Lewis overthrust is 25 miles. A northwesterly trending normal fault along the east side of Flathead River valley marks a stratigraphic throw of about 23,000 feet. The strata on the northeast side have moved up relative to those on the southwest.

D.F. Stott completed stratigraphic studies of the Upper Cretaceous Smoky group and the Lower Cretaceous Fort St. John and Bullhead groups, and equivalent strata, in the foothills of Alberta and British Columbia between Smoky River and Red Willow River. It is anticipated that, in 1959, this work will be continued northerly towards Peace River.

D.C. McGregor spent about a month in Miette (83 F/4) map-area in Alberta (See E.W. Mountjoy), and about two months in the foothills between Smoky River and Red Willow River (See D.F. Stott). Macro and micro flora, as appropriate, were collected from Lower Cretaceous and adjacent strata.

H. Frebold studied the Lower, Middle, and Upper Jurassic fauna and stratigraphy of the Tyaughton Lake area, Bridge River District. Other time was spent in the study of the upper part of the Jurassic system in the central foothills of Alberta. This work suggested, but has not yet proven, that the Nikinassin strata are at least partly of late Jurassic age, and that the remainder are of Cretaceous age. In addition, Jurassic studies in the Nelson West Half (82 F W½) map-area were continued from 1957. This work demonstrated that the Elise and Beaver Mountain formations are of the same age. This conclusion, in turn, requires a re-interpretation of parts of Map 3-1956[1].

ALBERTA

D.K. Norris commenced and completed field work within Carbondale River (82 G/8 W½) map-area.

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[1] Little, H.W.: Nelson (West Half), Kootenay and Similkameen Districts, British Columbia; Geol. Surv., Canada, Map 3-1956 (1957).

The northern half of the map-area is underlain by highly deformed Lower and Upper Cretaceous strata and minor Jurassic formations. Field data suggest that the complex structures exposed along Carbondale River[1] are not due to a tear fault but to gentle folding of a major westerly dipping thrust fault.

The southern half of the map-area is underlain by Precambrian strata of the Lewis thrust sheet. These rocks have been thrust over the Mesozoic formations, and the surface trace of the Lewis thrust fault, which separates Precambrian and Mesozoic strata, trends easterly across the middle of the map-area. The trace continues easterly and southeasterly across the adjacent Beaver Mines map-area.[2] Preliminary studies in Carbondale River map-area indicate that the local easterly trend of the fault trace is the result of erosion of a gently warped Lewis thrust plate rather than of local overriding towards the north. It is thus possible that the southerly trending structural features of the Savanna Creek gas field extend beneath the Lewis thrust plate in Carbondale River map-area, and that structures of the Waterton Park-Castle River gas field likewise extend southerly beneath the thrust plate in Beaver Mines map-area.

E.W. Mountjoy completed geological study and mapping of Miette (83 F/4) map-area, the west half of which was done by him in 1957. It is anticipated that the results of this work will form the basis of a Ph.D. thesis, now being prepared in Ottawa for University of Toronto, in which particular attention will be paid to structural features. In addition, it is expected that an appropriate map and report will be prepared in due course for publication by the Geological Survey.

ALBERTA AND SASKATCHEWAN

W.F. Fahrig commenced, in 1957, a comprehensive study of the rocks of the Athabasca Series exposed between Athabasca, Wollaston, and Cree Lakes. The 1957 field investigations were confined mainly to the Trout Lake (74 K) map-area and to the northern edge of the area underlain by the Athabaska rocks (74 L, N, O, and P). The remainder of the area underlain by Athabasca rocks was studied during

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1 Clow, W.H.A., and Crockford, M.B.B.: Geology of Carbondale River Area, Alberta; Research Council of Alberta, Report No. 59 (1951).

2 Hage, C.O.: Beaver Mines, West of 5th Meridian, Alberta; Geol. Surv., Canada, Map 739A (1943).

1958. In addition, a short time was spent studying Athabasca rocks on the north shore of the lake, including those exposed on the islands immediately south and southwest of Crackingstone Peninsula.

A continued study of the sedimentary features indicating flow-direction of the waters from which the sediments were deposited added much to what had been learned during the 1957 field season. It now appears that these waters flowed westerly to west-northwesterly along what is now the northern boundary of the Athabasca rocks, westerly over what is now the eastern boundary, and northwesterly to west-northwesterly over the present south and southwestern boundaries. These data suggest that the currents converged towards the northwest and attained their maximum constriction, insofar as records are still available, in Lake Athabasca between Uranium City and Fort Chipweyan.

E.M. Cameron collected samples of sandstone for geochemical studies. The samples are of various ages from Cambrian to Cretaceous, but about 75 per cent are from Cretaceous formations, and most were collected from Cypress Hills, Crowsnest, Canmore, Entrance, Lake Louise, and Golden Districts.

SASKATCHEWAN

C.K. Bell concluded his work in Milliken Lake (74 N/7) map-area, which he commenced in 1954. Field work has been completed, for publication at 1 inch to 800 feet, within that part of Crackingstone Peninsula lying west of 108°40' and south of 59°30', except that part lying north of Milliken Lake between longitudes 108°40' and 108°45'.

The mapped area contains the Gunnar Mine. The most widespread rocks are those of the Tazin group. These comprise quartzose sediments and minor volcanic rocks, and their metamorphosed and granitized equivalents including the Gunnar granitoid gneiss and other gneisses. No publications have resulted from the current project, but the geology of much of the mapped area was published previously on a scale of 1 inch to 1 mile.[1]

E. Hall commenced a reconnaissance ground-water survey of that part of Saskatchewan lying within the Souris River watershed - that is, about 12,000 square miles comprising much of Saskatchewan south and east of Regina. The

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[1] Fraser, J.A.: Crackingstone (West Half), Saskatchewan; Geol. Surv., Canada, Paper 54-8 (1954).

survey was completed within Weyburn (62 E) map-area where about 25 per cent of the wells, mainly those penetrating bedrock, were examined. The object of this work was to bring the Survey's 1935 Ground-Water Inventory up-to-date on a reconnaissance basis, and to re-measure enough of the previously surveyed wells to permit a comparison between the 1935 and 1958 water-tables. The 1958 work indicates that the present height of the water-table, as measured in bedrock wells, is about the same as it was in 1935 when surveyed by Dr. B.R. MacKay of the Geological Survey. In addition, other reconnaissance studies were made during 1958 as required to aid planning for future ground-water surveys in the district.

J.S. Scott, a post-graduate geology student at University of Illinois, commenced the geological study and mapping of the surficial deposits of Elbow (72 O/2), Hawarden (72 O/7), and Outlook (72 O/6) map-areas. The project area includes the South Saskatchewan River dam and power site. About half the field work was completed, the mapping being done for publication on the scale of 1 inch to 1 mile, with special attention to the engineering requirements of the proposed dam and related construction, and to problems arising from the subsequent flooding. It is anticipated that the data obtained will form the basis of Mr. Scott's Ph.D. thesis at University of Illinois, and will provide an appropriate map and report for publication by the Geological Survey.

MANITOBA

H.A. Quinn and W.L. Davison commenced and completed field work in Kettle Rapids (54 D) map-area. Widely scattered outcrops occur in the western half, and along Nelson River in the eastern half; elsewhere the map-area is almost devoid of exposed bedrock. The eastern third is underlain by Palaeozoic strata, probably not extending quite so far west as shown on Map 850A[1]. Exposed rock in the western two-thirds of the map-area is of Precambrian age and, with the following exceptions, mainly gneiss and granite. North-westerly trending belts of metamorphosed sedimentary rocks outcrop along Moose Lake, and on Nelson River at Turtle Island. Similarly altered strata outcrop along Aiken River in the extreme southwest corner of the map-area. Sedimentary rocks of the Assean Lake belt of the adjacent map-area[2] were traced a few miles northeasterly into Kettle

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[1] Geological Survey of Canada: Geological Map of Manitoba, Map 850A (1946).

[2] Mulligan, R.: Split Lake, Manitoba; Geol. Surv., Canada, Map 10-1956 (1957).

Rapids map-area. In addition, abundant basic dykes were found in the southwest corner, between Split Lake and Ilford.

R. Kretz commenced and completed the geological study and mapping of Northern Indian Lake (64H) map-area, about 80 per cent of which is devoid of outcrops. Outcrops occur mainly in the centre of the west half of the map-area between Small Lake, Northern Indian Lake, and Partridge Breast Lake; and along Churchill River in the east half of the map-area. Except for a body of schist, gneiss, and amphibolite on the south side of Partridge Breast Lake, the observed rocks are mainly varieties of granites and gneisses.

H. Williams, a post-graduate geology student at University of Toronto, commenced a detailed study of an area (part of 63 K/16) including the Chisel Lake base metal deposit of Hudson Bay Mining and Smelting Company. The approximate boundaries of the map-area are: 54°49' to 54°52'; 100°05' to 100°10'. Field mapping is being done on a scale of about 1 inch to 500 feet. It is anticipated that this project will require another field season, and that it will provide data for Mr. Williams' Ph.D. thesis at University of Toronto, and an appropriate Geological Survey publication.

ONTARIO

M.J. Frarey mapped the eastern half of Echo Lake (41 J/12) map-area in 1957, and the western half during 1958. Somewhat more than the northeastern half of the area mapped during 1958 is underlain by granite and gneiss, and somewhat less than the southwestern half is underlain by Huronian strata and younger gabbro. All rocks previously mapped[1] as Mississagi, except a minor band on the southwest side of McMahon Lake, have been reassigned, mainly to the Gowganda and Lorrain formations. A band of basaltic and andesitic lavas, trending northwesterly and lying between Aberdeen and McMahon Lakes, was demonstrated to be a part of the Bruce Series. In addition, the 1958 work mapped a number of post-Cobalt major faults, some of which trend northwesterly, others northeasterly.

N.R. Gadd continued his investigation of geological matters related to the safe, economical, and otherwise satisfactory disposal of radioactive waste materials from the

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[1] Collins, W.H.: Bruce Mines, Algoma District, Ontario; Geol. Surv., Canada, Publication 1969 (1925).

Chalk River plant of Atomic Energy of Canada, Limited. Most of the 1958 field season was devoted to completing a map of the surficial geology of an area of about 25 square miles in the vicinity of the plant, including adjacent current and potential disposal areas. A map and report is being prepared for submission to Atomic Energy of Canada, Limited.

B.V. Sanford and C. Gauvreau used hammer percussion seismic (refraction) equipment on an experimental basis to determine depths to bedrock. Accurate depths would enable accurate contouring of bedrock surfaces, which would in turn indicate bedrock structures of interest to those engaged in the exploration for oil and gas, and bedrock depressions of interest to those engaged in the search for groundwater. The object of the seismic work was to determine the capabilities and limitations of the hammer equipment in southwestern Ontario. The results are still being evaluated although it appears, in general, that the depth determinations required (sometimes in the order of 200 feet) are beyond the capabilities of the equipment used.

In addition, Mr. Sanford visited the offices of various State Surveys to examine data from deep wells in order to facilitate his studies of stratigraphic relationships and structural trends of Palaeozoic strata beneath Lake Erie, and for purposes of regional correlation. The remainder of the field season was spent in offices of various oil and gas companies in southwestern Ontario in order to obtain further data required for current and contemplated subsurface geological studies of that district.

H.R. Wynne-Edwards mapped the west half of Westport (31 C/9) map-area in 1957, and the east half in 1958. It is anticipated that the field data, in particular those bearing on the influence of structure on the localization and development of granitic rocks, will provide the basis of a Ph.D. thesis for Queen's University and, at a later date, an appropriate map and report for publication by the Geological Survey.

S.M. Roscoe spent about 5 weeks in the field, mainly underground, completing the field phase of his subsurface study of the origin, distribution, and thorium content of the uranium ores of the Blind River district.

E. Mirynech, a geology student at University of Toronto, commenced the geological study and mapping of the surficial deposits of Trenton (31 C/4) and Presqu'ile (30 N/13) map-areas. This project is a Geological Survey contribution to cooperative studies of the Lake Ontario Basin being sponsored by the Great Lakes Geophysical Research group, and, in addition, is expected to provide data for Mr. Mirynech's Ph.D. thesis. The western half of the map-

areas was completed but a preliminary map is not warranted at this time.

L. Kirwan, a seasonal party chief, and currently a graduate geology student at McGill University, commenced and completed geological field work within Deer Lake East Half (53 D E½) map-area in extreme western Ontario. The map-area is underlain almost exclusively by granodiorite, granite, and related rocks, and granitic gneiss.

E.H. Chown, a seasonal party chief and currently a graduate geology student at Johns Hopkins University, commenced and completed the geological study and mapping of Carroll Lake East Half (53 M E½) map-area. Except in the extreme southeast corner, the map-area is underlain by granodioritic rocks, in part porphyritic and gneissic. In the extreme southeast corner are pre-granite basic volcanic rocks and sedimentary strata as previously mapped[1].

J. Terasmae spent most of the 1958 field season investigating surficial deposits temporarily exposed by the St. Lawrence Power and Seaway development and related construction. No report is planned, but the data obtained will greatly facilitate mapping of other surficial deposits in the vicinity.

ONTARIO AND QUEBEC

N.R. Gadd, because of the higher priority assigned to his work at Chalk River, Ontario, limited his study of the surficial deposits of Ottawa (31 G/5) map-area to an examination of sections exposed in current temporary excavations. Miss J.M. Bostock, working on a phase of this project and under his direct supervision, compiled additional data concerning the thickness of drift within the city. This information is being used to revise the recent map[2] showing drift-thickness contours for the west part of the city, and to prepare for publication similar data concerning the east part of the city.

QUEBEC

T.E. Bolton commenced a study of the Ordovician and Silurian stratigraphy and palaeontology of Anticosti Island

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1 Horwood, H.C.: Geology and Mineral Deposits of the Red Lake Map Area; Ontario Department of Mines, Pub. 49A (1940).

2 Bostock, J.M.: Drift-Thickness Contours, City of Ottawa (West Part), Carleton County, Ontario; Geol. Surv., Canada, Map 13-1958 (1958).

in 1957, and in 1958 completed his study by examining formations in the western 60 miles of the island. Two stratigraphic sections, each of which cross the Ordovician-Silurian contact, were measured and studied in detail; one of these extends from the mouth of Oil River south-south-easterly to Jupiter River, and the other from Martin Bay south to the mouth of Ste. Marie River. In addition, the Ellis Bay formation (top of the Ordovician) was measured and studied in detail at the type locality near Port Menier. The base of the Ellis Bay formation was traced in detail from West Point easterly for some 60 miles. Excellent collections of fossils were obtained, particularly from the Ordovician rocks. Studies of surficial deposits showed that the island was submerged to a depth of only 250 feet in post-glacial times, rather than completely submerged as previously believed.

E.I.K. Pollitt continued a ground-water survey of that part of Lachine (31 H/5) map-area lying south of St. Lawrence River, and Ile Perrot. That part of the map-area south of St. Lawrence River and east of the St. Martine-Caughnawaga Road was mapped previously; that part south of the river and west of the road was completed during 1958; and the survey of Ile Perrot remains to be completed at a later date.

Much of the area mapped in 1958 is underlain by Potsdam sandstone[1]. This rock was found to be an excellent aquifer, much the best in the map-area. For instance, industrial wells between 100 and 200 feet deep were found to yield 400 to 500 gallons of water a minute. The water is of good quality.

Two belts of relatively thick drift (60 to 110 feet) were outlined. These are potential sources of groundwater. One is near St. Philomene Station; the other, 1 mile to 2 miles wide, extends from the extreme southwest corner of the map-area to Chateauguay.

C. Gauvreau, of the Geophysics Division, spent about two-thirds of the field season with Mr. Pollitt. He experimented with the use of hammer percussion seismic equipment as a means of measuring the depth of overburden. The results are being evaluated to determine the accuracy of this equipment under conditions encountered in Lachine (31 H/5) map-area.

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[1] Clark, T.H.: Montreal Area, Laval and Lachine Map-Areas; Department of Mines, Quebec, Geol. Rept. 46 (1952).

E.R. Rose examined iron-titanium deposits of the Morin anorthosite body north of Montreal, and of the St. Urbain anorthosite body. Particular attention was paid to the mineralogy of the mineral deposits, and to the relations of these deposits to the composition and structure of the enclosing anorthosite and related rocks. Appropriate samples were obtained for further investigations in the office and laboratory.

NEW QUEBEC AND LABRADOR

K.E. Eade and W.W. Heywood continued helicopter-supported Operation Fort George. The following areas, totalling about 35,000 square miles, were mapped during 1958: NTS 33 east of 75°30'; part of 23 M; and an area between latitudes 52°00' and 52°50', and longitudes 74°30' to 76°00'. A preliminary map on a scale of 1 inch to 8 miles, embracing the results of the 1958 field season, has been forwarded for publication.

Operation Fort George differs from previous Geological Survey helicopter-supported projects in the Canadian Shield in that it involved one instead of two helicopters, and employed three instead of five geologists. Furthermore the previously standardized system of radial helicopter traverses was abandoned in favour of a system whereby the aerial traverses are parallel and spaced at intervals of 6 miles. The cost of the Operation to date, about $2.03 a square mile[1], is the lowest so far achieved by a Survey helicopter project in the Shield.

Greenstones, the oldest rocks recognized, occur as three main bodies in the southern half of the area mapped in 1958. The largest of these is about 35 miles long and 6 miles wide. Otherwise, most of the southern third of the 1958 area is underlain by gneiss and schist derived from sedimentary formations, and most of the northern two-thirds by gneissic or massive granitic rocks. Four bodies of pink, crossbedded and ripple-marked Proterozoic (?) quartzite were encountered. The largest body is about 12 miles long and 4 miles wide. The quartzite is younger than the surrounding granitic rocks, and the dip of the beds is commonly less than 30 degrees. Most structural features within the 1958 area trend east to east-northeast.

J.A. Donaldson, a graduate geology student at Johns Hopkins University, continued and completed the

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[1] This figure does not include staff wages, cost of equipment, or overhead.

geological study and mapping of Marion Lake (23 I/13) map-area. It is anticipated that the results of this project will provide a Ph.D. thesis for Mr. Donaldson, and an appropriate map and report for publication by the Geological Survey.

S. Duffell and R.A. Roach completed field work within Mount Wright (23 B W½) map-area. Charnockites are the oldest rocks, and underlie the northwest quarter of the map-area. Younger biotite-hornblende gneisses, and associated rocks, underlie about half the map-area as a northeasterly trending belt passing through its centre. Within this belt are small, scattered, intricately folded areas of still younger quartzite, marble, iron formation, and iron ore. These areas are common in the northeast part of the belt, less common in the central part, and abundant in the southwest part. The youngest rocks mapped are hornblende-garnet gneisses, and these underlie the southeast part of the map-area. Two periods of folding were recognized, one along northeasterly axes, the other along northwesterly axes. The latter may be the younger.

W.R.A. Baragar commenced the geological study and mapping of Wakuack Lake (23 O) map-area and completed field work within the southern three-quarters of the west half. Trough rocks trend diagonally through the centre of the map-area from southeast to northwest, and granitic and gneissic rocks underlie the southwest and northeast corners. Most of the Trough rocks have been mapped by mining and exploration companies, in part in considerable detail. Mr. Baragar will do sufficient field work to enable these data to be incorporated into a Geological Survey report and map for publication on a scale of 1 inch to 4 miles. No preliminary map is planned or warranted at present.

NEW BRUNSWICK

H.A. Lee continued the geological study and mapping of the surficial deposits of St. John River valley, a project carried on intermittently since 1950. This project, when completed, is expected to provide maps of the surficial deposits of the valley between Edmundston (21 N/8)[1] and Fredericton (21 G/15)[2] map-areas. The results, in addition to their usefulness for engineering geology and soils

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1 Lee, H.A.: Surficial Geology of Edmundston, Madawaska and Temiscouata Counties, New Brunswick and Quebec; Geol. Surv., Canada, Paper 55-15 (1955).

2 -------- Surficial Geology of Fredericton, York and Sunbury Counties, New Brunswick; Geol. Surv., Canada, Paper 56-2 (1957).

purposes, should be of particular scientific interest inasmuch as the St. John River valley presents a unique opportunity to study the surficial record in a valley crossing the Appalachian Mountains and trending parallel with the direction of ice retreat.

Field work in connection with this project has been completed within the following map-areas: Grand River (21 O/5), Grand Falls (21 O/4), Aroostook (21 J/13), Andover (21 J/12), north half of Florenceville (21 J/5), and north half of Woodstock (21 J/4). Field work within the following map-areas is required to complete the project: south half of Florenceville (21 J/5), south half of Woodstock (21 J/4), and north half of Canterbury (21 G/14). Field work was completed within the following map-areas during the 1958 field season: north half of Florenceville (21 J/5), and north half of Woodstock (21 J/4). Preliminary maps are currently being prepared for the following map-areas: Grand River (21 O/5), Grand Falls (21 O/4), and Aroostook (21 J/13).

A barite occurrence was found in 1958 a few miles northeast of Woodstock. The barite does not outcrop and its extent is not known, but it occurs in a topographic depression that is about 20 feet deep, 500 feet wide, and continuous southeasterly for upwards of a mile. The mineral was found by digging, while mapping the surficial geology. About 50 pounds of barite in pieces approximately 6 inches in diameter were collected. It is mainly white and of good paint grade. It contains a little galena. The occurrence can be found by following these instructions: proceed 1.3 miles north of the east abutment of the Woodstock-Grafton bridge, along the river road; thence 1.7 miles southeast along the Woodstock-Millville highway to where the highway leaves the valley and bends to the left; thence to the second farm on the left of the road beyond the bend; thence 0.5 mile north along a private tractor road to the intersection of this road and an alder swamp. Otherwise stated, the locality is: latitude 46°09.8'; longitude 67°31.4'.

F.D. Anderson completed field work in Big Bald Mountain (21 O/1) map-area, and started his geological study and mapping of Nepisiquit Lakes (21 O/7), Riley Brook (21 O/3), and Serpentine Lake (21 O/2) map-areas. The current study of the latter three map-areas will make use of unpublished results of field work by B.R. Rose between 1935 and 1938, and will bring this early field work up to modern 1-mile standards. Field work was completed within Nepisiquit Lakes and Serpentine Lake map-areas in 1958, but additional mapping will be required to complete Riley Brook. Several new collections of fossils were obtained which should add much to our knowledge of the age of the pre-Carbonifercus strata.

W.H. Poole mapped the southeast half of Napadogan (21 J/7) map-area in 1957[1], and the northwest half in 1958. In addition, the 1958 work included some revision of the geology of the pre-Carboniferous rocks as shown on Map 11-1958.

A linear magnetic anomaly[2] that trends northeasterly across the map-area lies in most places along the southeast border of a quartzite and slate belt (Map Unit 1, Map 11-1958). On Lower and Middle Hayden Brooks, the anomaly coincides with a basic volcanic rock; and in the southwest corner of the map-area it extends into a body of closely fractured, reddened, granitic rock.

One piece of float, well mineralized with arsenopyrite and comprising about one cubic foot of material, was found on Brewer Brook 2.85 miles from its mouth on Hovey Brook. Drusy quartz cements a breccia of light grey slate and quartzite similar to Map Unit 1 of Map 11-1958. In addition to arsenopyrite, the piece contains a little sphalerite, galena, and pyrite.

E.D. Kindle continued and completed his geological study and mapping of Waterford East Half (21 H/11 E½) map-area, and extended this work to include all of Fundy National Park lying east of that map-area.

R.W. Boyle started geochemical studies of the Bathurst-Newcastle base metal district, and devoted about a month of the 1958 field season to this project. About a square mile around the Nigadoo deposit was mapped on a scale of 1 inch to 500 feet, and appropriate samples obtained from mineral deposits and country rock for laboratory and office study. In addition, J. Kalliokoski, of the Department of Geology, Princeton University, and a member of Dr. Boyle's field party, obtained specimens from all the principal base metal deposits for geothermometry studies expected to indicate the temperature of the formation of the contained sphalerite.

J.M. Johnston, a seasonal party chief, commenced the geological study and mapping of St. Leonard (21 O W½) map-area, and completed the southern half. Most of the rocks examined were mapped many years ago[3] as tightly folded

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[1]Poole, W.H.: Napadogan, York County, New Brunswick; Geol. Surv., Canada, Map 11-1958 (1958).

[2]Geological Survey of Canada: Aeromagnetic Map, Napadogan, York County, New Brunswick: Geol. Surv., Canada, Geophysics Paper 135 (1953).

[3]Bailey, L.W., and MacInnes, W.: Report on Explorations in Portions of the Counties of Victoria, Northumberland, and Restigouche, New Brunswick; Geol. Surv., Canada, Ann. Rept. (New Series), vol. 2, 1886, pt. N.

pre-Carboniferous strata. Fossil collections obtained during 1958 promise to provide further information concerning the age of these strata.

NOVA SCOTIA

W.G. Smitheringale completed field work within Bridgetown East Half (21 A/14 E½) and Gaspereau West Half (21 A/15 W½) map-areas. The results of this project are expected to provide data for Mr. Smitheringale's doctorate dissertation at Massachusetts Institute of Technology, and an appropriate map and report for publication by the Geological Survey. After completing the above field project he commenced field work within Clementsport (21 A/12 E½) map-area.

I.M. Stevenson continued and completed field work in Chedabucto Bay (11 F/6) map-area. In addition, mapping was completed in the Cape Canso appendage that projects into 11 F/7, and in the Port Howe appendage lying in the northeast quarter of 11 F/3; and some field work was done within the northwest quarter of 11 F/3.

G.A. Collins, a seasonal party chief from the staff of Nova Scotia Technical College, Halifax, commenced and completed the geological study and mapping of Arichat (11 F/11 E½) map-area.

R.H.C. Holman completed a geochemical reconnaissance of mainland Nova Scotia, commenced in 1956, by sampling and analyzing stream sediments in the following places: mainland Nova Scotia northwest of the New Glasgow-Truro line; a small area surrounding the village of East River St. Marys; and an area between Halifax and Lunenburg. The zinc content of the stream sediments was found to be anomalously high within the Cobequid Mountains between Parrsboro and Pictou. Within this zinc anomaly, high local lead anomalies were found: at Lakelands, north of Parrsboro; centred on Newton Lake, which drains into Economy River; and centred on Totten Lake, which drains into Folly River. The significance of these anomalies is being assessed.

D.G. Kelley commenced field work within St. Ann's (11 K/7) map-area, and completed the eastern three-quarters of the east half. This is the last unmapped 1-mile map-area of Cape Breton Island. The geology of the area mapped in 1958 is much as would be expected from an examination

of adjacent previously published maps[1]. Disseminated pyrite is common in rocks of the Precambrian George River group on a branch of McDonald Brook, 3 miles due west of the village of North River Bridge.

PRINCE EDWARD ISLAND

G.H. Crowl, Chairman, Department of Geology and Geography, Ohio Wesleyan University, as a seasonal party chief employed by the Geological Survey, continued the geological study and mapping of the bedrock and surficial deposits of the island. This project has been going on continuously since 1953, at the rate of one or two field parties each season. Field work within about 80 per cent of Mount Stewart West Half (11 L/7 W½) map-area was completed during 1958.

MARITIME PROVINCES AND QUEBEC

K.H. Owens made an aeromagnetic survey of those parts of New Brunswick, Nova Scotia, and Prince Edward Island for which aeromagnetic maps were not previously available, except that he did not complete the extreme northwestern corner of New Brunswick. In addition, the survey covered parts of the eastern tip of Gaspé; parts of southeastern Anticosti Island; Gulf of St. Lawrence between Gaspé, Anticosti Island, Port aux Basques of Newfoundland, Cape North of Cape Breton Island, and mainland Nova Scotia and New Brunswick; and Bay of Fundy.

Flight altitude was 1,000 feet above surface. Flight lines over land were one-half mile apart. Flight lines over water were controlled by the Decca system of navigation. This is believed to be the first time that an aeromagnetic survey has used Decca control. In these instances the flight lines followed the Decca "lanes" and their spacing was, therefore, commonly greater than one-half mile.

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Bell, W.A. and Goranson, E.A.: Bras d'Or Sheet, Cape Breton and Victoria Counties, Nova Scotia; Geol. Surv., Canada, Map 359A (1938).

MacLaren, A.S.: Cheticamp River, Inverness and Victoria Counties, Cape Breton Island, Nova Scotia; Geol. Surv., Canada, Map 55-36 (1956).

Kelley, D.G.: Baddeck, Victoria, Cape Breton, and Inverness Counties, Cape Breton Island, Nova Scotia; Geol. Surv., Canada, Map 14-1956 (1957).

An Aero-Commander aircraft was used for this project, in place of the Canso employed on previous aeromagnetic surveys. The aircraft was leased for the season, and operated by Spartan Air Services Limited under contract to the Department of Mines and Technical Surveys. As in previous similar surveys, the magnetic data were obtained with Geological Survey equipment operated by Survey staff, and will be compiled and published by the Survey.

The project involved 748.25 hours flying, and 87,931 line-miles of surveying. The field operation cost about $1.10 a line-mile, excluding salaries of continuing employees, purchases of equipment, and overhead. Similar work with the Canso aircraft during past years has cost about $2.29 a line-mile, calculated on the same basis.

The results of the aeromagnetic survey have not yet been compiled, but it is anticipated that they will provide significant information concerning submarine geology, including the extent and thickness of the New Brunswick-Nova Scotia-Prince Edward Island Carboniferous basin beneath the Gulf of St. Lawrence.

NEWFOUNDLAND

E.P. Henderson continued and completed field work required for the geological study and mapping of the surficial deposits of Conception Bay (1 N) map-area. The project has, however, been re-defined to include all of Avalon Peninsula, and about another field season will be required to complete those parts of the peninsula lying beyond the Conception Bay map-area.

Most of that part of the map-area lying west of the longitude of Holyrood, except Bay de Verde Peninsula, was mapped during 1958. This work demonstrated that Avalon Peninsula was glaciated from a local ice cap in the central part of St. Mary's Bay. No evidence was recognized that would indicate that ice from the main part of the island of Newfoundland ever extended across Avalon Peninsula; although it was demonstrated that the ice moved east-south-easterly to slightly beyond Rantem Station on the peninsula.

G.C. Riley continued the geological study and mapping of Burgeo-Ramea (11 P/11, 12, 13, and 14) map-area, and completed field work in detail appropriate to publication on a scale of 1 inch to 4 miles. Probably all the map-area was under concession at the close of the 1958 field season.

The southern part (11 P/11, 12) is underlain mainly by granitic rocks and gneisses, except on Grey River and

Goose Head Peninsulas. These peninsulas are underlain by schist and gneiss derived from sedimentary and volcanic rocks, and by minor shale, limestone, and quartzite. Tungsten-bearing quartz veins, explored by Buchans Mining Company, are in the non-granitic rocks of Grey River Peninsula.

The northern part (11 P/13, 14) is underlain by substantial areas of non-granitic rocks. The oldest formations, of Devonian (?) age, occupy a belt about 15 miles long and up to 4½ miles wide. This belt trends east-northeasterly and lies mainly within the central part of 11 P/13, but extends into the west-central part of 11 P/14. Shale, quartzite, and sandstone, likewise of Devonian (?) age, were traced from the adjacent map-area[1] westerly across the northern part of 11 P/13, and southeasterly across the northeast part of 11 P/14. These strata are accompanied by tuff in 11 P/13. Devonian (?) granitic rocks, and gneisses derived partly or wholly from sedimentary and volcanic strata, are the youngest abundant rocks and underlie most of the remainder of 11 P/13, 14.

E.R.W. Neale, who investigated the east half of Baie Verte (12 H/16) map-area in 1957[2], completed field work within the west half during 1958. In addition, field work was started in Fleur de Lys (12 I/1) map-area, and almost completed. Both map-areas were included in the Advocate Mines Concession.

The west half of Baie Verte map-area is underlain by quartz-feldspar gneisses and minor gneissic conglomerate of the Fleur de Lys group, previously regarded as Precambrian[3]. Traced northeastward into Fleur de Lys map-area, these gneisses appear to be conformably intercalated with schistose meta-volcanic rocks of the Ordovician (?) Baie Verte group. Also, it is probable that chloritic schists previously mapped within the Fleur de Lys group[4]

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1 Riley, G.C.: Red Indian Lake (West Half), Newfoundland; Geol. Surv., Canada, Map 8-1957, Map Unit 11.

2 Neale, E.R.W.: Baie Verte, White Bay and Green Bay Districts, Newfoundland; Geol. Surv., Canada, Map 10-1958 (1958).

3 Fuller, J.O.: Geology and Mineral Deposits of the Fleur de Lys Area; Geol. Surv., Newfoundland, Bull. 15 (1941).
Baird, D.M.: The Geology of the Burlington Peninsula, Newfoundland; Geol. Surv., Canada, Paper 51-21 (1951).

4 Fuller, J.O.: op. cit.

are equivalent to Baie Verte meta-volcanic rocks and merit the same attention from prospectors as the latter, a well-mineralized group. For instance, it was noted that chloritic schists of this type in the Coachman Cove region contain abundant disseminated pyrite and minor chalcopyrite.

Several thin sills and discontinuous lenses of ultrabasic rocks were mapped within the Fleur de Lys gneisses of Fleur de Lys map-area. These ultrabasic rocks occur within a belt that extends southwestward from ultrabasic bodies previously mapped[1] near Fleur de Lys village. The largest mapped in 1958 is 1½ miles north of what is locally known as Duck Island or Airbase Lake. The ultrabasic bodies may warrant prospecting for asbestos and chromite.

A preliminary map of Fleur de Lys map-area is being prepared, but a second preliminary map of Baie Verte map-area is not warranted because that part mapped during 1958 is underlain by gneisses of the Fleur de Lys group.

D.M. Baird, a seasonal party chief now on the staff of University of Ottawa, commenced and completed the geological study and mapping of Deer Lake (12 H W½) map-area. The oldest rocks, Precambrian gneisses, occupy most of the north half of the map-area. On the west, south, and southeast these are overlain by Cambrian slate and quartzite. The Cambrian strata are overlain, on the west and south, by Ordovician limestones which, in turn, are overlain by Ordovician shale, sandstone, and conglomerate. The latter outcrop throughout the western margin of the map-area except that they are intruded, between Bonne Bay and North Arm of Bay of Islands, by ultrabasic and associated intrusions. Except for Devonian (?) granite southeast of Grand Lake, much of the map-area southeast of Big Bonne Bay Pond is underlain by gently inclined sandstone, shale, and conglomerate of Mississippian and Pennsylvanian age. These strata form a northeasterly-trending basin. They are displaced by major faults that strike north-northeasterly through Grand Lake.

GENERAL

B.A. Latour continued to collect data required to maintain an up-to-date estimate of the coal reserves of Canada. Visits for this purpose were made to all producing coal mines of southern Saskatchewan, Alberta, and southeastern British Columbia.

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[1] Fuller, J.O.: Geology and Mineral Deposits of the Fleur de Lys Area; Geol. Surv., Newfoundland, Bull. 15 (1941).

C.H.R. Gauthier collected about 10 tons of material in Ontario and Quebec from which to prepare suites of rocks and minerals for sale to the public.

G.A. Gross continued his field studies of the iron deposits of Canada, spending most of the field season in southern Quebec and southern Ontario, between St. Urbain and extreme western Ontario.

C.R. McLeod continued his investigation, commenced in 1957, of the heavy mineral content of sand and gravel deposits in the Maritime Provinces. About 35 beaches were sampled, mainly on the north, east, and south coasts of New Brunswick, and on the north coast of Nova Scotia. About 70 inland deposits were sampled. These were mainly eskers, kames, kame terraces, and flood plain deposits; and delta deposits along St. John River, Miramichi River and its tributaries, and in Annapolis Valley.

R. Mulligan started a study of beryllium deposits of Canada, a project expected to culminate in an Economic Geology Series report for publication by the Geological Survey. Although only part of the field season was available for this project, an examination was made of the helvite deposit of the Low Grade claims, Needlepoint Mountain, near Cassiar, northwestern British Columbia; and of beryllium occurrences in extreme western Ontario, in the Nipigon-Beardmore district, near Mattawa, and near Renfrew.

P.M. DuBois collected samples for palaeomagnetic laboratory studies. About half the 1958 field season was spent obtaining appropriate samples of Devonian, Pennsylvanian, and Triassic rocks of Gaspé, New Brunswick, and Nova Scotia. It is anticipated that palaeomagnetic data from these samples, when compared with similar data obtained in Great Britain, will give further information concerning continental drift.

In addition, about six weeks were spent in western Ontario, including a brief excursion to Duluth in the United States. Specimens were collected from various Proterozoic rocks including the Logan sills and Lower Keweenawan sediments near the Lakehead, Duluth gabbro near Duluth, and Keweenawan lavas north of Sault Ste. Marie. Palaeomagnetic measurements made on these samples appear to have confirmed and supplemented our knowledge of the relative ages of various Keweenawan rocks as determined previously by classical geological methods. For instance, palaeomagnetic data suggest that the Duluth gabbro and Keweenawan lavas are of essentially the same age, whereas the Logan sills appear to be substantially older than the Duluth gabbro.

F.M. Vokes examined molybdenum deposits of western Quebec and eastern Ontario, of western Ontario near Sioux Lookout, and of British Columbia between Smithers and the 49th Parallel. Mr. Vokes resigned in October, but it is expected that the 1958 field work, supplemented by published and unpublished data, will permit him to prepare an Economic Geology Series report for publication by the Geological Survey.

C.H. Smith, as part of his continuing study of the ultrabasic rocks of Canada, made a reconnaissance investigation of ultrabasic bodies of the Cordillera between the 49th Parallel and Clinton Creek, Yukon, and of Northwest Territories. Some of these bodies contain asbestos, chromite, or nickel. Appropriate samples were obtained for office and laboratory investigations.