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DEPARTMENT OF ENERGY,
MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

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ANNUAL REPORT

APRIL 1, 1969 TO MARCH 31, 1970

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OTTAWA
1970

CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT - APRIL 1, 1969 to MARCH 31, 1970

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OTTAWA

1970

CONTENTS

	Page
Introduction: Y.O. Fortier	iii
Crustal Geology Division: S. Duffell, Acting Chief	1
Introduction	1
Precambrian Subdivision: M.J. Frarey	5
Cordilleran and Pacific Margin Section: J.O. Wheeler	14
Geological Research Unit	14
Information Services Unit	21
Appalachian, Eastern Lowlands and Atlantic Margin Section: W.H. Poole	23
Petrology Section: J.E. Reesor	31
Petrology laboratory	35
Lapidary services	37
Eastern Paleontology Section: T.E. Bolton	39
Geochronology Section: R.K. Wanless	45
Coal Research Section: P.A. Hacquebard	49
Economic Geology and Geochemistry Division: S.C. Robinson, Chief, J.A. Maxwell, Asst. Chief	53
Introduction	53
Special Projects: R.W. Boyle, A.H. Lang, H.W. Little	59
Geology of Mineral Deposits Section: G.A. Gross	62
Geochemistry Section: E.M. Cameron	69
Mineralogy Section: R.J. Traill	75
Analytical Chemistry Section: Sydney Abbey	80
Geomathematics and Data Processing Section: K.R. Dawson	88
National Index to Geological Data: B.A. McGee	91
Exploration Geophysics Division: G.D. Hobson, Acting Chief	93
Introduction	93
Special Projects: A.S. MacLaren	95
Electrical Methods Section: L.S. Collett	97
Magnetic Methods Section: P.J. Hood	102
Remote Sensing Methods: A.G. Darnley	109
Rock Magnetism Section: A. Larochelle	111
Seismic Section: G.D. Hobson	114
Theoretical Geophysics and Data Processing Section: B.K. Bhattacharyya	117
Institute of Sedimentary and Petroleum Geology: D.J. McLaren	120
Introduction	120
Staff Geologist: B.A. Latour	123
Administrative Services: A.W. Brusso	126
Manuscripts and Cartography Section: E.J.W. Irish	127
Geological Cartography Unit	129
Publications Distribution Office	130
Principal Research Scientist: H. Frebold	132
Senior Research Scientists: H.R. Belyea, R. Thorsteinsson	133

Page

Arctic Islands Section: R.L. Christie 134
Structural Geology Section: D.K. Norris 137
Paleozoic Stratigraphy Section: A.W. Norris 142
Mesozoic Stratigraphy Section: D.F. Stott 147
Western Paleontology Section: B.S. Norford 152
Macropaleontology laboratory 154
Micropaleontology laboratory 154
Palynology laboratory 155
Petroleum Geology Section: R.G. McCrossan 159

Quaternary Research and Geomorphology Division: J.G. Fyles, Chief 162
Introduction 162
Regional and Stratigraphic Studies 166
Engineering Geology and Geodynamics Section: J.S. Scott 173
Sedimentology laboratories 173
Calgary laboratory 174
Paleontology and Geochronology Section: W. Blake, Jr. 178

Manuscripts and Cartography: P. Harker 181
Geological Cartography: C.E. McNeil 184
Publications Distribution: L. Touchette 186

National Advisory Committee on Research in the Geological Sciences: J.F. Henderson 187

Administrative Services
Secretarial Services: Mrs. B. Richard 189
Photographic Services: J.B. Emslie 190
Instrument Development Shop: G.A. Meilleur 192

Library: Mrs. D.M. Sutherland 193

Appendix
Staff List 196
Organization Chart 204
Geological map coverage (bedrock, surficial, aeromagnetic) .. in pocket

ANNUAL REPORT April 1 1969 to March 31 1970

GEOLOGICAL SURVEY OF CANADA

INTRODUCTION

Y. O. Fortier, Director

This report, intended for departmental use but not for publication, presents an accounting of the activities of all the components which comprise the Geological Survey of Canada. In previous years detailed information was provided on most active projects but as these data are already available through our internal reporting procedures only project numbers, project titles and responsible officers are listed in this report for this aspect of our work.

The Geological Survey has grown from a 2-man survey at its founding in 1842 to an organization with a continuing staff of more than 450 that maintains a capability in mapping, detection, interpretation, research, and advice in the geological sciences including mineralogy and paleontology, the complementary aspects of geophysics, geochemistry and physical geography, and in the necessary supporting disciplines. Through these activities it provides a comprehensive, descriptive and interpretative, national and regional inventory of formations of rocks and surficial materials, their structures, contained minerals, containing landforms, and conditions of stability; and develops concepts and techniques in order to maintain the standard of the inventory in conformity with national requirements, to increase the usefulness of the inventory, to enhance the effectiveness of exploration for earth resources, and to promote our ability to contend with the physical environment.

The Geological Survey thus assists the Department to achieve its objectives by providing knowledge and methods which simultaneously contribute:

1. to the identification and inventory of mineral, water and energy resources; to the promotion of exploration for these resources and to their development; to the management of their development and utilization with a scientific base for enlightened administration and best conservation practice;

2. to the identification and inventory of the physical environment – the nature, dynamics, and factors of stability and balance of its terrains, subsoils and landforms, of its rock formations and structures

physiographically expressed, their chemical and physical characteristics related to pollution, waste disposal, construction engineering, renewable resources, rehabilitation from utilization – and to the identification of geological hazards; to promote effective and efficient development and utilization of the environment, on site or by extraction of its resources; to the management of the environment according to best conservation and administrative practices;

3. to the programs of other departments and agencies, by the same and related contributions and by the advice of its specialists; and to the national and international scientific communities through the above activities and through the branch's unique position as a central, national, operational centre of excellence in the Earth Sciences, achieved through its spectrum of specialists in various disciplines and their acknowledged performance.

During the report period we had 489 active projects of which 221 had a field component. Although most field projects were directed by permanent officers some were led by temporary staff members including university professors and postdoctoral fellows. Some studies such as those of the Pacific Continental Margin were carried out under contract as were aeromagnetic surveys and some airborne geophysics developmental work.

Our role in the study of lunar material brought back by Apollo XI astronauts drew much interest from the public and nearly 25,000 people including H. R. H. Prince Philip and Governor-General and Mrs. Mitchener visited the display of the samples in October.

To stimulate and support research in the solid earth sciences at Canadian universities the National Advisory Committee on Research in the Geological Sciences awarded $225,242 in general grants-in-aid.

During the report period we published 3 memoirs, 2 economic geology reports, 13 bulletins, 77 papers, 9 preliminary maps, 23 coloured (final) maps, (including those included in some of the above reports) and 395 new aeromagnetic maps as well as reprinting numerous items including 403 aeromagnetic maps. More than 430,000 items were distributed through the Ottawa office, an increase of more than 18% over the previous year. The dollar value of the departmental reports distributed through the Institute of Sedimentary and Petroleum Geology more than doubled last year and the same trend occurred in Vancouver where in excess of 27,000 Survey publications were sold. More than 9,350 standard sets of minerals and rocks were distributed as well as 151 special 120-specimen sets.

Members of the staff published 161 papers in outside journals, gave 97 addresses to scientific meetings, seminars etc. and delivered 76 university lectures. Several of our staff participated in the presentation of university courses.

The report period saw the virtual completion of the preparation of the 5th edition of "Geology and Economic Minerals of Canada" a task that has, for the past several years, involved many staff members. Four additional maps of the 1:5,000,000 series that will accompany the report were published during the year as well as the French language edition of the Geological Map of Canada. It is anticipated that the French edition of the Tectonic Map and the English edition of the Physiographic Map will be released during May 1970.

DIVISION OF CRUSTAL GEOLOGY

S. Duffell - Acting Chief

INTRODUCTION

The prime objective of the Division is to study and interpret the folded, metamorphosed and igneous rocks that form the earth's crust under Canada in order to provide the basic geological data required to forecast, discover and evaluate Canada's mineral resources and to provide scientific knowledge on the origin and historical evolution of the earth's crust under Canada.

The Division at present has a staff of 92 including 69 professionals, and 23 support staff. This is enlarged during the field season by the hiring of summer students and casually employed other help to bring the total man year usage to 131. Three Post Doctorate Fellows were working on projects during the past year but two completed and left before the end of 1969. The other will continue his term until the end of 1970. Active projects in the Division during the report year numbered 150.

Top priority programme in the Division is the completion of the broad scale reconnaissance of the unmapped portions of Canada at scales of 1"-8 miles and 1"-16 miles. At the present rate it is anticipated that this programme will be completed by the mid 1970's. Major existing gaps are still present on Baffin Island, Labrador and northern Quebec and the more inaccessible parts of British Columbia and the Yukon. At the same time there is a need to reassess previous work to determine where more detailed mapping and investigation must be done in order to elucidate complex geology. Projects arising from such an assessment would best be conducted by an interdisciplinary group designed to solve the particular problems at hand.

The Division continues it's efforts on the longer term applied or (basic) research in the fields of petrology, volcanism, sedimentation, stratigraphy, coal research, structural geology and geochronology in a program designed to increase our knowledge of the geology of Canada and to provide guidelines in the search for mineral resources, to aid in urban and regional development and to provide information for environmental studies.

In addition to the Administrative unit consisting of Division Chief, Staff Geologist, Administrative Officer, Secretary and Clerk, the Division includes 7 scientific units or sections. Three of these, Cordilleran and Pacific Margins, Precambrian, and Appalachian, Eastern Lowlands and Atlantic Margin are responsible for the investigation of the geology of these three great regions of Canada. In addition, there are four support or complementary units namely Geochronology, Eastern Paleontology, Petrology and Coal Research conducting laboratory and/or topical field research problems to assist in the interpretation and understanding of the broader geological problems being studied by the regional sections. Except for the Cordilleran and Pacific

Margin Section which is located in Vancouver the remainder of the Division is housed in the main Geological Survey of Canada building, 601 Booth Street, Ottawa.

In Ottawa, the Division administration together with the Appalachian, Eastern Lowland and Atlantic Margins Section, Precambrian and Petrology Sections are located on the fourth floor. Eastern Paleontology and Coal Research are located on the sixth floor and the Geochronology Section on the seventh floor of the Geological Survey building.

Division administration continued to be heavily involved in the institution and application of new management and reporting systems introduced into the Branch. Some of these systems were introduced previously and new innovations as well as entirely new formats were added during the year. It is hoped that each of these new innovations will eventually lead to improvement but the amount of paper work required to satisfy the demands of these new formats is too great for the present Division staff to handle even with a great deal of overtime. It is imperative that more support staff be made available to properly process the paper load and allow the scientific staff the required time for discussion with project leaders on scientific matters. The Division has one Administrative officer who is attempting to carry the increasing purely administrative load which has now reached the stage where it is a physical impossibility. It is absolutely necessary that help be given in this area in the form of increased staff.

The Division has experienced a busy year scientifically. During the field season it mounted 49 field projects varying from small topical investigations to large helicopter supported regional reconnaissance surveys.

The Division is heavily involved in the preparation of a series of 1:1,000,000 scale regional compilations planned by the Survey. This programme has just commenced and it is expected that ten maps will be completed during the coming year.

During the year the members of the Division published through the Survey 2 Memoirs, 3 Bulletins, 16 Papers, 8 A Series Maps and in addition published 50 papers in outside journals.

Members of the Division also gave a total of 67 talks to various meetings and institutions throughout the year.

Dr. Smith, Chief of the Division, continued his secondment to the Science Secretariat as Project Officer for the Solid Earth Science Study and was absent for the whole year. On completion of his role as Project Officer he was seconded to Departmental Headquarters to institute a Departmental Planning Branch.

Other highlights during the year were the Precambrian Workshop on Proterozoic Basins and Geosynclines held in Ottawa in March of 1970, and the activities of the Cordilleran Section in the organization and conduct of two major meetings in Vancouver. The meetings in Vancouver were a symposium on "Global Tectonics and the Pacific Continental Margin" organized by the Cordilleran Section of the Geological Association of Canada and a symposium on "Decision Making in Mineral Exploration". The Division felt honoured indeed to have five members of the Cordilleran Section invited specifically to participate in the Geological Society of America Penrose Conference on "The Meaning of the New Global Tectonics for Magmatism, Sedimentation and Metamorphism in Orogenic Belts".

Dr. C.H. Stockwell was retained as a consultant on Precambrian geology and Special Projects. During the year he completed a draft of a paper on Pontiac-Temiskaming relationships in the Rouyn area of the Precambrian Shield and conducted library research for a manuscript on geochronology in the Canadian Shield. Unfortunately he was stricken by a heart attack toward the end of the year and has not yet recovered from this illness.

PERSONNEL CHANGES

During the year the following personnel changes accurred in the Division:

R.T. Bell, A.M. Goodwin, D.G. Kelley, H. Hofmann and P. Dunsford resigned from the Division to take employment elsewhere.

P.F. Hoffman, J.B. Henderson, T. Gordon, R.H. Ridler and H. Helmstaedt joined the staff during the year.

R.F. Emslie spent the winter at the Geophysical Laboratory in Washington conducting petrological research on anorthosites. Administratively he was transferred to the Petrology Section.

H.W. Tipper, H. Gabrielse and G. Eisbacher transferred from Ottawa to the Vancouver office.

ATTENDANCE AT MEETINGS

S. Duffell attended the following meetings during the year:

1. Royal Society of Canada, Earth Science Subdivision Ottawa; May-June 1969.

2. Manitoba Department of Mines Symposium on 1969 field work; Winnipeg, Nov. 1969.

3. Annual meeting Prospectors and Developers Association; Toronto, March 1970.

ACTIVE PROJECTS DURING REPORT YEAR.

690025	G. Eisbacher	Regional structural study in the Elliot Lake area, Ontario.
690032	G. Eisbacher	Tectonic Framework of Sustut and Sifton Basins.
690033	G. Eisbacher	Regionalization of Crustal Stresses in Canada: Assessment of techniques.
690059	C.H. Stockwell	Temiskaming-Pontiac relationships, Noranda area, Quebec.
690060	C.H. Stockwell	Geochronology of the Canadian Shield.

PRECAMBRIAN SUBDIVISION

M.J. Frarey

The Precambrian Subdivision with a staff of 22 officers is responsible for geological investigations of rocks in the Canadian Shield. Objectives of these investigations are to determine the composition, stratigraphy, structure, origin and evolution of these rocks and to publish these results in appropriate maps, reports, and papers. Such data and results contribute to the continuing effort to define the geological history of the Precambrian Shield and to evaluate its mineral resource potential as a guide to future exploration and development.

Activities of the Subdivision are divided between initial reconnaissance programs and more detailed studies of areas and problems. The amount of unmapped territory in the Canadian Shield was further reduced in the report year by the reconnaissance mapping of large areas in Labrador and northern Quebec and on Southampton Island, and preparations are in progress for Operation Penny Highlands, a helicopter-supported project that will essentially complete initial geological coverage of Baffin Island in 1970. Thereafter, parts of Melville Peninsula and the northern extremity of Quebec lying west of Ungava Bay will constitute the only sizeable unmapped parts of the Shield.

Coverage of the unmapped terrain will allow more of the resources of the Subdivision to be available for the study of geological problems previously recognized, for closer examination of areas recommended as a result of the initial surveys, and for revision and remapping of other areas considered to be inadequately covered by modern standards. These future problem studies and remapping projects in the Canadian Shield will require long-term, continuing programs in order to attain an adequate level of knowledge and understanding and thus a meaningful geological foundation. These goals are essential for future mineral development throughout the Canadian Shield, particularly in the Northwest Territories where geological knowledge is still rudimentary over large regions. To facilitate future planning for the mainland Northwest Territories, all four-mile N.T.S. blocks have been systematically appraised geologically and assigned priorities for future investigation.

In 1969, fifteen staff members spent full seasons in the field. In addition two Ph.D. candidates, one post-doctoral fellow, and one professor completed full seasons under the auspices of the Subdivision. In the reconnaissance sphere, W.W. Heywood, in overall charge of Operation Southampton Island, mapped the Precambrian part of the island with the support of W.L. Davison. F.C. Taylor, supported by E.W. Reinhardt, W.C. Morgan and E. Froese, carried out Operation Torngat II comprising 20,000 square miles in Labrador and northern Quebec. Unfortunately, inclement weather prevented completion of the latter project and roughly 8,000 square miles remain unmapped in that region.

Other projects covered a wide scientific and disciplinary range. Examples are the investigation of the Ennadai belt of the District of Keewatin (Davidson and Eade), stratigraphic research and reconnaissance mapping in the Coppermine region (Baragar and Donaldson), stratigraphic - sedimentological studies of the Epworth Group near Coronation Gulf, N.W.T. (Hoffman), the restudy of Archean terrain in Manitoba (Ermanovics), and the stratigraphic and petrochemical investigation of previously unmapped Keweeawan lavas on

Michipicoten Island, Lake Superior (Annells). All such projects carry strong economic implications and relevance in addition to their scientific importance. As in the past the majority of parties and the bulk of the financial resources of the Subdivision were directed to field work in Canada's for north: in the report year over 85% of the operational expenditure went to finance activities north of the sixtieth parallel of latitude.

Members of the Subdivision participated in weekly seminars, organized by Dr. Baer, and dealing with the geology of Grenville Province. This group included specialists from Carleton University and the University of Ottawa. Many of the staff also took the opportunity to update their knowledge of sedimentary geology by attending a series of lectures on Sedimentary Environments given by P.F. Hoffman. A highlight of the year was a two-day workshop, organized and managed by the Subdivision, on "Precambrian Basins and Geosynclines" held at Camsell Hall. This conference heard eight papers by staff and former staff members, two of which were co-authored by geologists of provincial departments of mines and university faculty members. A closing address of review and appraisal by Professor F.J. Pettijohn of the Johns Hopkins University, was followed by an extensive discussion of the papers. The eight papers were wholly or in part the results of Subdivision projects, and the organizers were gratified by the large number of provincial governments and universities that sent delegates to this conference.

As is customary, a large number of visitors from the mining industry consulted with geologists of the Subdivision on matters pertaining to economic aspects and geological problems of various areas.

During 1969-70, officers of the Subdivision published 5 preliminary maps and papers, 10 memoirs, terminal maps and papers, and 1 bulletin. 7 papers were published in outside scientific journals. In addition, 3 manuscripts for papers and preliminary maps, 4 memoir or bulletins, and 3 outside papers were submitted.

PERSONNEL CHANGES

R.T. Bell resigned from the Survey in Sept. 1969 to join the staff of the Geology Department, Brock University.

R.F. Emslie transferred to the Petrology Section and moved his work to the Geophysical Laboratory in Washington, D.C.

A.M. Goodwin resigned in Sept. 1969 to join the staff of the University of Toronto as professor in the Department of Geology.

J.B. Henderson joined the staff in December, 1969.

P.F. Hoffman joined the staff in June, 1969.

ATTENDANCE AT MEETINGS

Canadian Institute of Mining and Metallurgists Convention, Montreal, Quebec - April 20-29, 1969.

- I.M. Stevenson, W.R.A. Baragar.

Geological Society of America, Eastern Section, Albany, N.Y. - April, 1969.

- H.H. Bostock, A.M. Goodwin, R.F. Emslie, J.C. McGlynn.

Friends of the Precambrian, Killarney, Ontario. - May, 1969.

- A. Davidson, H.H. Bostock.

Sub-Committee on Volcanology, Noranda, Quebec. - May, 1969.

- W.R.A. Baragar, A.M. Goodwin.

Fifteenth Annual Institute on Lake Superior Geology, Oshkosh, Wis. - May 6-10, 1969.

- F.C. Taylor, C.K. Bell.

Geological Association of Canada/ Mineralogical Association of Canada Annual Meeting, Montreal, Quebec. - June 3-8, 1969.

- W.C. Morgan, L.P. Tremblay, G.D. Jackson.

International Association of Volcanology and Chemistry of the Earth Interior Symposium on Roots of Volcanos, Scotland. - Aug. 30 - Sept. 6, 1969.

- W.R.A. Baragar.

Sub-Committee of Working Group on Geological Field Data, Queen's University, Kingston, Ontario. - Oct. 3 and 4, 1969.

- E.W. Reinhardt.

Workshop in computer processing of Geological Data, University of Western Ontario, London, Ontario. - Oct. 5-8, 1969.

- G.D. Jackson.

Saskatchewan Geological Society Conference Regina, Saskatchewan. - Oct. 29-31, 1969.

- C.K. Bell.

Geological Society of America Annual Meeting, Atlantic City, N.J. - Nov. 10-12, 1969.

- I.F. Ermanovics, M.J. Frarey, G.D. Jackson.

Geological Association of Canada, Cordilleran Section Symposium on Canadian Pacific Margin and Global Tectonics, Vancouver, B.C. - Feb. 13 & 14, 1970.

- A.J. Baer.

Annual Meeting of the Prospectors and Developers Association, Toronto, Ontario. - March 8-11, 1970.

- K.E. Eade, W.W. Heywood.

American Geophysical Union, Washington, D.C. - April, 1969.

- E.W. Reinhardt.

3rd Canadian Conference on Research and Tectonics, and Structural Geology Subcommittee of National Advisory Committee, Winnipeg, Man. - March 1970.

- W.C. Morgan.

MEMBERSHIP ON COMMITTEES

A.J. Baer	- Member, Organizing Committee for conference on Precambrian Basins and Geosynclines.
W.R.A. Baragar	- Member, Volcanology Subcommittee of Associate Committee on Geodesy and Geophysics of N.R.C.
K.E. Eade	- Member of Review Panel for Research Committee, Arctic Institute of North America.
M.J. Frarey	- Member, American Commission on Stratigraphic Nomenclature. - Member, Federal-Provincial Committee on Huronian Stratigraphy. - Member, Organizing Committee for Conference on Precambrian Basins and Geosynclines.
J.A. Fraser	- Member, Organizing Committee for Conference on Precambrian Basins and Geosynclines.
W.W. Heywood	- Member, G.S.C. Safety Committee for field survey operations.
G.D. Jackson	- Alternate, Branch Computer Facilities Committee, G.S.C.
J.C. McGlynn	- Age Determination Committee, G.S.C. - G.S.C. Stratigraphic Committee.
W.C. Morgan	- Member, Structural Geology Subcommittee of National Advisory Committee for Research in the Geological Sciences.
E.W. Reinhardt	- Member, Subcommittee on Geological Field Data of the Standing Committee on Storage and Retrieval of Geological Data (NAC). - Member, G.S.C. Branch Computer Facilities Committee.

F.C. Taylor - Chairman, Departmental Equipment Committee.

L.P. Tremblay - Program Co-ordinator, International Geological Congress (1972).

SPECIAL TALKS

Annels, R.N. - "Volcanic Geology of Iceland" G.S.C., Ottawa, May 1969.

Baragar, W.R.A. - "Geochemistry of the Coppermine Basalts". C.I.M.M. annual meeting, Montreal, April 1969.

Baer, A.J. - "Subdivision of the southern Grenville Province". G.S.A., Atlantic City, N.J., Nov. 1969. (Presented by M.J. Frarey).

Ermanovics, I.F. - "Flowage Differentiation in Monzonitic Rocks of the Grenville Province of southeastern Ontario". G.S.A. Atlantic City, N.J., Nov. 1969.

Hoffman, P.F. - "Depositional History of a Precambrian Geosyncline", Institute of Sedimentary and Petroleum Geology, Calgary, Nov. 1969; University of Ottawa, Nov. 1969; University of Montreal, Dec. 1969; Johns Hopkins University, Oct. 1969; Laurentian University, Jan. 1970, Queen's University, Jan. 1970; University of Massachsetts, Feb. 1970; Suny, New Pulse, Feb. 1970; University of Western Ontario, Mar. 1970.

- "Scum of the Earth" (Recent Carbonate Tidal Flat Sediments), Institute of Sedimentary and Petroleum Geology, Calgary, Nov. 1969; Queen's University, Jan. 1970, University of Mass., Feb. 1970; University of Western Ontario, Mar. 1970.

- "Coronation Geosyncline of Aphebian Age" Workshop on Precambrian Basins and Geosynclines, Ottawa, Mar. 1970, (written with J.C. McGlynn and J.A. Fraser).

McGlynn, J.C. - "Archean Volcanism and Sedimentation in the Slave Province" Workshop on Precambrian Basins and Geosynclines, Ottawa, Mar. 1970, (written with J.B. Henderson).

OUTSIDE PAPERS

Baer, A.J.
(1969) - Subdivision of the southern Grenville Province; G.S.A. abstracts, pt.7, p.6.

(1970) - The Grenville Province; C.I.M.M. Bull., vol.63, no.694, p. 200-203.

Baragar, W.R.A., Goodwin, A.M.
(1969) - Andesites and Archean Volcanism of the Canadian Shield; Proceedings of the Andesite Conference, Ed. A.R. McBirney, Bull. 65, Oregon Dept. of Geology and Mineral Industries.

Ermanovics, I.
(1969) - Flowage Differentiation in Monzonitic rocks of the Grenville Province of southeastern Ontario; G.S.A., abstracts, pt.7, p.58.

(1970) - Granites, 'Granite Gneiss' and Tectonic Variation of the Superior Province in southeastern Manitoba; in Precambrian Geology of Manitoba - Geol. Assoc. of Canada, Symposium on the Geology of Manitoba. A. Turnock, editor.

Fahrig W.F. & Jones, D.L.
(1969) - Paleomagnetic evidence for the extent of Mackenzie igneous events; Can. Jour. Earth Sci., vol. 6, no.4 (pt. 1), p.679-688.

Robertson, J.A., Frarey, M.J. and Card, K.D.
(1969) - The Federal-Provincial Committee on Huronian Stratigraphy; Progress Report Can. Jour. Earth Sci., vol.6, no.2, p.335.

Hoffman, P.F.
(1969) - Proterozoic Paleocurrent and Depositional History of the East Arm Fold Belt, Great Slave Lake, District of Mackenzie; Can. Jour. Earth Sci., vol. 6, no. 3, p.441-462.

(1969) - Base Metals Exploration in the Coppermine River Area; Northern Miner; 1969 Annual Review Number, page 11. (Nov. 27, 1969).

Hofmann H.J., Jackson, G.D.
(1969) - Precambrian (Aphebian) Microfossils from Belcher Islands, Hudson Bay; Can. Jour. Earth Sci., vol. 6, no.5, p.1137-1144.

ACTIVE PROJECTS DURING REPORT YEAR

490013 Fahrig, W.F.	Labrador-Quebec iron belt, near Schefferville.
540025 Bell, C.K.	Milliken Lake area, Saskatchewan.
580003 Jackson, G.D.	Belcher Islands, N.W.T.
590019 Jackson, G.D.	Roads to Resources Project.
600002 Heywood, W.W.	Operation Back River.
600004 McGlynn, J.C.	Regional correlation - northwestn Canadian Shield.

610030	Frarey, M.J.	Huronian rocks north of Lake Huron.
610044	Fahrig, W.F.	Diabase dykes of the Canadian Shield.
620001	Blackadar, R.G.	Operation Prince of Wales.
620004	Eade, K.E.	Kognak River area, N.W.T.
620012	Baragar, W.R.A.	Geochemical and petrologic study of Yellowknife volcanic rocks.
620288	Eade, K.E. & Fahrig, W.F.	Element abundances of the Canadian Shield.
630009	Donaldson, J.A.	Dubawnt Group sediments, N.W.T.
630025	Bell, C.K.	Geological investigations across the boundary between the Churchill and Superior tectonic provinces.
630032	Jackson, G.D.	Opocopa map-area, Quebec-Labrador.
640005	Heywood, W.W.	Operation Wager.
640010	Tremblay, L.P.	Yellowknife and Goulburn rocks in the Contwoyto Lake area, N.W.T.
640011	Bostock, H.H.	Itchen Lake map-area.
640036	Frarey, M.J.	Lake Panache and Collins Inlet areas, Ontario.
640039	Emslie, R.F.	Morin anorthosite, Quebec.
640423	Tremblay, L.P.	Source rock for uranium in the Beaverlodge area.
650008	McGlynn, J.C.	Stratigraphy, sedimentology and correlation of the Nonacho Group, N.W.T.
650009	Reinhardt, E.W.	Petrologic and structural study of the MacDonald fault system south of Great Slave Lake.
650044	Baragar, W.R.A.	Volcanic studies in the Noranda region, Ontario-Quebec.
650046	Stevenson, I.M.	Operation Northwest River.
660005	Heywood, W.W.	Tavani map-area, Keewatin.
660006	Davidson, A.	Granite studies in the Ennadai-Rankin Inlet region.

660007	Baragar, W.R.A.	Studies of the Coppermine River volcanic rocks, N.W.T.
660009	Hoffman, P.F.	A sedimentological and stratigraphic study of the Great Slave and Et-Then Groups in the East Arm fold belt, Great Slave Lake.
660011	Ridler, R.H.	The interrelation of the Archean volcanic stratigraphy and mineral deposits of the Kirkland Lake area.
660012	Goodwin, A.M.	Volcanic studies in the Timmins-Kirkland Lake-Noranda area.
660013	Taylor, F.C.	Operation Torngat.
660014	Emslie, R.F.	Michikamau anorthosite, Labrador.
660015	Williams, F.M.G.	A structural metamorphic and petrological study of the Naskaupi and older fold belts of the Grenville and Nain provinces.
670002	Jackson, G.D.	Operation Bylot.
670004	Bell, R.T.	Study of the Hurwitz Group in the eastern part of the Rankin-Ennadai belt.
670005	Fraser, J.A.	Nature of the Thelon Front, N.W.T.
670006	Henderson, J.B.	Sedimentology of the Yellowknife Group, N.W.T.
670569	Donaldson, J.A.	Clay minerals in Proterozoic sediments.
680012	McGlynn, J.C.	Paleomagnetic study of Proterozoic red beds in the Western Canadian Shield.
680030	Baer, A.J.	Geology of the Precambrian Shield in the Rivière Gatineau map-area.
680057	Donaldson, J.A.	Sedimentological study of the Hornby Group.
680074	Davison, W.L.	Geology of the Seal River map-area, Manitoba.
680076	Davison, W.L.	Geology of Southern Indian Lake.
680085	Eade, K.E.	Structural and stratigraphic study of the Precambrian rocks of southwestern Keewatin, N.W.T.
680092	Heywood, W.W.	Geology of Southampton Island.
680096	Baragar, W.R.A.	Studies in the Seal Lake volcanic province.

680115	Annells, R.N.	Keewanawan volcanic succession, Sault Ste. Marie.
680135	Fahrig, W.F.	Basin analysis of the Athabasca sedimentary basin.
680145	Goodwin, A.M.	Associate Editor for Precambrian Shield, Geological Society of America.
690001	Goodwin, A.M.	Volcanic studies in the Michipicoten area, Ontario.
690010	Ermanovics, I.F.	Berens River-Deer Lake map-area, Manitoba and Ontario.
690024	Hoffman, P.F.	A stratigraphic, sedimentological, and paleontological study of the Epworth Group, north central District of Mackenzie.
690025	Donaldson, J.A.	Sedimentary geology of the Coppermine area.
690028	Fraser, J.A.	Operations Coppermine and Bathurst Inlet.
690031	Goodwin, A.M.	Volcanic studies in the Flin Flon area.
690058	Hogarth, D.	Geology of part of Gatineau Park, Quebec.
690061	Jackson, G.D.	Operation Penny Highlands.

CORDILLERAN AND PACIFIC MARGIN SECTION

J.O. Wheeler

The Cordilleran and Pacific Margin Section consists of a Geological Research unit and an Information Services Unit.

GEOLOGICAL RESEARCH UNIT

This unit having 13 officers, 1 technician, and 1 clerk based in Vancouver, B.C. conducts geological research in the complex Cordilleran orogen. It publishes maps, reports, and scientific papers which describe the general composition, structure, origin, and geological development of the Cordillera and relates these to the mineral deposits of the region as base for future mineral exploration and as an aid for planning the orderly development in man's environment in the area. It supports by contract a submarine geology program on Pacific Continental Shelf by the Department of Geology at the University of British Columbia and also provides micropaleontological assistance. The investigations in many areas supplement or are supplemented by related cooperative activities by geologists from other divisions of the Geological Survey of Canada and the Mineralogical Branch of the British Columbia Department of Mines and Petroleum Resources. Although current activities are mainly directed towards completion of the reconnaissance phase of the regional investigations in which data and conclusions on structure and stratigraphy are integrated to develop the broad tectonic picture, other more detailed studies are also in progress. These include volcanological studies in Tertiary and Recent and Mesozoic volcanic rocks, structural investigations,some of which contribute to the southern Cordilleran Structure Project, stratigraphic projects restricted to particular groups of rocks such as the Permo-Carboniferous Cache Creek Group, the Upper Cretaceous and Tertiary Sustut Formation, and the Tertiary rocks of the west coast of Vancouver Island, and studies of plutonic rocks of the Coast Mountains Project.

Full field seasons were undertaken by seven members of the section in 1969. S.L. Blusson and D.J. Tempelman-Kluit were engaged in 4-mile mapping on Operation Stewart - a block of 20,000 square miles in Yukon and Northwest Territories. J.G. Souther undertook pilot volcanic studies in the Mesozoic sequences of Stikine Arch while J.W.H. Monger investigated the Permo-Carboniferous stratigraphy in the same region. R.B. Campbell revised his early work in Cariboo Mountains and continued his studies on the relationship between metamorphic grade and structural style. G.H. Eisbacher began his studies on the relationship of the Sustut Formation and its relations to the earlier Mesozoic rocks in northern British Columbia. J.E. Muller continued 4-mile mapping in northern Vancouver Island.

The remainder of the staff was engaged mainly in office and laboratory studies with short periods spent in the field.

Section office projects consisted of final compilation of the Metamorphic Map of the Cordillera accompanied by a text by W.W. Hutchison and J.W.H. Monger. Most members of the Section are contributing to compilation of 1:1 million geological maps - a project begun in March.

In addition to their normal office duties, officers of the section are frequently consulted by members of the mineral industry. They have also given lectures at the University of British Columbia, to the Cordilleran Section of the Geological Association of Canada, played leading roles in the G.A.C. Symposium on "Global Tectonics and the Pacific Continental Margin" and in the Symposium on "Decision Making in Mineral Exploration". Five of the section were selected to participate in the Geological Society of America Penrose Conference at Pacific Grove, California on "The meaning of the New Global Tectonics for Magmatism, Sedimentation, and Metamorphism in Orogenic Belts".

Professor Jean Dercourt of the University of Lille, France, visited officers of the Section both in the field and in the office as part of his comparative studies between the Canadian Cordillera and the Hellenides. Two of his students, J.L. Mansy and J. Terry, engaged in these studies, occupied offices in the Vancouver quarters. The exchange of ideas with these European geologists has been most stimulating.

During 1969-70 officers of the Cordilleran Section published 3 papers, 1 map, and 7 outside papers; submitted 6 papers, 2 preliminary maps, 1 memoir, 3 final maps, and 10 outside papers; and made 27 oral presentations.

PERSONNEL CHANGES

P. Dunsford, technician, resigned at the end of May. He was succeeded by B. Clayden (casual) in September. H. Gabrielse and H.W. Tipper moved from Ottawa in June.

ATTENDANCE AT MEETINGS

Alaskan Science Conference - Fairbanks, August 24-27, 1969.

- S.L. Blusson.

Symposium on "Decision making in Exploration III", Vancouver, January 1970.

- S.L. Blusson, W.W. Hutchison, J.A. Roddick.

Symposium on "Canadian Pacific Continental Margin & Global Tectonics", Vancouver. February, 1970.

- S.L. Blusson, B.E.B. Cameron, R.B. Campbell, G.H. Eisbacher, W.W. Hutchison, H. Gabrielse, J. Monger, J.E. Muller, J.G. Souther, J.A. Roddick, D.J. Tempelman-Kluit, H.W. Tipper, J.O. Wheeler.

C.I.M.M. - Western Meeting, Kimberley, B.C. October 1969.

- R.B. Campbell.

Penrose Conference, Monterey, California, December 1969.

- W.W. Hutchison, H. Gabrielse, J.G. Souther, J.A. Roddick, J.O. Wheeler.

Symposium on Man and Environments in northwest North America, University of Calgary, January 1970.

- J.G. Souther.

Royal Society of Canada, Earth Science Subdivision, Ottawa. May - June 1969.

- J.O. Wheeler.

American Geophysical Union Meeting, San Francisco, December 1969.

- G.H. Eisbacher.

MEMBERSHIP ON COMMITTEES

B.E.B. Cameron	- Co-chairman, Society of Economic Paleontologists and Mineralogists, Vancouver.
W.W. Hutchison	- Member, Ad Hoc Committee on Decision Making and Mineral Exploration, Vancouver.
	- Member, Computer Applications in Geological Sciences, appointed to main committee.
	- Sub-committee on Geological Field Data.
	- Secretary-Treasurer, Geological Association of Canada, Cordilleran Section.
J.O. Wheeler	- Vice President (1969-70), Geological Association of Canada.
	- Member, Canadian Geological Foundation.
	- Member, N.R.C. Subcommittee on Geodynamics.
	- Member, G.S.A. Committee on Nominations.
	- Member, Organizing Committee 24th International Geological Congress - Coordinator of Field Trips Western Cordillera.

G.H. Eisbacher - Member, NAC Subcommittee on Structural Geology.

SPECIAL TALKS

Cameron, B.E.B. - "Summary account of Tertiary foraminifera of Vancouver Island and the adjacent Continental Shelf", Geological Association of Canada, Cordilleran Section Symposium, Vancouver, February 1970.

- "Introduction to Foraminifera", lectures to undergraduate students, University of British Columbia, Vancouver.

- "Foraminiferal Paleoecology and Environmental Interpretation", graduate students, University of British Columbia, Vancouver.

Campbell, R.B. - "Geology and Exploration Potential of the Quesnel Trough, B.C.", Western Meeting of C.I.M.M., Kimberley, B.C., October, 1969 (co-authored with H.W. Tipper).

- "Structural Elements and Metamorphism of the Cariboo Mountians, B.C.", Geological Association of Canada, Cordilleran Section, Vancouver, March 1970.

Eisbacher, G.H. - "Remanent Stresses and Tectonics", American Geophysical Union, San Francisco, California, December 1969.

- "Kinematic and Dynamic Interpretation of the Cobequid Mylonite Zone", Canadian Conference on Research in Tectonics, Winnipeg, March 1970.

Gabrielse, H. - "Granitic plutons, compositions, succession, and relationship to metamorphism and orogeny in Omineca Geanticline", Penrose Conference, Pacific Grove, California, December 19, 1969.

- "Some Aspects of Yukon Geology", Graduate Seminar Group, University of B.C., February 5, 1970.

- "Introduction to Crustal-Plate Tectonics", Cordilleran Section of G.A.C. Meeting, February 13, 1970.

- "A stratigraphic outline of southwestern Mackenzie and adjacent Selwyn Mountains", Institute of Sedimentary and Petroleum Geology, G.S.C., Calgary, March 18, 1970.

Hutchison, W.W. - "Evolution of Coast Mountains", B.C., Penrose Conference, Pacific Grove, California, December, 1969.

- "Tectonic elements of the Coast Mountains metamorphic and plutonic complex", Cordilleran Section of G.A.C. Meeting, February 14, 1970.

Monger, J.W.H. - "Tectonic significance of Upper Paleozoic oceanic (?) crust in north central British Columbia", Cordilleran Section of G.A.C. Meeting, February 14, 1970.

Roddick, J.A. - "Evolution of the Coast Crystalline Belt", Penrose Conference, Pacific Grove, California, December, 1969.

- "Data recording on the Coast Mountains Project", 3rd Symposium on Decision Making in the Mineral Industry, Vancouver, January, 1970.

Souther, J.G. - "Geology of Mt. Edziza Volcano", Victoria Geological Discussion Group, B.C. Department of Mines, Victoria, April, 1969.

- "Continental Margin of northern North America", Seminar at University of British Columbia, November, 1969.

- "Volcanism in British Columbia Cordillera", Penrose Conference, Pacific Grove, California, December, 1969.

- "Recent Volcanism and its influence on the Development and Preservation of Native Culture in northwestern, B.C.", Symposium on Early Man and Environments in northwest North America, University of Calgary, January, 1970.

- "Mesozoic and Cenozoic tectonics of the westernmost Cordillera", Cordilleran Section of G.A.C. Meeting, February 13, 1970.

Wheeler, J.O. - "Mid-Paleozoic deformation in Kootenay Arc", Royal Society of Canada, Earth Science subdivision, Ottawa, June, 1969.

- "Tectonics of Canadian Cordillera", University of British Columbia, Graduate Students, Vancouver, January, 1970.

- "Geological Survey of Canada", University of British Columbia, Geology Students, Vancouver, January, 1970.

- "Geological Survey of Canada", British Columbia Institute of Technology, Mining Technology Students, Vancouver, February, 1970.

- "Tectonic Framework of Western Cordillera", McConnell Club, Institute of Sedimentary and Petroleum Geology, Calgary, November, 1969.

Tempelman-Kluit, D.J. - "Mining and Prospecting in Western Canada", St.George's School, Vancouver.

OUTSIDE PAPERS

Campbell, R.B.
- Structural and Metamorphic Transitions from Infrastructure to Suprastructure, Cariboo Mountains, B.C.; Geol. Assoc. Can. Special Paper No.6, pp. 67-72. 1970.

Eisbacher, G.H.
- Displacement and Stress field along part of the Cobequid Fault, Nova Scotia; Can. Jour. Earth Sci., vol.6., no.5, pp.1095-1104.

Hutchison, W.W., Roddick, J.A.
- Computer based system for recording geologic field data in the Coast Mountains, B.C., contribution to the National System for Geological Data in Canada, Progress Report 1.

Monger, J.W.H.
- Upper Paleozoic eugeosynclinal rocks of northwestern British Columbia and south-central Yukon; Geol. Soc. America, Cordilleran Section Meeting, Abstract, 1970.

Muller, J.E.
- Sedimentation and Faunal Zonation of Upper Cretaceous Nanaimo Group, Western British Columbia; Geol. Soc. America, abstracts with Programs for 1969, pt. 3 Cordilleran Section Meeting, 1970.

Muller, J.E., Carson, D.J.T.
- Geology and Mineral Possibilities of Vancouver Island; Can. Min. Jour., May 1969, pp.66-70.

Roddick, J.A.
- Computer-based system for recording geological field data in the Coast Mountains, B.C., for publication in National System for Geological Data: Progress Report I.

Souther, J.G.
- Recent Volcanism and its Influence on the Development and Preservation of Native Culture in northern B.C.; paper, Symposium on Man and Environments in northwest North America, University of Calgary, January 31, 1970.

Tipper, H.W. H. Frebold.
- Status of the Jurassic in the Canadian Cordillera of British Columbia, Alberta and Southern Yukon; Can. Journal of Earth Sciences, vol. 7, no. 1, pp.1-21.

Wheeler, J.O.
- The Western Cordillera; Can. Inst. Mining Met. Bull., vol.63, pp.37-44.

- Introduction; in Structure of the southern Canadian Cordillera; Geol. Assoc. Can. Special Paper no.6, pp.1-5.

- Summary and Discussion; in Structure of the Southern Canadian Cordillera; Geol. Assoc. Can. Special Paper no. 6, pp. 155-166.

ACTIVE PROJECTS DURING REPORT YEAR

490038	Wheeler, J.O.	Miscellaneous field investigations by staff at Vancouver Office.
580009	Roddick, J.A.	Operation Pelly.
610011	Tipper, H.W.	Taseko Lakes map-area.

620017	Wheeler, J.O.	Big Bend map-area, B.C.
620019	Hutchison, W.W.	Prince Rupert-Skeena map-areas.
630011	Gabrielse, H.	Operation Nahanni.
630014	Muller, J.E.	Alberni map-area, B.C. (Vancouver Island, part).
630016	Roddick, J.A.	Coast Mountains project.
630375	Tipper, H.W.	Glacial geomorphology of central British Columbia.
640018	Ross, J.V.	Revelstoke vicinity, B.C.
650010	Gabrielse, H.	Operation Selwyn.
650015	Souther, J.G.	Geology of the Mt. Edziza volcano.
650016	Wheeler, J.O.	Lardeau W½ map-area, B.C.
650017	McMillan, W.J.	Seymour Arm vicinity.
650433	Wheeler, J.O.	Tectonic synthesis of Cordillera.
660001	Giovanella, C.A.	The Malton gneiss along the Rocky Mountain Trench near Valemount, B.C.
660002	Monger, J.W.H.	Atlin Horst project.
660003	Lowes, B.E.	Harrison Lake, East, B.C.
670009	Tempelman-Kluit, D.J.	Stratigraphic-structural study of the Anvil-Vangorda district.
670011	Lambert, M.S.	Study of a Tertiary Cauldera Complex, Bennett Lake, B.C. and Yukon.
680029	Souther, J.G.) Tipper, H.W.)	Chemical and petrographic study of the Tertiary and Quaternary lavas of central British Columbia.
680038	Muller, J.E.	Geology of northern Vancouver Island.
680066	Campbell, R.B.	Geology of the Cariboo Mountains, British Columbia.
680087	Souther, J.G.	Volcanoes of Canada.
680119	Blusson, S.	Operation Stewart.

680138	Wheeler, J.O.	Offshore studies, UBC contract.
680142	Monger, J.W.H.	Geology of the Hope area, (west half), B.C.
690009	Tipper, H.W.	Smithers map-area.
690023	Monger, J.W.H.	Upper Paleozoic rocks of Stikine Arch.
690063	Souther, J.G.	Volcanic stratigraphy of Telegraph Creek map-area.
690075	Cameron, B.	Tertiary Foraminiferal succession of western Cordillera and Pacific Margin.

INFORMATION SERVICES UNIT

S. Leaming.

The number of visitors during 1969 was essentially the same as the previous year but the amount of sales as well as the amount of items handled increased. Part of the increased volume of sales is attributable to new prices of topographic maps, but in part it was due to greater sale of both topographic maps and G.S.C. publications.

Sales for the B.C. Department of Mines and Petroleum Resources amounted to $3701.20. This is an increase of $1265.40.

The monthly sales breakdown is tabulated on the facing table.

	Visitors	Sales	Topo Maps	G.S.C. Public.	Rock + Min. Sets	Photo copies[1]	B.C. Dept. Mines Sales[2]	Mines Branch Public.
1969		$					$	$
APRIL	1185	3614.25	3441	3430	108	555	239.80	60.25
MAY	1305	4715.35	4589	4292	135	339	247.00	2.00
JUNE	938	3162.75	4009	1809	25	243	166.40	26.75
JULY	963	2973.90	3324	1806	64	243	123.00	33.10
AUGUST	701	2812.95	4131	1214	80	222	297.80	47.75
SEPTEMBER	817	2714.90	2548	1315	138	243	311.70	35.85
OCTOBER	946	3491.40	3579	1938	91	210	213.10	7.00
NOVEMBER	819	2683.60	2147	1345	164	331	455.50	21.50
DECEMBER	783	2774.45	1962	2150	43	176	292.00	6.50
1970								
JANUARY	925	5072.90	4120	2517	71	329	563.10	4.50
FEBRUARY	945	4405.20	3005	2507	51	375	432.80	13.25
MARCH	1036	4720.85	3198	3118	30	280	359.00	.85
TOTAL	11363	43142.50	40053	27441	1000	3546	3701.20	259.30

(1) Not including photocopying by staff.

(2) Not included under Sales.

APPALACHIAN, EASTERN LOWLANDS AND ATLANTIC MARGIN SECTION

W.H. Poole

The Appalachian, Eastern Lowlands and Atlantic Margin Section is responsible for geological investigation of the Appalachian geosynclinal rocks (in Quebec, New Brunswick, Prince Edward Island, Nova Scotia and insular Newfoundland) and the Paleozoic sedimentary strata of eastern lowlands comprising the St. Lawrence Lowlands (southern parts of Ontario and Quebec) and the Hudson Bay Lowland (northern Hudson Bay and northern parts of Manitoba, Ontario and Quebec). Objectives of the eight geologists of the Section are to define the composition of the rocks, their stratigraphy and structure; to determine their mode of origin and evolution; to evaluate the implications of these features on the potential of mineral and petroleum resources and so guide exploration; and to publish the results in maps, reports and scientific papers. Although current activities are directed towards onshore studies, offshore data gathered by others at an increasing rate will be integrated into the onshore geological models; the section lacks capability of mounting offshore projects.

Geological studies of a mainly stratigraphic and structural nature, carried out by the Section during the year, varied from reconnaissance to detailed. Reconnaissance studies of the Appalachian region have been completed for some time, with the exception of insular Newfoundland where field work on one of the two remaining areas is in progress (680130). This project has two parts. During the year, the Grenvillian metamorphic rocks of the Great Northern Peninsula were studied at 1-mile scale (H.H. Bostock) in part as a pilot study for 4-mile mapping in the future. The Cambrian-Ordovician platformal rocks with their petroleum and base metal potential were studied on each side of the Strait of Belle Isle (L.M. Currming). Within the eastern lowlands region, reconnaissance of the Paleozoic strata was completed when the stratigraphy of Southampton Island was studied with the aid of helicopters (B.V. Sanford, 680092). Stratigraphic data from Southampton and from nearby Coats and Mansel Islands, all in northern Hudson Bay, when added to that from southern Hudson Bay and James Bay (670014), will assist in the interpretation of geophysical surveys and drill holes within the bay itself.

Problem studies in Newfoundland were restricted to a contract let by the Department to Memorial University of Newfoundland (690030). Professor Harold Williams, formerly the Section's Newfoundland expert and now with Memorial's Department of Geology, carried out a 1-mile stratigraphic and regional structural study of the Belleoram map-area (1M/11) in northern Fortune Bay, southern Newfoundland. The stratigraphic relationships and ages of strata appeared anomalous in comparison to better known rocks elsewhere on the Island. Professor Williams succeeded in providing a more plausible model of the geology, and his terminal report will be submitted before August 1970 by the terms of the contract.

No field parties of the Section operated in Nova Scotia during the year with the exception of 2 weeks of scuba diving in St. Georges Bay (D.G. Benson, 660019) to sample subsea bedrock to aid in determining the geology under the bay. This work was aided by sparker profiles by K. Kranck of Bedford Institute, by seabottom gravity records by A.K. Goodacre of Earth Physics Branch, and by reflection seismic profiles by G.D. Hobson of Geological Survey. Preliminary maps on the Antigonish Highlands and Antigonish Basin areas were submitted for publication (D.G. Benson, 640043 and 660019).

Three field parties operated within the central mineral belt of New Brunswick during the summer. In central New Brunswick, field work on the regional geology of Tuadook Lake map-area at 1-mile scale was completed (R. Skinner, 680078). The metamorphic rocks are some of the oldest in the belt, at the core of Miramichi Geanticline. Coverage of the entire belt at 1-mile scale is now almost completed. Another party completed a study of the Catamaran Fault (F.D. Anderson, 690013) which cuts across the mineral belt in central New Brunswick. The third party completed the first study-area in a two-year project to determine the structural style of the rocks in the metalliferous Bathurst-Newcastle district (H. Helmstaedt, 690015), with an important objective of keying the sulphide bodies into the structural evolution of the host rocks. The results will prove valuable to those geologists speculating on the age and origin of the deposits and to exploration geologists actually drilling a deposit to determine its geometry and tonnage.

Exploration activities of the petroleum and natural gas industry continued to be monitored (R.D. Howie, 600456) and geological assistance provided the industry where possible. A subsurface study of the Albert Formation oil shales was begun.

Throughout the year, geologists of the Section were consulted by many geologists and geophysicists in both the mineral and petroleum industry regarding onshore and offshore potential resources in Eastern Canada.

At year's end, personnel of the Section consisted of eight geologists (F.D. Anderson, D.G. Benson, L.M. Cumming, H. Helmstaedt, R.D. Howie, W.H. Poole, R.V. Sanford and R. Skinner) and five technicians in the well sample preparation laboratory and repository (S.F.P. Colletta, J.M. Greer, R.J.G. Seguin, W.U. ter Haar Romeny and W.L. White).

Summary accounts of these investigations are carried in Geological Survey Paper 70-1, Part A. During the fiscal year 1969-70, scientists of the Section published 2 papers and preliminary maps and 1 terminal map. 11 papers were published in outside scientific journals. In addition, 3 manuscripts for papers and preliminary maps, and 3 outside papers were submitted for publication.

Well Sample and Core Preparation Laboratory and Repository.

Cutting samples and cores from onshore wells drilled in Eastern Canada are prepared and housed in Ottawa for examination by industry. Roughly 90% of the samples in the repository and of the incoming samples originate from Ontario. The samples have been collected since the 1930's, although in recent years, the Ontario Department of Energy and Resources Management has assumed responsibility for collecting the samples from Ontario. Two geologists of that Department are housed at the Geological Survey to study the samples and consult with Section geologists.

Several functions are performed by the five staff members (W.U. ter Haar Romeny in charge).

1. Well chip samples. Samples from well drilling are received, sorted, washed, bottled and labelled. The bottled samples are indexed and filed in the repository in room B-10 for study on request by geologists from industry and others in an examination room, G.27. During the year, 64,539 samples were thus prepared. Duplicate sets of bottled samples are generally made by arrangement for provincial authorities in Atlantic Provinces and Quebec. Some 13,941 samples were bottled from already prepared samples; most were shipped to Quebec, New Brunswick and Nova Scotia. Reserve samples marked for keeping are stored at the Laperrière Street warehouse. Samples from a Hudson Bay offshore well were placed in the repository by Resource Administration Division.

Throughout the year, 24 geologists from industry examined samples from the repository during 42 days.

2. Core. Core of stratigraphic value is received, indexed and housed in the Laperrière Street warehouse for study on request by geologists mainly from industry. Some core of particular value is slabbed with a diamond saw. The slice is indexed and housed in the repository (B-10) and the remainder returned to the warehouse. 31,229 feet of core were received during the year and 8,221 feet were slabbed. About 20,000 feet of core were received from Imperial Oil Company when its Chatham office closed.

3. Representative rock collection. Rock specimens (and thin sections) selected by GSC geologists at the end of a project as representative of the geology of a project-area are indexed and housed in B-10 for use by geologists of industry and other agencies. During the year, about one-half dozen collections were added.

Annual report of the Well Sample Preparation Laboratory 1969-1970

	RECEIVED				PROCESSED				RESERVED		DUPLICATES SHIPPED	
	CORE		DRILL	CHIPS	CORE		DRILL	CHIPS	CORE		DRILL	CHIPS
	Footage	Wells	Samples	Wells	Footage	Wells	Samples	Wells	Footage	Wells	Samples	Wells
Manitoba	-	-	27	1	-	-	27	1	-	-	-	-
Ontario	22937.5	278	47229	331	8221	69	47229	331	8167	66	782	3
Quebec	278	21	7770	25	-	-	7770	25	-	-	5189	12
New Brunswick	8198	10	5746	14	-	-	5746	14	-	-	4958	10
Nova Scotia	-	-	3030	23	-	-	3030	23	-	-	3012	22
Prince Edward Island	-	-	329	11	-	-	329	11	-	-	-	-
Newfoundland	-	-	-	-	-	-	-	-	-	-	-	-
Michigan, U.S.A.	-	-	408	1	-	-	408	1	-	-	-	-
TOTAL	31229.5	309	64539	406	8221	69	64539	406	8167	66	13941	47

Operating days ..... 245 dyas
Staff available during this period ..... 5 men per days
Total operating man- days ..... 1225 man-days

Utilized as follows:

	men	man-days	%
Drill chip preparation	1.6	400	32.6
Core Set preparation	0.6	161.5	13.2
Related work	2.2	525.5	42.9
Leave, Etc.....	0.6	138	11.3
Total	5	1225	100

PERSONNEL CHANGES

J.M. Greer transferred from Divisional administration to Appalachian Section in April 1969.

H. Helmstaedt joined the staff in March 1969 and was on leave until May.

D.G. Kelley transferred to Department of National Health and Welfare in April 1969.

ATTENDANCE AT MEETINGS

American Association of Petroleum Geologists, Dallas, Texas - April 14-17,1969.

- R.D. Howie.

Geological Association of Canada, Montreal, Quebec. - June 5-7, 1969.

- D.G. Benson, R.D. Howie, W.H. Poole.

New England Intercollegiate Geological Conference, Albany, N.Y. - October 10-12, 1969.

- R.D. Howie, B.V. Sanford.

Ontario Petroleum Institute, Toronto, Ontario. - October 15-17, 1969.

- B.V. Sanford.

Atlantic and Maine Universities Geological Conference, Fredericton, N.B. - Nov.8-10, 1969.

- W.H. Poole.

Geological Society of America, Atlantic City, New Jersey. - November, 10-12, 1969.

- L.M. Cumming.

Geological Society of America, Northeastern Section, Pittsburgh, Pa. - February 12-14, 1970.

- F.D. Anderson, W.H. Poole.

Prospectors and Developers Association, Toroton, Ontario. - March 8-11, 1970.

- F.D. Anderson, L.M. Cumming.

Third Canadian Conference on Research in Tectonics, Winnipeg, Manitoba. - March 19-20, 1970.

- H. Helmstaedt.

MEMBERSHIP ON COMMITTEES

L.M. Cumming - Associate editor for Eastern Canada, A.A.P.G.

- Branch representative, Departmental Field Equipment Committee.

R.D. Howie - Member, Canadian Committee on Statistics of Drilling.

W.H. Poole - Vice-Chairman, Northeastern Section, Geological Society of America.

- Member, Departmental Committee on Recent Crustal Movements and Seismic Regionalization.

- Member, Program Committee for Earth Science Symposium on Offshore Eastern Canada.

- Member, Advisory Committee for Cape Breton Mineral Resources Project.

- Associate member, I.G.C. Field Excursion Committee.

B.V. Sanford - Member, Ontario Stratigraphic Committee.

- Associate member, I.G.C. Field Excursion Committee.

SPECIAL TALKS

Anderson, F.D. - "The Catamaran Fault of North Central New Brunswick", G.S.A., Pittsburgh, Pa., Feb. 1970.

Cumming, L.M. - " "Ordovician Lithofacies, Northern Manitoba". G.S.A., Atlantic City, N.J., Nov. 1969.

Helmstaedt, H. - "Petrofabrics and Origin of Eclogite Nodules from Kimberlitic Pipes of the East Colorado Plateau". Carleton University, Ottawa, March, 1970.

Howie, R.D. - "Recent Offshore Developments, Atlantic Coast of Canada". A.A.P.G. S.E.P.M., Dallas, Texas, April 1969.

Sanford, B.V. - "Silurian of Southwestern Ontario". O.P.I., Toronto, Ont., October, 1969.

OUTSIDE PAPERS

Anderson, F.D.
(1970) - The Catamaran Fault of North Central New Brunswick; Geol. Soc. Am., abstract, p.10.

Cumming, L.M.
(1969) - Ordovician Lithofacies, Northern Manitoba; Geol. Soc. Am., abstract, p.42.

Helmstaedt, H.
(1969) - Eine Ammoniten-Fauna aus den Spiti-Schiefen von Muktinath in Nepal; Zitteliana, vol. 1, pp. 63-88.

(1969) - Polgonization of quartz under stress; Trans. Am. Geophys. Union, abstract, vol. 50, p. 232.

Helmstaedt, H., Anderson, O.L.
(1969) - Petrofabrics of Mafic and Ultramafic Inclusions from Kimberlite Pipes in Southeastern Utah and Northeastern Arizona; Trans. Am. Geophys. Union, abstract, vol. 50, p.345.

Brown, R.L., Helmstaedt, H.
(1969) - Paleozoic Wrench Faults in Canadian Appalachians: Discussion: in North Atlantic - Geology and Continental Drift, Ed. Marshall Kay; Amer. Assoc. Petrol. Geol., Mem. 12, p.787.

Gavasci, A.T., Helmstaedt, H.
(1969) - A Pryoxene-Rich Garnet-Peridotite Inclusion in an Ultramafic Breccia Dyke at Moses Rock, Southeastern Utah; J. Geophys. Res., vol.74. pp. 6691-95.

Howie, R.D.
(1969) - Recent Offshore Developments, Atlantic Coast of Canada: Am. Assoc. Petrol. Geol. and Soc. Econ. Paleo. and Mineral., abstract, p. 75.

Howie, R.D. Hill, J.V.
(1969) - Developments in Eastern Canada in 1968; Bull. Am. Assoc. Petrol. Geol., vol. 53, pp. 1181-93. Reprinted in: Canadian Petroleum, vol. 9, pp.63-96. Abstracted in: International Oil Scouts, and Canadian Petroleum Statistical Year book 1968.

Poole, W.H.
(1970) - Solid-Earth Science in the Appalachine Region of Canada; Bull. Can. Inst. Mining Metal., vol.63, pp.204-213.

Sanford, B.V.
(1969) - Silurian of Southwestern Ontario; Eighth Ann. Proc. Ont. Petrol. Inst., Tech. Paper 7, pp.1-44.

ACTIVE PROJECTS DURING REPORT YEAR

530025	Skinner, R.	Tetagouche Lakes, Bathurst and Nepisiquit Falls map-areas, N.B.
580159	Sanford, B.V.	Subsurface studies of each of the Paleozoic systems of southwestern Ontario (Cambrian, Ordovician, Silurian and Devonian).
600032	Anderson, F.D.	Belleoram map-area.
600456	Howie, R.D.	Subsurface and regional studies in Eastern Canada as related to oil and gas.
610037	Kelley, D.G.	Cobequid Mountains.
610039	Williams, H.	Botwood map-area, Newfoundland.
630035	Gillis, J.W.	Port aux Basques.
640043	Benson, D.G.	Geological study of the Antigonish Highlands.
650470	Sanford, B.V.	Ottawa bedrock investigations.
660019	Benson, D.G.	Geological study of the Antigonish Basin.
680078	Skinner, R.	Tuadook Lake map-area, N.B.
680130	Cumming, L.M.	Operation Strait of Belle Isle.
690008	Skinner, R.	Compilation of California Lake map-area, N.B.
690013	Anderson, F.D.	Catamaran and Tomogonops faults.
690015	Helmstaedt, H.	Structural evolution of rocks of the Bathurst-Newcastle district, N.B.
690030	Poole, W.H.	Belleoram map-area, Newfoundland, M.U.N. contract (H. Williams).

PETROLOGY SECTION

J.E. Reesor

The Petrology Section conducts field and laboratory research into the theories and problems of petrology by carrying out systematic studies of specific rock types. These studies are expected to provide a means of elucidating petrologic problems of economic or regional significance. The Section also carries out research on extraterrestrial materials and maintains the National Meteorite Collection. In addition it provides consultation on petrologic problems for Government agencies and the public. The Petrology Section maintains the lapidary facilities and a general petrology laboratory for the Branch.

Individuals of the Petrology Section have continued to pursue diverse scientific studies ranging from ultramafic and high grade metamorphic rocks and migmatites, to experimental work on fenetization in alkaline rocks and the role of water in the evolution of metamorphic and igneous rocks. Results have been embodied in a number of publications in Survey reports and in scientific journals.

PERSONNEL CHANGES

During the past year Dr. R.F. Emslie has been transferred to the Section and Dr. T.M. Gordon joined the Section at the end of March. Mr. Lawrence of the Petrology Laboratory has submitted his resignation for April 1970. He has not yet been replaced. Dr. J. Ferguson completed his post-doctorate studies with the Petrology Section in December, 1969 and returned to South Africa. Prior to departure, he completed his studies with K.L. Currie on the Callander Bay alkaline complex, and manuscripts have been prepared for outside journals on the project.

K.L. Currie completed study of the granitic rocks of the Loughborough Lake region, Ontario, and submitted a final manuscript for publication as a GSC Bulletin. A final manuscript on the resurgent crater at Mistastin Lake, Labrador was also completed and submitted. Study of dike swarms and fenitization phenomena around the alkaline complex at Callander Bay, Ontario was completed and a number of manuscripts prepared for outside publication. Work was commenced on alkaline complexes at Port Coldwell, Ontario, Ice River and Copeland Mountain, British Columbia. Dr. Currie worked out a model for the origin of alkaline igneous rocks and presented it to the GAC-MAC symposium on the subject in Montreal. He set up and expanded the experimental petrology laboratory in new quarters, and continued his work on the solubility of rock-forming minerals, the composition of interstitial fluids in igneous and metamorphic processes, and the stability of certain minerals in alkaline rocks.

J.A.V. Douglas continued his curatorial duties and laboratory studies of meteorites in the Canadian National Collection.

From October to December he directed an intensive team study of eleven specimens and a sample of fines from the Apollo 11 landing. This lead to the characterization of the common rock forming minerals and the discovery of the new mineral pyroxferroite and styles of deformation.

Emslie, R.F. Dr. Emslie has spent most of the year on leave of absence at the Geophysical Laboratory in Washington, D.C. where he has continued his experimental investigation of the origin of anorthosites.

Froese, E. During the 1969 field season, Dr. Froese assisted F.C. Taylor in Operation Torngat, a helicopter reconnaissance survey of northeastern Quebec and Labrador. He continued work on the metamorphic petrology of the Pinnacles Peak area, B.C.

Irvine, T.N. Dr.Irvine continued his study of the Muskox intrusion. He completed a major paper analysing its crystallization sequences in structurally similar intrusions. This was presented at a symposium on layered intrusions held in Pretoria, South Africa in July, and is being published in a symposium volume. He also completed a comprehensive paper dealing with heat transfer during solidification of layered intrusions that is in press in the Canadian Journal of Earth Sciences. Further field work on the Muskox intrusion in August resulted in a revision of its geologic age relations as described in G.S.C. paper 70-1, Part A.

Dr. Irvine gave special lectures at McMaster University and Dalhousie University; he acted as external examiner of a thesis submitted to McGill University; he referred papers for the Journal of Petrology, Economic Geology and Journal of Geology; and he critically reviewed several papers for associates working on mafic and ultramafic rocks.

Reesor, J.E. Dr. Reesor continued the duties of Head of the Petrology Section. This continues to involve increasing amounts of work not directly connected with scientific achievement. During the past year about 6 weeks were spent on a Departmental Committee concerned with evaluating the impact of collective bargaining on field work. Another two weeks was spent on various organization and personnel courses. In addition to this, much time was spent in planning, estimating, filling in, and editing records of projects for the section, critical reading of manuscripts for publication, etc. Well over 50% of all productive time is spent on these activities, and this year following the trend of recent years, increasingly less time is available for maintaining scientific competence and for scientific work.

During the summer Dr. Reesor spent about 7 weeks on a visit to various areas and Scientific Institutes in the U.S.S.R.

He acted as outside examiner in a Ph.D. thesis at Carleton University.

The remainder of the time was spent in preparation of final reports on current projects for G.S.C. publication.

ATTENDANCE AT MEETINGS

A.G.U. Meeting, Washington, D.C. - April 1969.

- K.L. Currie, E. Froese.

G.A.C. /M.A.C. Meetings, Montreal, - June 1969.

- K.L. Currie, J. Reesor, E. Froese.

Apollo 11 Lunar Science Conference Houston, Texas. - January, 1970.

- J.A.V. Douglas.

G.S.A. Meeting, Atlantic City, - November 1969.

- R.F. Emslie.

Symposium on layered intrusions, Pretoria, South Africa with field trips to the Bushveld complex (S.A.) and Great Dyke (Rhodesia), - July 1969.

- T.N. Irvine.

AZOPRO meetings, Lake Baikal, U.S.S.R. - August, 1969.

- J. Reesor.

MEMBERSHIP ON COMMITTEES

J.A.V. Douglas	- Secretary, Associate Committee on Meteorites (NRC).
	- Co-convenor Section XV Planetology, International Geological Congress, 1972.
J.E. Reesor	- Co-convenor Section II, Petrology, International Geological Congress, 1972.

SPECIAL TALKS

K.L. Currie - "An hypothesis on the origin of alkaline rocks", GAC/MAC meeting, Montreal, June, 1969.

J.A.V. Douglas - "Report on Apollo 11 Lunar sample analysis programme", Logan Club, Ottawa, Feb. 1970.

E. Froese - "Metamorphism of the Coronation sulphide deposit, Saskatchewan", A.G.U. meeting, Washington, D.C. April 1969.

-"Calculated phase diagrams of the system $CaCO_3$-$SrCO_3$, G.A.C./M.A.C. meeting, Montreal, June 1969.

T.N. Irvine - "Crystallization sequences in the Muskox intrusion and other layered intrusions", McMaster University, Feb. 1970., Dalhousie University, Mar. 26, 1970.

J. Reesor - "The Shuswap Metamorphic Complex" Inst. of Precambrian Geology and Geochronology, Leningrad U.S.S.R., Inst. of Geology, Tbilisi, Georgian U.S.S.R. Inst. of Geology, Moscow, U.S.S.R. August 1969.

OUTSIDE PUBLICATIONS

Currie, K.L., J.C. Murtaugh.
(1970) - Preliminary study of Manicouagan structure; Quebec Department of Natural Resources. P.R.#583.

(1970) - An hypothesis on the origin of alkaline rocks - suggested by the tectonic setting of the Monteregian Hills; GAC-MAC Symposium published by the MAC., in Can. Mineralogist vol.10, Part 2.

Douglas, J.A.V.
(1970) - Petrological-Mineralogical investigations of some lunar samples; Lunar Research Centre, Houston, Texas.

Douglas, J.A.V., Dence, M.R., Plant, A.G. and Trail, R.J.
(1970) - Mineralogy and Deformation of some Lunar samples; Since, vol. 167, pg.594-597.

Froese, E.
(1970) - Chemical petrology of pelitic gneiss and migmatites, Thor-Odin area, B.C.; Can. Jour. Earth Sci., vol.7, no.1, pgs. 164-175.

Irvine, T.N.
(1969) - Crystallization sequences in the Muskox intrusion and other layered intrusions I Olivine-plagioclase-pyroxene relations; Symposium in Pretoria, S. Africa.

D.E. Lawrence.
(1969) - A wide field technique for viewing rock textures; Canadian Mineralogist Vol.9, pt.5, p.716-717.

Reesor, J.E.
(1970) - Some aspects of structural evolution and regional setting in part of the Shuswap Metamorphic Complex; in Structure of the Southern Canadian Cordillera Ed. J.O. Wheeler, pp.73-86.

ACTIVE PROJECTS DURING REPORT YEAR

530008	Reesor, J.E.	Lardeau map-area, B.C.
570119	Douglas, J.A.V.	Meteorite studies.
590283	Irvine, T.N.	Muskox intrusion.
600284	Findlay, D.C.	Tulameen ultramafic Complex, B.C.
620265	Currie, K.L.	Diffusion studies in supercritical water.
630029	Currie, K.L.	Geology of the Manicouagan structure, Quebec.
630277	Reesor, J.E.	Petrology and structure of the Thor-Odin gneiss dome, B.C.

630444	Reesor, J.E.	Petrological, chemical, and mineralogical study of White Creek granite, B.C.
660497	Irvine, T.N.	Classification and nomenclature of Canadian volcanic rocks.
660547	Currie, K.L.	Geochemistry of Canadian craters.
670278	Reesor, J.E.	Structural and petrological study of Pinnacle Peaks gneiss dome, B.C.
670281	Reesor, J.E.	Ultrabasic rocks of the Yukon.
680070	Currie, K.L.	Geology of the Mistassin Lake circular structure.
680071	Currie, K.L.	Alkaline rocks in Canada.
680124	Douglas, J.A.V.	Mineralogy and petrology - lunar material.

PETROLOGY LABORATORY

D.E. Lawrence

The Petrology Laboratory provides special petrographic services and is the repository for the rock, thin section, and meteorite collections of the Branch. Equipment is provided for petrographic investigations and certain custom mineral separations. Petrographic services carried out on request include specific gravity and mineral composition determinations, mineral staining, special petrographic studies, determination of certain optical properties of minerals, photomicrography and the development of new petrographic techniques.

Due to the relocation and expansion of the experimental petrology laboratory facilities, the petrographic services are now housed in a newly remodeled laboratory of approximately half the floor area. These changes have necessitated the removal of all rock, thin section and meteorite collections to alternate locations. The thin section and representative rock collections are now housed in the basement adjacent to the core storage and are curated by W.U. Ter Haar Romeny. The meteorite collection is now located in the office of J.A.V. Douglas.

The petrographic services offered remain unchanged and have not suffered due to the reduction in space. The small chemistry laboratory Room 741 is still held by the petrology section and is used extensively for wet chemical work (mineral staining, etc.) and for mineral separation.

LABORATORY SERVICES AND UTILIZATION

Work Performed During Report Year.

Specific gravity, rocks	177
Mineral staining	363
Refractive indicies and other optical measurements	318
Modes	43
Petrofabric analyses, axes	-
Petrographic descriptions	176
Sample preparations & mineral separations	195
Photomicrographs	168

In addition to the above service work the following investigations were undertaken:

The identification, description and evaluation of 36 selected Canadian soapstones to ascertain their suitability as materials for Eskimo carvings. Cooperating Agency - Dept. of Indian Affairs and Northern Development.

The identification and description of 16 rock and metal artifacts from the excavations of a prehistoric settlement at Coteau du Lac, P.Q. Cooperating agencies - Dept. of Indian Affairs and Northern Development.

The petrographic description of well cuttings from several drill holes. Cooperating agency - Defence Construction Ltd.

Examination of the Isle Bizard Kimberlite prospect. Description of and identification of rock and mineral types. Cooperating agency - Southern Exploration Ltd.

Examination and identification of heavy minerals from the siltation basin of the Warsak Shadiwall Dam Site, Pakistan. Cooperating Agency - Canadian International Development Agency and Inland Waters Branch.

Mineral separations on ultra basic rocks. Cooperating Agency - Mines Branch.

LAPIDARY SERVICES

A.E. Whitehead

The Lapidary Laboratory has a three-man staff consisting of A.E. Whitehead (Supervisor), Y. Demers, and M. Beaulne. Additional personnel were employed for 6 weeks during the summer only.

Two standard presentation plaques of conglomerate were prepared for the retirements of Dr. J. Caley and Mr. G. Daughtry, as well as a smaller polished sample for Dr. A Goodwin's resignation. Special plaques of anorthosite and jade were prepared for the retirements of Col. D.H.W. Aitken, head of Army Survey, and Mr. A.C. Tuttle, from Aerial Survey Division, respectively.

Several cuts were made on collected cement samples to obtain rectangular blocks of designated thicknesses to study the reflectance properties of weathered surfaces. Several extremely thin slices of samples were cut and lapped for Dr. J. Ferguson. A number of drill cores and cubes were cut, levelled and polished to prescribed thicknesses in order that Dr. Katsube might better study the electrical properties of various rocks. Twenty-five cuts were made for Dr. K. Currie on samples to obtain 38 prisms 5/8 in. long for experimental work.

Various improvements were made to our cutting and polishing equipment and techniques during the year, which resulted in increased output of services.

Special projects for the year included:

(1) preparation of 4 samples which were placed in a G.S.C. collection which was presented to Prince Phillip on the occasion of his visit here.

(2) preparation of samples of jade for the Embassy, Economic and National Film Board collections.

(3) cutting in half of 34 ft. of drill core plus the cutting of 3 slabs 1 in. thick of a very large sample for identification purposes and sedimentological analysis.

In addition, training and advice were given to various university personnel and technicians from Canada and elsewhere.

Work Report for 1969-70.

(1) Standard thin sections with small, large and no cover slips.	5011
(2) Standard orientated thin sections with small, large and no cover slips.	205
(3) Standard oil thin section; orientated, no cover slips, small cover slips.	226
(4) Standard thin sections stained for large cover slips.	72
(5) Grain thin sections with no cover slips.	02
(6) Large thin sections, orientated, with cover slips, standard cover slips, no cover slips	324
(7) Polished thin sections	251
Total thin sections	6091

Man Hour Jobs

(1) Large and small polished surfaces for 1969-70 were		754 = $162\frac{1}{2}$ hrs.
(2) Time saw cuts for 1969-70 were		2749 = 106 hrs.
(3) Drill cores made for 1969-70 were		22 = $5\frac{3}{4}$ hrs.
	Total	3525 = $274\frac{1}{2}$ hrs.

Slab Saw

Our slab saws production for 1969-70 was 338 = $181\frac{1}{2}$ hrs.

EASTERN PALEONTOLOGY SECTION

T.E. Bolton

The Eastern Paleontology Section with a staff of 6 officers, 2 seasonal, and 5 support, is responsible for paleontological and biostratigraphical investigations of Phanerozoic sedimentary rocks of Eastern Canada. The nature and stratigraphic importance of Precambrian fossils was an additional charge during the report year.

The objectives of these investigations are to date geological formations, to explain their mode of origin and deposition, and to define their regional and intercontinental equivalence. The macro and microfaunas and floras of the Phanerozoic rocks are determined, interpreted, and described in order to provide total stratigraphic, taxonomic, morphologic, and paleoecologic documentation, information essential in all aspects of geological mapping. Achievement of these objectives is from data attained in part through individual field activities and in part through referred fossil collections from Appalachian investigations, all other stratigraphic activities of the Survey, and outside agencies.

In 1969, individual field activities ranged from an examination of several Precambrian stromatolite and metazoan sites in northern Quebec and southeastern Newfoundland (Hofmann), to Ordovician and Silurian biostratigraphic studies in the south-central and eastern parts of Anticosti Island, Quebec, directed toward the production of a geological map on the scale of 1 inch: 4 miles (Bolton and Copeland), collection of Cambrian and Ordovician faunas of European affinities in the Eastern Townships, Quebec, Cape Breton Island, Nova Scotia, and northern and eastern Newfoundland (Dean), and the measurement of stratigraphic sections in the Queen Elizabeth Islands, District of Franklin, combined with the collection of samples for palynomorph biostratigraphy development within the Devonian rocks of the Franklin miogeosyncline (McGregor).

Additional scientific activities of the Eastern Paleontology staff arising from referred collections included delineation of the biostratigraphy and faunas of the Ordovician and Silurian rocks of Southampton Island and the Ordovician rocks of Akpatok Island, palynomorph studies in the Moose River basin of Northern Ontario to assist in correlation of the Lower and Middle Devonian formations of that region with selected regions of North America and Europe, paleoecological investigations of the early Middle Ordovician faunas within the Ottawa Valley, and determination of the biostratigraphic value and systematics of charophytes within Devonian rocks of Western Canada and Paleozoic acritarchs within the Hudson Bay Lowland.

Paleontologists from Canada, United States, France, Great Britain, Germany, Australia and Denmark, as customary, were assisted by various members of the section either through direct consultation or the loan of GSC type specimens, specific fossils, thin sections, and plaster casts. In Canada and other countries, more than a dozen experts on particular groups of fossils, or students working under supervision of such experts, are engaged in study of GSC fossil material collected in Eastern Canada that will result in reports to field officers and/or publications on Canadian fossils.

PERSONNEL CHANGES

H.J. Hofmann resigned from the Survey early in July, 1969, to join the staff of the University of Montreal.

Mrs. D.K. Nash joined the micropaleontological staff of the G.S.C. in September, 1969.

TYPE COLLECTION

T.E. Bolton continued as Curator of the National Type Collection of Invertebrate and Plant fossils. A total of 1129 types described in both Survey and outside publications was added to the Type Collection in 1969. Publications in which these types were reported are as follows:

GSC Bull.	165	- Silurian conodonts, Nova Scotia	27 types
	169	- Devonian brachiopods, Western Canada	228
	170	- Triassic ammonites, B.C. and Arctic	44
	182	- Cambrian trilobites to Cretaceous forams, Western and Arctic Canada	95
	185	- Cretaceous forams, District of Mackenzie	73
GSC Paper	67-10	- Jurassic ammonites, British Columbia	43
	68-65	- Cretaceous insects, Quebec	2
	68-69	- Precambrian, Ontario	26
			538

Types in Outside Publications:

Delorme, L.D. (Inland Waters), Can. J. Zoology, 46:5	86
Frebold, H. (GSC), Can. J. Earth Sci., 20:1	14
Gauri, K.L. and Boucot, A.J. (Univ. Oregon), Paleontographica, 131:A	7
Handfield, R.C. (Catawba Univ.), Can. J. Earth Sci., 6:4	6
Harper, C.W. et al. (Univ. Oklahoma), J. Pal., 43:1	14
Hofmann, H. (GSC), Can. J. Earth Sci., 6:5	17
Johnson, J.G. (Univ. Oregon), J. Pal., 43:3	2
Klapper, G. (Univ. Iowa), J. Pal., 43:1	102
McGill, P. (Imperial Oil), J. Pal., 37:6	18
McGill, P. (Imperial Oil), Int. Symp. Dev. System, vol. 2	59
Neuman, R.B. (USGS), Studies of Appalachian Geol.	12
Norford, B.S. and Steele, M. (GSC), Pal., 12:1	30
Paul, C.R.C. (Indiana Univ.), Pal., 11:5	2
Sinclair, G.W., Bolton, T.E. and Copeland, M.J. (GSC), ODM Guidebook 3	41
Tozer, E.T. (GSC), Geol. Mag., 106:4	1
Wagner, F.J.E. (Bedford Inst.), Le Nat. Canadian, 95:6	61
Walmsley, V.G. et al. (Univ. Wales), J. Pal., 43:2	64
Waterhouse, J.B. (Univ. Toronto), J. Pal., 43:2	31
Whittington, H.B. and Rickards, R.B. (Cambridge), J. Pal., 43:3	24

An additional 500 fossil specimens were deposited in the National Type Collection during the year by several outside agencies.

PALEONTOLOGY PREPARATION LABORATORY SERVICES 1969-1970

	Saw Cuts	Thin Sections	Polished Sections	Rubber Moulds	Plaster Casts	Rubber Casts	Mechanical Preparation
Bolton, T.E.	107	91		33	99	1	6
Copeland, M.J.	43	39	1	1	3	1	
Frebold, H.	118			101	244	151	142
Fritz, W.H.	12			225		225	
Hofmann, H.	18	16	4				
Jeletzky, J.A.	2			180	429	14	
McGregor, D.C.	4	4					
Norris, A.W.	6	6					
Sinclair, G.W.	16	10			10		
Steele, M.	358	242					
Tozer, E.T.					42	29	7
Uyeno, T.T.	5						
Divisional Service							
Howie, R.	40						
Larochelle, A.				1	14		
Brown, D.A.	4						
Hacquebard, P.A.		2					
Benson, D.	3						
Anderson, F.	4						
Waldeman, M.	10	11	10				
TOTAL	750	421	15	541	841	421	155

Parcels Received 308
Parcels Shipped 238
Fossil Localities catalogued -
Invertebrate (GSC #83443 to 85072) 1629
Plant (GSC #8458 to 8838) 380

MICROPALEONTOLOGY LABORATORY SERVICES 1969-1970 SEASON

Since joining the micropaleontology staff in September, 1969, Mrs. D.K. Nash processed for the recovery of microfossils (conodonts & ostracods) a total of 217 samples. To-date 35 of these have been examined and picked. 196 samples have undergone "heavy liquid separations" in the search for conodonts.

	Nfld.	Quebec	Man.	Sask.	B.C.	N.W.T.	Arctic Islands	USA	Foreign (Turkey)	Total
Devonian		4	47	3	3	1	50	9		117
Silurian	6	7			15		11			39
Ordovician	25	14					15		6	61
TOTAL	31	25	47	3	18	1	76	9	6	217

W.T. Dean - Adviser, Treatise on Invertebrate Paleontology.

D.C. McGregor - Member, Nominating and Programme Committees, American Association of Stratigraphic Palynologists.

SPECIAL TALKS

D.C. McGregor - "Spores from the Devonian-Carboniferous Boundary in Canada", Commission International de Microflore du Paleozoique, Belgium, April, 1969.

OUTSIDE PAPERS

Hofmann, H.J. and Jackson, G.D.
(1969) - Precambrian (Aphebian) microfossils from Belcher Islands, Hudson Bay; Can. J. Earth Sci., vol. 6, No.5, pp. 1137-1144.

McGregor, D.C.
(1970) - Hymenozonotriletes lepidophytus Kedo and associated spores from the Devonian of Canada; Symposium vol., 8 ième Réunion C.I.M. P., Liège, Belgium.

Sinclair, G.W., Copeland, M.J. and Bolton, T.E.
(1969) - Ordovician fossils from Lakefield quarry; in Hewitt, D.F., Geology and scenery Peterborough, Bancroft and Madoc area, Ontario Dept. Mines, Geological Guide Book 3, pp. 24-29.

ACTIVE PROJECTS DURING REPORT YEAR.

500029	Staff	Identification and biostratigraphic interpretation of referred fossils.
520230	T.E. Bolton	Silurian coral faunas of Eastern and Arctic Canada.
570011	G.W. Sinclair	Ordovician of Lake Winnipeg and vicinity.
570015	T.E. Bolton	Silurina-Ordovician macrobiostratigraphy of Anticosti Island.
580037	T.E. Bolton	Maintenance of the paleontological type collection.
580153	T.E. Bolton	Lexicon of Stratigraphic Names in Canada.
600192	D.C. McGregor	Reference slide collection and photographic record of small spores of known geological age.
600227	D.C. McGregor	Devonian plant microfossils of Eastern Canada.
620297	M.J. Copeland	Middle Devonian Ostracoda, southwestern Ontario.
640040	M.J. Copeland	Ordovician and Silurian microfauna, Anticosti Island.

The technical Curator spent two weeks at the Institute of Sedimentary and Petroleum Geology, Calgary, consulting and exchanging techniques with the technical staff.

Devonian fossil specimens, chiefly from the Hudson Bay Lowlands, contained in some forty metal storage cabinets, were recorded and forwarded to the Calgary office. This shipment consisted of some 20,000 lbs and therefore was shipped via "Piggy Back". As a result of this shipment to Calgary, the section was able to relinquish some 1200 square feet of storage space at the Leperriere storage depot. All the paleontology study collections now are stored in one area at 601 Booth Street.

One large conglomerate specimen (36" x 30" x 16"), property of National Parks Branch of Northern Affairs, was sawed and polished to the specifications submitted. This specimen is to be displayed in one of the National Parks.

A two hour lesson period, entitled "The Story of Living Things or An Introduction to the Study of Fossils", was presented by B.J. Botte at Ottawa University to some fifty members of a local scientific group. An hour question period completed the session.

The staff dismantled and packed the Ordovician "track bed" and Carboniferous forest displays of the National Museum of Canada, in preparation for remodelling of the Museum.

ATTENDANCE AT MEETINGS

Geological Association of Canada, Annual Meeting, Montreal, Quebec.

- T.E. Bolton, M.J. Copeland, H.J. Hofmann.

Commission Internationale de Microflore du Paleozoique, Liège, Belgium.

- D.C. McGregor.

Biostratigraphy Seminar, Ottawa.

- T.E. Bolton.

American Association Stratigraphic Palynologists, Penn. State University.

- D.C. McGregor.

North American Paleontological Convention, Chicago, Illinois.

- T.E. Bolton.

MEMBERSHIP ON COMMITTEES

T.E. Bolton	- Chairman, GAC Programme and Publications Committee. - Member, GAC Editorial Committee.
M.J. Copeland	- Editor and Chairman, GAC Editorial Committee.

660058	H.J. Hofmann	Precambrian paleontology.
670024	J. Legault	Chitinozoans and acritarchs from the Hamilton Group (subsurface of southwestern Ontario).
670083	D.C. McGregor	File of diagnoses of fossil spore and pollen genera.
680112	T.E. Bolton	Silurian-Ordovician macrobiostratigraphy, Lake Timiskaming and Lake Nipissing.
680113	D.C. McGregor	Biostratigraphic study of Paleozoic palynomorphs of the Arctic Islands.
680117	M.J. Copeland	Ordovician and Silurian Ostracoda, Lakes Nipissing and Timiskaming, Ontario.
690006	W.T. Dean	Middle Paleozoic biostratigraphy Gaspé, Quebec, and Maritime region.
690007	H.M. Rice	Canadian fossil charophytes.
690027	G.W. Sinclair	Ordovician of Ottawa valley.
700001	H.M.Rice	Canadian Paleozoic Acritarcha.

GEOCHRONOLOGY SECTION

R.K. Wanless

The section is responsible for the development of facilities for isotope geology; for the coordination and conduct of the G.S.C. age determination and stable isotope investigation programs; for the preparation and publication of the results of isotopic investigations; and for the initiation and supervision of research projects in geochronologically complex regions.

A highlight of the year's activities was our participation in the study of the first samples returned from the Moon on the flight of Apollo XI. The generous allocation by N.A.S.A. of four crystalline rock samples and a portion of fine material collected from the lunar surface provided an opportunity to apply isotope dilution techniques for the determination of the concentrations of several geochronologically important elements. In addition, the relative isotopic abundances of 7 elements (Li, K, Rb, Sr, Pb, U and Th) were precisely determined for comparison with isotopic ratios measured for terrestial and meteoritic samples. No abnormal isotopic abundance ratios were obtained for the lunar rocks. Apparent K-Ar ages of 2270, 2875 and 3370 m.y. were calculated for three crystalline rock samples while the Rb-Sr results for the same samples were found to be compatible with a 4600 m.y. reference isochron. These results may be compared with a $^{207}Pb/^{206}Pb$ age of 4670 m.y. determined for our sample of fine material from the lunar surface. The results of our investigation were presented at the Apollo XI Lunar Science Conference held in Houston, Texas in early January and are published in special issues of Science and Geochimica et Cosmochimica Acta.

Traditionally our annual K-Ar isotopic age reports have been accompanied by a simplified map illustrating the distribution of samples dated and the ages obtained. This year, however, age results from other laboratories have been combined with those determined in our own laboratories and plotted on a larger (1:5,000,000) base. A system of symbols and colours has been used to identify the rock type and mineral dated and the dating method employed for each age result plotted. The new Isotopic Age Map of Canada will be included in the map folio accompanying the G.S.C. publication entitled Geology and Economic Minerals of Canada.

The discovery of an anomalously high K-Ar 'age' of 3800 m.y. for biotite from the Dauversière stock in the Superior Geological province near Chibougamau, Quebec, lead to an isotopic study of whole-rock samples and mineral concentrates from rock units both north and south of the Grenville front. The results obtained for samples of the granodioritic Dauversière stock revealed that the K-Ar and Rb-Sr isotopic systems in both biotites and muscovites had been dramatically altered thus yielding a variety of apparent ages, whereas the Rb-Sr analyses of whole-rock samples defined an isochron that indicated an age of emplacement of 2610 m.y. On the other hand all mineral ages (with the sole exception of the above mentioned anomalously high biotite K-Ar 'age') fell below this value and were distributed between the limits of 950 m.y. and 2535 m.y.; the higher values being obtained for samples remote from (9 miles norhwest) the Grenville front. The apparent

age distribution has been attributed to the temperature gradient established in the Archean rocks of the Superior Province at the time of the Grenville orogeny (approximately 1000 m.y. ago) and its differential effort on the retention and absorption of radiogenic argon by biotites and muscovites. The possibility exists that such distributions might not be uncommon in areas adjacent to the boundaries between major geological provinces and that isotopic analyses may be a valuable tool in delineating such boundary zones.

The rate of development of new K-Ar and mass spectrometric apparatus was reduced due to curtailment of staff, but by the end of the report year we were able to complete the assembly of the two remaining high vacuum argon extraction lines and essentially complete the 15 inch radius solid source mass spectrometer.

The interconnection of the electronic components of the mass spectrometer is now well advanced and initial testing will be started early in the new year. The new assembly will greatly facilitate our zircon age studies since at the present time all Rb-Sr and Pb-U-Th isotopic analyses are carried out on one mass spectrometer. The 15" radius unit, which will have a higher resolving power than our other mass spectrometers, will be used to obtain precise analyses of the heavier ions of Pb,U and Th extracted from zircon and sphene samples. In addition, since the new analyser tube is fitted with a vacuum lock to isolate the source area from the remainder of the system it will be possible to rapidly introduce a new sample without bringing the complete analyser up to atmospheric pressure. It is anticipated that it will be possible to commence an isotopic analysis of a new sample 15 minutes after placing the material in the mass spectrometer.

The problem of determing the actual age of emplacement or formation of Archean rocks has proved to be very difficult in Canada since all K-Ar and Rb-Sr age investigations carried out to date have failed to yield ages greater than 2700 m.y.. In order to ascertain if this represents the true age or an indication of a post-emplacement thermal event we have turned our attention to the study of zircons and/or sphenes. Large samples (several hundred pounds) of selected pre-Kenoran rock units have been collected and zircon and sphene concentrates have been prepared. We are currently endeavouring to purify the concentrates and to separate them into suitable size fractions in order to obtain a 'family' of zircon types from each rock unit. We then plan to undertake the required analyses, using the new solid source mass spectrometer and to analyse the data obtained using the 'Concordia' technique. This method finds particular application to the study of minerals that have been influenced by geological events subsequent to their formation and have consequently not remained as closed systems with respect to the gain or loss of parent and/or daughter isotopes. The analysis of the age results from various size fractions of the zircon population using the 'Concordia' technique often provides evidence of the original or true age of formation of the zircons in the rock.

The facilities for stable isotope studies have been augmented through the modificiation of the simultaneous collection mass spectrometer to permit the precise determination of $^{12}C/^{13}C$ ratios in addition to the determination of $^{32}S/^{34}S$ ratios. The equipment is operated to provide data for other units of the G.S.C.

PERSONNEL CHANGES

Dr. Ken Shibata of the Geological Survey of Japan completed the tenure of his N.R.C, Postdoctorate Fellowship in September 1969 and has now returned to Japan. While in Ottawa he undertook a rubidium-strontium study of rocks of the Hida metamorphic complex of Japan and prepared and calibrated enriched isotopic tracer solutions to be used in the laboratories of the Japanese Geological Survey.

ATTENDANCE AT MEETINGS

Colloquium on the Geochronology of Phanerozoic Orogenic Belts, Zurich and Bern, Switzerland. - Aug. 29 - Sept. 5, 1969.

- R.K. Wanless, K. Shibata.

American Geological Society, Atlantic City, U.S.A. - Nov. 10 - 12th, 1969.

- R.D. Stevens.

Lunar Science Conference, Apollo XI, Houston, Texas, U.S.A.- Jan. 5 - 8th 1970.

- R.K. Wanless.

Seminar on Tectonism and Metallogenesis, Univ. of Toronto, Jan. 29th, 1970.

- R.K. Wanless.

MEMBERSHIP ON COMMITTEES

R.K. Wanless - Secretary, N.R.C. Subcommittee on Isotope Studies and Geochronology for an additional 3 year term.

SPECIAL TALKS

R.K. Wanless - "Age determinations and isotopic abundance measurements on lunar samples" Houston, Texas, U.S.A. Jan. 5 - 8th 1970.

- "Anomalous parent-daughter isotopic relationships in rocks adjacent to the Grenville front near Chibougamau, Quebec". Colloquium on the Geochronology of Phanerozoic Orogenic Belts, Zurich and Bern, Switzerland, Aug. 29 - Sept. 5, 1969.

OUTSIDE PAPERS

Wanless, R.K., Stevens, R.D. and Loveridge, W.D.

(1969) - Excess radiogenic argon in biotites; Earth and Planetary Science Letters, vol. 7, pp. 167-168.

(1970) - Age determinations and isotopic abundance measurements on lunar samples; Science, vol. 167, pp. 479-480.

Wanless, R.K., Stevens, R.D. and Loveridge, W.D.
(1970) - Anomalous parent-daughter isotopic relationships in rocks adjacent to the Grenville front near Chibougamau, Quebec; Eclogal Geologicae Helveticae, vol.63/1, pp.1-20.

(1970) - Age determinations and isotopic abundance measurements on lunar samples (Apollo XI); Geochimica et Cosmochimica Acta, Supplement 1, 17 pages.

Boyle, R.W., Wanless, R.K. and Stevens, R.D.
- Sulphur isotope investigation of the lead-zinc-silver-cadmium deposits of the Keno Hill-Galena Hill area, Yukon, Canada; Economic Geology, vol. 65, pp.1 - 10.

ACTIVE PROJECTS DURING REPORT YEAR

540028	Wanless, R.K.	Isotopic age determinations of rocks and minerals.
550062	Wanless, R.K.	Isotope chemistry of sulphur in rocks and ore deposits.
580144	Boyle, R.W.	Lead and sulphur isotope geology of Keno and Galena Hills, Yukon.
650466	Wanless, R.K.	Isotopic study of mica-bearing rocks yielding anomalous K-Ar 'ages'.
670553	Wanless, R.K.	Development of a 15" radius solid source mass spectrometer.
670558	Wanless, R.K.	National isotopic age data file.
680136	Wanless, R.K.	Isotopic investigations, Lunar material.
680137	Wanless, R.K.	Isotopic age determinations, Japanese rocks.
680148	Wanless, R.K.	Development of K-Ar dating techniques and their application to very young continental basalts, from British Columbia.
680152	Wanless, R.K.	Isotopic Age Map of Canada.

COAL RESEARCH SECTION

P.A. Hacquebard

The section is responsible for microscopic investigations of Canadian Coals and associated clastic sediments in the fields of coal petrology and palynology. The petrological studies are carried out to obtain information valuable for coal geology, coal mining and coal utilization (particularly as applied to the evaluation of coking coals). The palynological investigations are concerned with the biostratigraphy of the coalfields and regions with Carboniferous and Permian rocks.

P.A. Hacquebard, apart from his duties as Section Head, has been engaged in completing the manuscript on the coal rank studies in Eastern Canada. He has made a petrographic correlation of a coal seam at Carmacks, Y.T., and has given advice on a coal-drilling program at Springhill, N.S.

A.R. Cameron has written the manuscript on the field surveys of uraniferous lignites in Western Canada. He has continued with the petrological studies of the seams of the Crowsnest Coalfield, and has commenced with his research project on the petrographic evaluation of coking coal charges (in cooperation with the Fuels Research Centre of the Mines Branch).

J.R. Donaldson has completed reports on his petrological studies of the coal from the Blakeburn Mine and the Bowron River area in British Columbia. He has carried out a large number of rank determinations by means of reflectance measurements on samples from both Eastern and Western Canada. Tests to check the value of microhardness as a rank parameter for low rank coals were also made by him.

T.F. Birmingham has finished a report on the first phase of the petrological study of the seams of the Smoky River Coalfield.

M.S. Barss has continued with his palynological studies of the Carboniferous type sections in the Atlantic Provinces. He has prepared 10 reports on age determinations of rock samples submitted by G.S.C. and outside geologists. For this work he has made 197 maceratious and 500 slides.

C. Gange Harris has prepared coal for microscopic studies by cutting, grinding and polishing samples and has produced 500 grain mounts and 430 polished sections. He has also assisted with the compilation of diagrams for reports.

During the report year the following highlights can be mentioned: (1) The completion of the coal rank studies in the Atlantic Provinces and their application for oil exploration; (2) The utilization of vitronite rank (as determined by reflectance) for correlating seams in the Canmore Coalfield:

(3) The observation that the seams in the lower part of the section of the Crowsnest Coalfield are all considerably higher in fusinite and semifusinite than those of the upper part, which is significant in relation to their coking properties; (4) The result that the No.4 seam of the Smoky River Coalfield has a rank and petrographic composition which indicates excellent coking properties; (5) The evaluation of the coking properties of the coals from the Blakeburn strip mine (of Tulameen Coalfield) and the Bowron River area of British Columbia, and the effect on the coal of overlying basalt; (6) The petrographic correlation of the coal seam in the Tantalus Butte mine at Carmacks, Y.T and the recognition of 13 tonstein horizons in this seam; (7) The observation that of the 19 areas with Tertiary lignite tested for radioactivity only the one at the Cypress Hills in Saskatchewan would warrant further exploration for uranium; (8) The geological appraisal of the coal mining possibilities (based on new borehole data) in Miller's Corner area of Springhill Coalfield; (9) The preparation of 10 spore reports for age determinations of rock samples submitted by G.S.C. and outside geologists from New Brunswick and Yukon Territory.

ATTENDANCE AT MEETINGS

Canadian Advisory Committee on Coal Research, Ottawa. - April 24, 1969.

- P.A. Hacquebard, A.R. Cameron.

21st Canadian Conference on Coal, Calgary. - September 9-11, 1969.

- P.A. Hacquebard.

American Association of Stratigraphic Palynologists, Penn. State University. - October, 19-22, 1969.

- M.S. Barss.

MEMBERSHIP ON COMMITTEES

M.S. Barss	- Several working groups of the I.C.M.P. - Member, Organizing Committee for 1970 Toronto Meeting of A.A.S.P.
A.R. Cameron	- Member, Canadian Advisory Committee on Coal Research. - Member, Coal Petrology Committee of Coal Geology Division of G.S.A. - Secretary, Logan Club, 1969-70 season.
P.A. Hacquebard	- Member, Nomenclature Subcommittee of the International Committee on Coal Petrology. - Member, International Committee on the Microflora of the Paleozoic. - Member, Canadian Advisory Committee on Coal Research. - Symposium Committee of Coal Geology Division of G.S.A. for 1970 meeting.

SPECIAL TALKS

P.A. Hacquebard - "Coal metamorphism and hydrocarbon potential etc. in the Atlantic Provinces". October 8, 1969. Logan Club.

P.A. Hacquebard, A.R. Cameron - "Coal rank studies in eastern Canada" and some petrographic aspects of Canadian lignites". North American Coal Petrologists Ottawa, October 9-10, 1969.

OUTSIDE PAPERS

Hacquebard, P.A., Donaldson, J.R. (1969) - Carboniferous coal deposition associated with flood plain and limnic environments in Nova Scotia; G.S.A. Special Paper 114, pp. 143-191.

OTHER ACTIVITIES.

1. A.R. Cameron and P.A. Hacquebard critically examined one "Outside" manuscript each.

2. J.R. Donaldson and A.R. Cameron reviewed the report by Y. Nakayanagi on the No.1 seam from Michel.

3. P.A. Hacquebard and A.R. Cameron prepared recommendations on coal geology for the Solid Earth Sciences Studies of the Science Council of Canada.

4. P.A. Hacquebard revised the reviewed manuscript on "Coal metamorphism and hydrocarbon potential. etc"., which has been submitted to the Can. Jour. Earth Sci.

ACTIVE PROJECTS DURING REPORT YEAR

500029	M.S. Barss	Identification and biostratigraphic interpretation of referred fossils.
610269	A.R. Cameron	Petrographic examination of coking coals from the Crowsnest coalfield, Alta., and B.C.
680102	P.A. Hacquebard) J.R. Donaldson)	Rank studies of coal and carbonaceous matter.
680103	P.A. Hacquebard) M.S. Barss)	Environmental and facies studies of coal.
680104	P.A. Hacquebard	Coal mine geology and evaluation of coal reserves.
680105	T.F. Birmingham	Petrography of coal seams in the Rocky Mtn. Foothills Belt, north of the Crowsnest area.

680106	A.R. Cameron) T.F. Birmingham)	Uranium possibilities in lignite.
680108	J.R. Donaldson	Petrography of Tertiary coals in British Columbia.
680109	M.S. Barss	Carboniferous and Permian palynology.
680133	R.G. McCrossan) J.R. Donaldson)	Correlation of coal rank and hydrocarbon properties in Mesozoic rocks of Western Canada.
690022	A.R. Cameron	Petrographic study of particle types in coking coal charges.
690026	P.A. Hacquebard	Petrographic correlation of coal seams at Carmacks, Y.T.

FIELD ACTIVITIES

A.R. Cameron, T.F. Birmingham and P.A. Hacquebard spent from 2 to 5 weeks each on checking the radioactivity of various Tertiary lignite occurrences in Western Canada. Cameron and Hacquebard spent additional time in collecting coal samples at Fording River, Canmore and Carmacks, while the latter also made a brief visit to Springhill, N.S.. M.S. Barss collected samples for the spore investigations in New Brunswick and Nova Scotia during a 2 week period.

ECONOMIC GEOLOGY AND GEOCHEMISTRY DIVISION

S.C. ROBINSON, Chief

J.A. Maxwell, Assistant Chief

INTRODUCTION

The change to the above title was approved during the year in order to emphasize the Division's principal objectives. Formal statements of these objectives and benefits appear in the program forecast. Briefly, the Division is concerned with the geological occurrence of economically important elements and minerals in Canada. Its work is designed to provide the data base, information and concepts needed for selection of favourable geological units and areas for prospecting, for assessment of national and regional potential and for formulation of government policy on non-renewable resources. It also provides laboratory services and the advice of specialists in mineralogy, chemistry and geomathematics to the Branch, and limited services in mineralogy to the Public.

At the beginning of the year the establishment of the Division totalled 103, comprising 45 scientists, 35 technical and office staff, and 23 man years of casual staff. The staff freeze of 1 August 1969 reduced these figures to 96, 43, 34, and 19 respectively.

The budget for 1969 was $1,355,000. Publication output comprised a total of 63 papers, of which 44 were published in professional journals, and 19 by the Geological Survey(2E.G. Series reports and 17 paper series reports). Publications by sections were as follows:

Section	Outside	G.S.C.
Admin. & Special Projects	15	3
Mineral Deposits	5	6
Geochemistry	6	8
Analytical Chemistry	3	-
Mineralogy	14	1
Data Processing	1	1
	44	19

Laboratory output involved the processing of 25,500 samples including 6,500 for crushing and mineral separation, 2,800 for X-ray examination and identification and 18,000 for chemical analysis resulting in 105,000 elemental determinations.

1969/70 saw progress in studies of the geology of many of Canada's important metals, including Cu, Ni, Ag, Fe, V, Li, Sn, Pb, Zn, U and Th, and provision for writing comprehensive professional appreciations of the current state of knowledge on three others, Cr, Nb, and Ta. The importance of comprehensive E.G. Series reports is documented by the

fact that, following publication in August 1969, the report on Titanium in Canada was out of print by early 1970. The Division was well represented at the Annual Meetings of the Prospector's and Developer's Association and of C.I.M.M., at both of which results of the year's work were reported publicly and in conversation with members of the professional Public.

Highlights of field activities in Geochemistry were the first full scale helicopter-supported operation testing methods of prospecting for uranium in Northern Saskatchewan, and the success of the first attempts to apply geochemical exploration techniques in permafrost of the Coppermine region. In the geochemical laboratories a major addition to the quantometer laboratory was carried out so that the instrument now has 40 effective channels and a small computer controls its spectrometer, reads the voltages, and computes the results of the analyses. The combination of equipment by which this is done and its capability are virtually unique. Much of the work of the Section during the year was devoted to preparation for the Third International Symposium on Exploration Geochemistry that was held in April 1970 under the general chairmanship of R.W. Boyle.

In mineralogy, the year saw completion of the major revision of Memoir 74, to be published as a catalogue of minerals in Canada. It is expected that this will be a valuable source book for mineral exploration as well as an essential reference work for mineralogists in Canada. Mineralogical study of lunar material commenced during the year and proved to be highly rewarding and resulted in preparation of 4 scientific papers. Emphasis is being shifted to use of mineral studies as a basis for understanding the provenance and genetic processes of mineral deposits.

The analytical chemistry laboratories took part in analysis of lunar samples collected by the Apollo Xl mission. Results checked well with other major laboratories. A study of results on international standard samples indicates that the Geological Survey continues to rank among the ten leading rock analysis laboratories in the world. A cost/benefit study of results and costs of their output shows that there is a slight cost advantage over commercial laboratories, and that our results are markedly superior in quality.

The storage, retrieval and service functions of the Geomathematics and Data Processing Section were transferred to the new Geological Information Processing Division at the end of the fiscal year. At the same time, the National Index was transferred to the new Canadian Centre for Geoscience Data. Dr. Agterberg was away most of the year as a visiting scientist at the British Columbia Research Council and at Kansas State Geological Survey. In his absence work on probability models for estimating regional mineral potential was carried on by Mr. A.G. Fabbri and Professor Jan Kutina with the assistance of Mrs. J.E. Springer. A new position for a computer scientist has been made available for this group.

DIVISION ADMINISTRATION

Personnel Notes

J.A. Maxwell: was on leave of absence from his administrative duties from June 12, 1969 - March 31, 1970, in order to carry out chemical studies of lunar samples returned from the Apollo X1 lunar landing, as a Principal Investigator with the NASA Apollo program; he also acted as Branch Coordinator of the lunar studies being done at the Geological Survey of Canada. While on annual leave in Europe in August-September, he made brief visits to lunar Principal Investigators, and to laboratories engaged in rock and mineral analysis, in Geneva and Berne (Switzerland), Oslo (Norway) and Harwell, Cambridge and London (England); he also worked for one week in the laboratory of H.B. Wiik at the Geological Survey of Finland, on the analysis of meteorites.

E. Hall: as Acting Assistant Division Chief, assumed the administrative duties relinquished by J.A. Maxwell during his leave of absence for lunar work, June, 1969 - March, 1970. The Division wishes to acknowledge his unstinted efforts, and the contribution that he made to Division operations, during this period.

F.W. Jones: provided expert guidance and assistance in the construction and installation of new electronic equipment, and in the maintenance of existing equipment, in the Division laboratories, including the following major jobs:

- Completed changes on the Jarrell-Ash Direct Reading Spectrometer to convert to solid-state digital read-out system with coded output for automatic processing (Analytical Chemistry Section);

- Completed installation, in conjunction with I.P. Sharpe Associates, of computer-controlled fifty channel spectrometer (Geochemistry Section);

- Installed an ASR 33 Teletypewriter read-out system and interfaced with Perkins-Elmer DCR1 Control and multi - sample feed unit of Atomic Absorption Spectrometer (Geochemistry Section);

- Technical assistance was given with regard to interface between existing readout systems and new computer, to be installed by I.P. Sharpe Associates, for use with MAC Electron microprobe (Mineral Section);

- Technical assistance in connection with installation of new recorder, nitrous oxide flame source, etc. for Techtron Atomic Absorption Spectrometer (Analytical Chemistry);

In addition, the following work was done for other Divisions:

Crustal Geology: advised K.L. Currie on high temperature furnace control system and constructed a prototype module for him;

Quaternary Research and Geomorphology: with M.L. Parker, completed the design and construction of a system to analyze tree ring sections for dendrochronology measurements.

J.H. Lapp: formerly with the Administrative Branch of the Canadian Radio - Television Commission, joined the Division as Administrative Officer in August.

Mrs. F. Vachon: joined the staff as temporary typing and clerical assistant in June.

Attendance at Meetings

S.C. Robinson: Cogeodata Committee, European members, Ispra, Italy, April, 1969.

Centennial of the Hungarian Geological Institute, Budapest, September, 1969 (as a Canadian delegate).

Unesco - I.U.G.S. meeting on the International Geological Correlation Programme, Budapest, Hungary, September, 1969.

Systematics Association Symposium on Data Processing in Biology and Geology, Cambridge, England, September, 1969.

Workshop on Computer Processing of Geological Data, University of Western Ontario, October, 1969.

Third Annual Symposium on Decision Making in the Mineral Industry, Vancouver, January, 1970.

J.A. Maxwell: Annual Meeting, American Chemical Society, Minneapolis, Minnesota, April, 1969.

Principal Investigators Meeting, Apollo Lunar Program, Manned Spacecraft Center, Houston, Texas, April, 1969.

Apollo XI Lunar Science Conference, Houston, Texas, January, 1970.

Week-long seminar on Planning, Programming and Budgetting Systems, Ottawa, January, 1970.

two-day seminar on Position Classification, Ottawa, February, 1970.

two-day briefing on the revised general instructions for field parties, Ottawa, March, 1970.

F.W. Jones: Institute of Electronic and Electrical Engineers, New York, March, 1970.

two-week course on computer maintenance given by Hewlett-Packard Company, Palo Alta, California.

J.H. Lapp: two-day briefing on the revised general instructions for field parties, Ottawa, March, 1970.

Papers, Lectures and Talks Given

S.C. Robinson: "International needs and problems in applying data processing to geology"; Concluding Dinner, University of Western Ontario, Workshop on Data Processing in Geology, October, 1969

"A review of data processing in the Earth Sciences in Canada"; Geological Society of Washington, December, 1969.

"Data processing requirements of the International Geological Correlation Programme"; Third Annual Symposium on Decision Making in the Mineral Industry, Vancouver, January, 1970.

J.A. Maxwell: "Canadian participation in the Lunar Sample Analysis Program"; Observatories Branch (with J.A.V. Douglas and L.S. Collett), May, 1969.

"The lunar sample investigation program at the Geological Survey of Canada";
-Canadian Aeronautics and Space Institute, November, 1969;
-Ottawa Student Chapter, Chemical Institute of Canada, Carleton University, November, 1969;
-Logan Club, with L.S. Collett, J.A.V. Douglas, E. Schwarz and R.K. Wanless, February, 1970;
-Ottawa Section, Chemical Institute of Canada, Algonquin College, February, 1970;
-Division of Chemistry, National Research Council, March, 1970.

Membership on Committees

S.C. Robinson: Chairman, I.U.G.S. Committee on Storage, Automatic Processing and Retrieval of Geological Data (Cogeodata Committee);

Chairman, Working Group No. 4, Unesco - I.U.G.S. meeting on the International Geological Correlation Program, Budapest;

Member, Organizing Committee of XXIV International Geological Congress.

J.A. Maxwell: Chairman, Branch Technician Appraisal Committee;

Member, Associate Committee on Meteorites, National Research Council;

Member, Standards Committee, Geochemical Society.

Branch Representative, Departmental Committee on Bilingualism and Biculturalism.

Outside Publications

Robinson, S.C. 1969: International Aspects of geologic data storage and retrieval; in A decade of digital computing in the mineral industry, Alfred Weiss, editor, AIME, New York, pp. 319-330

Robinson, S.C. In press: The role of the Geological Survey of Canada in the storage and retrieval of geologic data; Proceedings of the Hungarian Geological Institute.

Maxwell, J.A. 1970: Geological Survey of Canada participation in the Apollo lunar program. Chem in Canada, vol. 22, No. 3, pp. 13-17

Maxwell, J.A., Abbey, S., and Champ, W.H. 1970: Chemical composition of lunar material; Science, vol. 167, No. 3918, January 30, pp. 530-531.

Active Projects

Lunar crust investigation	670561
Ultrabasic reference rock sample	620280
Study of field sampling errors	650474

REPORTS ON SECTIONS

SPECIAL PROJECTS

R.W. Boyle A. H. Lang H.W. Little

Activities

R.W. Boyle continued the compilation of the geochemistry of gold and its deposits. In connection with this, field work was done in the Falcon Lake and Bird River areas of Manitoba, in the Beaverlodge area of Saskatchewan, and in the Yellowknife area, N.W.T.

A.H. Lang made further progress in his studies of the contributions of the G.S.C. to the economic development of Canada. He also continued his duties as chairman of the committee on the history of the G.S.C., which is providing general guidance and critical assessment of the history which is being prepared by Professor M. Zaslow.

H.W. Little (Uranium Programme)

Dr. Little continued his field and laboratory investigations of Canadian deposits of uranium and thorium, including a study of anhydrite - pegmatite ores in the Bancroft area, Ontario, and compilation of data on the uranium content of stream sediments in Nova Scotia. He also compiled information on Canadian uranium reserves, and on types of uranium deposits in Canada, for presentation at the April, 1970 IAEA meeting in Vienna, and continued to collect material for the revision of Economic Geology Series 16 (Canadian Deposits of Uranium and Thorium).

Dr. V. Ruzicka, N.R.C. Postdoctorate Fellow, compared Canadian and East European uranium and thorium deposits, proposed a genetic classification of uranium deposits based on this comparison, and studied regularities in the distribution of uranium deposits, and in the localization of uranium mineralization.

T.J. Bottrill began a new study of uranium deposits in Proterozoic sediments, with particular emphasis on the environmental controls of uranium localisation; a hypothesis combining features of earlier theories has been proposed to explain the origin of these deposits.

Visits by staff members were made to uranium occurrences in British Columbia, Northwest Territories, Ontario, Labrador, and New Brunswick.

M. Fratta completed his thesis study of uranium deposits in the Grenville Province, and J. Bushell undertook the gamma-ray logging of water-wells in S.E. Alberta and S.W. Saskatchewan as a summer project.

Attendance at Meetings

R.W. Boyle:	Annual Meeting, Canadian Institute of Mining and Metallurgy, Montreal, April, 1969.
:	Annual Meeting, Prospectors and Developers Association, Toronto, March, 1970.
H.W. Little:	Annual Meeting, Canadian Institute of Mining and Metallurgy, Montreal, April 1969.
T. J. Bottrill:	Annual Meeting, Canadian Institute of Mining and Metallurgy, Montreal, April, 1969.
:	Phase Systems Symposium, McMaster University, Hamilton, February, 1970.

Papers, Lectures and Talks Given

R.W. Boyle:	Lecture, Queen's University, Kingston, February, 1970.
:	Lecture, Guelph University, March, 1970.

Membership on Committees

R.W.Boyle:	International Association on the Genesis of Ore Deposits, I.U.G.S. (Treasurer).
:	Technical Committee, Section 10 (Geochemistry) of the Twenty-fourth I.G.C., Montreal, 1972 (Convenor).
:	Symposium Committee, International Symposium on Exploration Geochemistry, Toronto, 1970 (Chairman).
:	Advisory Committee, Faculty of Geology, University of Western Ontario, London.
H.W. Little:	Branch Committee on Uranium.

Outside Publications

Boyle, R.W. 1969:	Further remarks on the origin of massive sulphide deposits; Econ. Geol. vol. 64, No. 7, p. 829.
1969:	The Source of elements in epigenetic mineral deposits - a metallogenic concept for prospecting. Can. Mining Jour. vol. 90,- April, pp. 104-107.
1970:	Regularities in wall rock alteration phenomena associated with epigenetic mineral deposits; Int. Assoc. Genesis Ore Deposits Special Volume.
1970:	The source of metals and gangue elements in hydrothermal deposits; IAGOD - Kongresszus Volume on The Source of Metals in Hydrothermal Deposits. pp. 8-11.

Boyle, R.W., Wanless, R.K., and Stevens, R.D.
1970: Sulphur isotope investigations of the lead-zinc-silver-cadmium deposits of the Keno Hill-Galena Hill area, Yukon, Canada; Econ. Geol., vol. 65, No. 1, pp. 1-10

Boyle, R.W., and Garrett, R.G.
1970 Geochemical prospecting - a review of its status and future; Earth Sci. Reviews, vol. 6, pp. 51-75

Lang, A.H.
1969: Sir William Logan and the Economic Development of Canada; Canadian Public Administration Vol. XII, No. 4, pp. 551-565.

1969: The Roles of the Geological Survey of Canada in Former Uranium Programs; Can. Inst. Min. Met. Bull., vol. 62, No. 691, pp. 1210-1218.

1969: Discovery of the Pinchi Mercury Deposit; Can. Min. Jour. Vol. 90, No. 11, pp. 45-46.

1970: Historical Sidelights of Brenda Mine and Region, Part I; Can. Min. Jour. Vol. 91, No.3, pp. 41-43.

Little, H.W.
1969: Anhydrite - pegmatite uranium ore at Bancroft, Ontario. Econ. Geol. Vol. 64, pp.691-695.

Little, H.W., and Smith, A.Y.
1969: Techniques currently used in uranium prospecting in Canada; Internat. At. Energy Proc., Vienna, 1968, pp. 131-145.

Active Projects

Geochemical study of mineral deposits in Bathurst-Newcastle area, N.B.	570022
Geochemistry of gold deposits	650438
Study of the contribution of the G.S.C. to the economic development of Canada	680143
Committee on history of G.S.C.	680149
Geology of uranium and thorium deposits of Canada	670029
Study of conglomeratic uranium deposits in Canada	690014
Gamma-ray probing of selected water wells in Canada	690021
Study of pegmatitic uranium deposits of the Grenville Province.	680088

GEOLOGY OF MINERAL DEPOSITS SECTION

G.A. Gross

This Section is composed of a group of economic geologists and staff who are investigating the nature and kinds of mineral deposits and geological environments or regions favourable for the occurrence of economic mineral deposits, and those geological factors on which estimates of the mineral potential of Canada can be based.

The first and largest part of the Section program is devoted to the comprehensive study of all aspects of the geology of a specific economic element or geologically coherent group of such elements and particularly to the study of the many ways in which these are concentrated in the earth's crust.

The second part of the program deals with the systematic collection, recording, compilation and presentation of geological information on mineral deposits for reference and documentation of Section project research and reports, and of other Geological Survey reports. Emphasis is being placed on the conversion of records and data to systems or formats for the computer storage, retrieval and processing of data. Field data, previous records on mineral deposits from various sources and systematized data files are being amalgamated and co-ordinated in a Mineral Deposits Section Data Bank.

The principal scientific contributions arising out of the Section program include the series of Economic Geology Reports which provide a comprehensive treatment of the geology of economic minerals or commodities, shorter papers of an economic geology and related nature, metallogenic maps and reports, and appraisal of potential mineral deposits. Considerable time is spent by the staff in consultation, and on advisory or liaison work, with senior representatives of the mining industry, Departmental and other government agencies, and International organizations such as United Nations.

Activities

Geology of Mineral Commodities

Highlights in the diversified program and activities of the Geology of Mineral Deposits Section during the year were the publication of two volumes in the Economic Geology Series reports and the Mineral Deposits map of Canada. The reports on Titanium and Titaniferous Deposits of Canada by Dr. E.R. Rose and Iron Ranges of the Labrador Geosyncline by Dr. G.A. Gross, along with the Mineral Deposits map by Dr. D.R.E. Whitmore, A.G. Johnston et al, were enthusiastically received by the public as shown by the rapid sale of these editions. An earlier report on the General Geology and Evaluation of Iron Deposits by Dr. G.A. Gross was translated into Russian and published by the Soviet Academy of Sciences in the Soviet Union. A Survey of World Iron Ore Resources with two chapters by Dr.G.A. Gross was published by United Nations which revises a previous survey published in 1954.

Principal field activities included study of mineral deposits in the Coppermine River area of the Northwest Territories by Drs. E.D. Kindle and R.V. Kirkham, continued work on lead and zinc deposits in carbonate rocks and examination of complex zinc copper sulphide deposits in volcanic rock environments by Dr. D.F. Sangster, examination of nickel deposits in the Ungava area of Quebec and various parts of Central Canada by Dr. O.R. Eckstrand, continuing investigation of deposits of tin and lithophile elements in Yukon Territory and British Columbia by Dr. R. Mulligan, and continued work on Algoma Type iron-formations in Central Canada by Dr. Gross.

The Section laboratories for ore microscopy and mineral separation continued an active program of work in support of Section project studies. The following summarizes the number of polished sections prepared for Branch and Department research:

Polished Sections Prepared For Economic Geology and Geochemistry Division	Number of Sections
Mineral Deposits Section	361
Geochemistry Section	3
Mineralogy Section	93
For Crustal Geology Division	86
For Exploration Geophysics	94
For Mines Branch	20
Total	657

Officers of the Section prepared short papers which outlined recent trends and developments in the geological investigation and use of major metallic mineral commodites for an annual review of the geology of mineral deposits.

Metallogeny

Dr. G.B. Leech continued work on the general metallogeny of Canada and submitted first drafts of a manuscript of a Metallogenic Map of Canada which will form part of the metallogenic Map of North America, one of a series of continental maps initiated by the International Geological Congress and carried through the Commission for the Geological Map of the World affiliated with the I.U.G.S.

General

More than 100 representatives from mining and exploration companies consulted the Section Staff concerning favourable areas and geological environments for mineral exploration, on geological aspects of mineral deposits appraisal and evaluation and various scientific and technical matters related to mineral development. Consultation and advice on mineral potential and possible future mineral developments were provided for a number of Department and Government agencies including the Department of Regional and Economic Development and the Department of Indian Affairs and Northern Development.

Personnel Notes

Dr. R.V. Kirkham joined the Section in May 1969 and is studying copper and molybdenum deposits.

Mr. J. Lepinis, one of the Section support staff, was transferred in July to other duties in the Division.

Professor J. Kutina of Charles University in Prague, Czechoslovakia has spent 5 months with the Section studying structural features in the Precambrian.

Ph.D. Candidates Sponsored in the Mineral Deposits Section.

D.J. Bachinski	-	Yale University. Metamorphism of Sulphide Deposits, principally Whalesback and nearby deposits, Newfoundland.
J.M. Franklin	-	University of Western Ontario. Metallogenesis in the Thunder Bay District of Ontario.

H.P. Wilton - University of Manitoba.
Iron Formations in the Timagami Lake area, Ontario.

I.S. Zajac - University of Michigan.
Stratigraphy of Superior Type Iron-Formation in the Schefferville-Knob Lake area of Quebec and Labrador.

Attendance at Meetings

O.R. Eckstrand
- C.I.M.M. Annual General Meeting, Montreal, April 21-23, 1969.
- Summer School in Ore Microscopy, University of Toronto, September, 1-5, 1969.
- Experimental Petrology Symposium, McMaster University, February 26-27, 1970.
  Prospectors and Developers Association Annual Meeting, Toronto, March 9-11, 1970.

R.V. Kirkham
- Geological Society of America, Annual Meeting, Atlantic City, N.J., November, 1969.
- Experimental Petrology Symposium, McMaster University, February 1970.
- Prospectors and Developers Association Annual Meeting, Toronto, March 1970.

G.A. Gross
- 9th Commonwealth Mining and Metallurgical Congress, in London, England, May 1969.
  Part I - Congress Proceedings and Technical Sessions
  Part 11 - Congress Tour of South Wales Iron, Steel and Coal Industry
  Part III - Congress Tour Jurassic Iron Mines, in Central and Northern England.
- Prospectors and Developers Association Meeting in Toronto, March, 1970.

G.B. Leech
- C.I.M.M. Annual Meeting, April, 1969.
- Committee for the Metallogenic Map of North America, Guatamala, December, 1969.

C.R. McLeod
- Summer School in Ore Microscopy, University of Toronto, September 1-5, 1969.

R. Mulligan - Prospectors and Developers Association Annual Meeting, March 1970.

E.R. Rose - Geological Association Canada and Mineralogical Association Canada Annual Meeting, Montreal, June 5-10, 1969.

D.F. Sangster
- Geological Association Canada Annual Meeting, Montreal, June 1969.
- Prospectors and Developers Association Annual Meeting, Toronto, March 1970.

R. I. Thorpe
- Mineralogical Society of America, Symposium on Sulphides, Atlantic City, N.J., November 8, 1969.
- Geological Society of America Annual Meeting, Atlantic City, N.J., November 10-12, 1969.
- Experimental Petrology Symposium, McMaster University, Hamilton, February 26-27, 1970.

Papers, Lectures and Talks Presented

O.R. Eckstrand
- "Geology of the El Salvador Porphyry Copper Deposit", University of Ottawa, Geology Department Seminar, January 28, 1970.
- "Alteration and Sulphide Zoning in a Chilean Porphyry Copper Deposit", Geochemistry Discussion Group, Carleton University, March 19, 1970.

G.A. Gross
- Presented paper - "Geological Concepts Leading to Mineral Discovery" at Prospectors and Developers Meeting
- As a C.I.M.M. sponsored lecturer presented a sequence of three lectures at six Western Ontario Universities on the "Depositional Environment and Origin of Iron formations and Iron Ore Deposits" in October 1969.
- Presented a lecture at the Noranda chapter of the C.I.M.M. in February on the Iron Ore Deposits of the Soviet Union and a discussion of geological research on mineral deposits in that country.

D.F. Sangster
- papers presented
- Metallogenesis of some Canadian lead-zinc deposits in carbonate rocks; Geol. Assoc. of Canada Meeting.
- Geological exploration guides for Canadian lead-zinc deposits in carbonate rocks; Prospectors and Developers Association Meeting.
- Sulphur isotope geochemistry in relation to problems of genesis of base metal ore deposits; Geology Department, University of Western Ontario, London, December 1969.

Five officers of the Section presented Talks on mineral deposit geology to the Graduating Class in Geology from Carleton University in April 1968 and March 1969.

Membership on Committees

G.A. Gross
- Canadian Collaborator, Journal of Mines, Metals and Fuels, India.
- Member, International Association on the Genesis of Ore Deposits. Committee for "Correlation of Iron-Manganese Precambrian Stratabound Ore Deposits".
- Member, Publications Committee, Society of Economic Geologists

G.B. Leech
- Chairman, Committee on History of the Geological Survey of Canada.
- Chairman, Canadian Metallogenic Map Committee.
- Member, Committee for the Metallogenic Map of North America.
- Member, Commission for the Tectonics of Ore Deposits, International Association on the Genesis of Ore Deposits.

D.F. Sangster
- Building Representative, Ottawa Group, C.I.M.M.
- Chairman, Geochemical Discussion Group.
- Vice-Chairman, Geologists Sub Group, Professional Institute of Public Service, Canada.

Papers Published in Outside Journals

Gross, G.A.
1970: Chapters on Nature and Occurrence of Iron Ore Deposits and Iron Ore Deposits of Canada and the West Indies; in United Nations Survey of World Iron Ore Resources, United Nations, New York, N.Y.

Rose, E.R.
1969: Vanadium: Its Occurrence and Prospects in Canada; Part of a Symposium, Guidelines to Prospecting; Can. Min. Jour. April.

Thorpe, R.I. Metallogenesis and Exploration in the Northwest Territories; Part of a Symposium, Guidelines to Prospecting; Can. Min. Jour., April.

Harris, D.C. and Thorpe, R.I.
1969: New Observations on Matildite; The Canadian Mineralogist, Vol. 9, Part 5, pp. 655-662.

Sainsbury, C.L. Mulligan, R., and Smith, W.C. Jr.
In Press: The Circum Pacific Tin Belt in North America; International Tin Council, Proc. 2nd Technical Conference on Tin.

Active Projects

Geology of Canadian nickel and platinum group deposits	630037
Geology of lead and zinc deposits in Canada	650056
Nakina geologic - magnetic study	630028
Geology of iron and manganese deposits in Canada	570029
Mode of occurrence and origin of the iron deposits, Mary River, Baffin Island.	650006
Development and supervision of Mineral Deposits data bank	680114
Geology of copper deposits in Canada	600009
General Metallogeny of Canada	640125
Preparation of Geological Base Map for Map 900-A	670559
Geological Survey of NTS 82G W½ (Fernie W½)	560006
Geological Survey of NTS 82J W½ (Kananaskis Lakes, W½)	620018
Geology of Canadian Lithophile metals (Li, Be, Sn, W, Mo)	530014
Metallogenic study of the beryllium-tin province of the Cassiar batholith.	650012
Operation of Mineral Deposits Section Laboratories	610251
Geology of Vanadium Deposits in Canada.	630039
Geology of Titanium and Titaniferous Deposits of Canada	580036
Geology of rare earth deposits of Canada	670028
Geology of silver and gold deposits in Canada	680060
Whalesback comprehensive mine study	640058
Certification of bedded and non-bedded mineral deposits	640402
Geological aspects of mineral supply problems	680150

GEOCHEMISTRY SECTION

E. M. Cameron

During the year under review the Geochemistry Section, in some ways, resembled a crouched lion, ready to spring, but with his tail unfortunately caught around a tree. Over the past two years we have been carrying out a transition to a purely mission-oriented role. This role, we have discovered, is much more demanding of money than our former, mixed basic research/applied research program, particularly when it is played along our norther frontiers. It is unfortunate that this transition and an era of austerity are coincident.

The primary objective of our staff is to develop new methods of mineral exploration, based on the science of geochemistry. Fortunately, we are allowed to base this search for new methods on investigations of the geological and geochemical principles involved. This is an essential requirement for attracting and retaining the high calibre of staff needed for this work. Equally fortunately, we are able to combine with our primary objective a good deal of data collection on the composition of the rocks, minerals, soils and waters of our environment. That this can be of value to Canada in unsuspected ways is evidenced by the almost continuous consultations that we have enjoyed, during the latter few months of the fiscal year, on the role of mercury as a pollutant. The interest of our many visitors has been twofold: they wish information on the geochemical cycle of mercury and they are anxious to use our analytical methods for this element. We have (in the persons of Mr. Lynch and Dr. Jonasson) become an authority on the latter; but we can give them a woefully small amount of information on the geochemical cycle of this element.

The present problems that we are having with mercury as a pollutant in Canada can directly be related to our ignorance of its geochemical cycle. However, we are even more ignorant of the cycle of certain other elements such as selenium, which we suspect may be just as serious a pollutant. The section has therefore proposed that an environmental geochemistry unit be created which will be charged with basic studies of the geochemical cycle of those elements that may pose an environmental hazard. Our experience with mercury has convinced us that the science of geochemistry has very real responsibilities to society.

The work that the section undertook during the year is best summarized in the titles, which are appended below, of the eight papers presented for the Third International Geochemical Symposium held in Toronto at the end of the review year. The papers represent a diverse approach to mineral exploration, based on the analysis of rocks, waters, gases, tills, vegetation and other surficial materials. These geochemical methods of exploration are particularly oriented to Canada's environment; thus techniques applicable to the Canadian Shield, to permafrost regions and to making broad reconnaissance studies have been emphasized. Our particular challenge now is to apply some of these methods that we have developed and make the geochemical maps of Canada that will be invaluable to the geologist, the prospector, the ecologist and others in the decades ahead.

Papers Presented to The Third International Geochemical Symposium

Allan, R.J. and Hornbrook, E.H.W.

Exploration Geochemistry Evaluation Study in a Region of Continuous Permafrost; the Coppermine Basalt Belt, N.W.T. Canada.

Cameron, E.M. and Hobbs, D.

Computerized Methods for Interpreting Reconnaissance Geochemical Surveys.

Cameron, E.M., Siddeley, G., and Baragar, W.R.A.

Distribution Functions of Ore Elements in Rocks for Evaluating Ore Potential.

Dyck, W., Dass, A.S., Durham, C.C., Pelchat, J.C., and Galbraith, J.H.

Comparison of Regional Geochemical Uranium Exploration Methods in the Beaverlodge Area, Saskatchewan.

Garrett, R.G.

The Dispersion of Copper and Zinc in Glacial Overburden at the Louvem Deposit, Val d'Or, Quebec.

Hornbrook, E.H.W.

Effectiveness of Geochemical and Biogeochemical Exploration Methods in the Cobalt Area, Ontario.

Morse, R.H.

Comparison of Geochemical Prospecting Methods using Radium, with those using Radon and Uranium (In collaboration with Queens University).

Nigrini, A.

Investigations into the Transport and Deposition of Copper, Lead and Zinc in the Surficial Environment.

Personnel Notes

In April Mr. A.Y. Smith resigned to enter private practice as a consulting geochemist. He was replaced in June by Dr. R.J. Allan, a soil scientist with a broad experience in the Arctic environment, who is working on the application of geochemical exploration methods to permafrost regions. In January, Dr. G. Siddeley resigned to join a mineral exploration company and has been replaced by Mr. Quentin Bristow who is to work on the airborne sensing of vapours for geochemical exploration. Dr. Ian Jonasson, a physical chemist and post-doctorate fellow from the Universities of Melbourne and Adelaide, joined the section in July; he visited the U.S.G.S. in Denver for two days in March.

Analytical Services and Development

The productivity of the Sample Preparation, Trace Element and Direct Reading Laboratories are briefly recorded in Tables 1, 2 and 3. It is gratifying that we are proceeding into the new fiscal year with virtually no backlog of samples. A more detailed record of the output of these three laboratories may be obtained from the monthly or bi-monthly reports submitted for this project.

TABLE 1

Sample Preparation Laboratory

	1968-69	1969-70
Samples carried over	0	0
Samples received	5716	3286
Samples completed	5716	3286
Samples carried forward	0	0
Sizing	524	796
Crushing	4964	2280
Grinding	4478	2166
Ball Milling	4854	1649
Superpanner	5	58
Frantz	5	23
Heavy Liquid	0	286
Hand picking	31	35

Table 2

Trace Element Laboratory

	1968-69	1969-70
Samples carried over	?	570
Samples received	10,918	9808
Samples Completed	10,348	10258
Determinations	32,301	32662
Samples carried forward	570	120

Table 3

Direct Reading Laboratory

	1968-69	1969-70
Samples carried over	?	1349
Samples Received	6725	2178
Samples completed	5376	3527
Determinations	44084	19580
Samples carried forward	1349	0

REMARKS

The deuterium background corrector, digital readout and printout systems were installed in the atomic absorption spectrophotometers.

The colorimetric methods for molybdenum and tungsten were revised and the precision and detection limit of both methods were improved.

With the assistance of Miss Laura Johnston and Dr. I. Jonasson, a method for the determination of mercury in water, rocks, soils, sediments and minerals has been developed.

Preconcentration techniques for the determination of zinc, copper, lead, nickel, cobalt, silver and cadmium in natural water were investigated. No improvement on the ammonium pyrrolidine dithiocarbamate-methyl iso-butyl ketone system was observed. This latter system was employed a number of years ago in the trace element laboratory and it will continue to be used.

Quick tests for the determination of copper in water, soil and sediment were developed for use in the field.

The use of mixture of ascorbic acid and hydrogen peroxide was investigated as a selective leaching agent for the determination of copper, nickel and cobalt present in rocks as sulphides.

A new spectrometer and computer were installed in the Direct Reading laboratory. Extensive tests are presently being carried out to determine optimum conditions for the analysis of major, minor and trace constituents

Attendance at Meetings

W. Dyck, E.M. Cameron, R.G. Garrett and A.Y. Smith attended the Annual Meeting, Canadian Institute of Mining and Metallurgy, Montreal in April, 1969.

R.J. Allan, E.M. Cameron, R.G. Garrett, E.H. Hornbrook and A. Nigrini attended the Annual Meeting, Prospectors and Developers Association, Toronto, March, 1970.

R.G. Garrett: Third Annual Symposium on Decision Making in the Mineral Industry, Vancouver, January, 1970.

Papers, Lectures and Talks Given

R.J. Allan and E.H.W. Hornbrook gave a talk on "The Development of Geochemical Techniques in Permafrost as Exemplified by Studies in the Coppermine River Area" at the Prospectors and Developers Convention, March, 1970.

W. Dyck gave a paper at the C.I.M. Annual Meeting, April 1969, on "The Application of Radon Methods to Geochemical Prospecting for Uranium".

R.G. Garrett talked on "Interpretation of Geochemical Data using Computers" to the January meeting in Vancouver on Decision-Making in Mineral Exploration and at Queens University. A talk on glacial sediment geochemistry in mineral exploration was given to the Toronto Geological Discussion Group.

A. Nigrini talked about "A Quantitative Model for Wall Rock Alteration at Elevated Temperatures" at the Ottawa Geochemical Discussion Group.

Memberships on Committees

R.G. Garrett: Branch Computer Facilities Committee

: N.A.C.R.G.S. Sub-committee on Storage and Retrieval of Geological Data (Chairman, Geochemical Data Working Committee).

J.J. Lynch: Branch Technician Appraisal Committee.

A. Nigrini: Branch Computer Facilities Committee (alternate member).

Outside Publications

Allan, R.J. and Hornbrook, E.H.W.
1970: Development of Geochemical Techniques in Permafrost, Coppermine River Region, Can. Min. Journal, April 1970; pp. 45-49

Boyle, R.W. and Garrett, R.G.
1969 Geochemical Prospecting, its Present Status and Future. Earth Science Reviews, December, 1969.

Cameron, E.M.
1970 Trends in the Search for Metals During the Seventies, Min. in Can. March, 1970.

Cameron, E.M.
1970: Geochemical Exploration Methods Find Increasing Use in the Shield, Annual Review Number, Northern Miner.

Dyck, W.
1969: Uranium Exploration Using Radon in Soils, Can. Min. Jour. August, 1969; pp. 45 - 49.

Garrett, R.G.
1969: The Determination of Sampling and Analytical Errors in Exploration Geochemistry; Econ. Geol. v. 64, pp. 568-9

Nichol, I., Garrett, R.G. and Webb, J.S.
1969: The Role of Some Statistical and Mathematical Methods in the Interpretation of Regional Economic Geochemical Data. Econ. Geol. v. 64, pp. 204-220

Active Projects

Geochemical Study of Papaskwasati Group	680022
Microdeposits as a Probabilistic Indicator of Ore Potential	690050
Development of radiochemical exploration methods using radon.	680028
Geochemical study of economic elements in glacial till.	670097
Regional geochemical census of plutonic rocks in the Eastern Yukon.	690036
Development of biogeochemical exploration methods for metallic mineral deposits for winter use.	680051

Analytical services and development in Geochemistry	580175
Transport and Deposition of Ore Indicator Elements in Streams and Sediments.	690039
The Geochemical composition of ultramafic rocks and its relation to their contained mineral deposits.	680061
Geochemical Dispersion of Uranium and its decay Products	690080

MINERALOGY SECTION

R.J. Traill

The scientists and support staff of the Mineralogy Section produce data and concepts that contribute to the search for mineral deposits, provide an inventory of potential mineral resources, and add to the basic knowledge of the geology of Canada. Current research includes: studies of primary mineral alteration zones in the Cobalt silver deposits; micas as indicators of the history of deposition of the Thompson area nickel deposits; compilation of a catalogue of Canadian minerals. Scientists also provide support scientific services to the Branch through development and use of X-ray diffraction, X-ray fluorescence and absorption, and electron beam and analytical techniques, and through the operation of sample preparation and mineral separating laboratories. Section officers are responsible for cataloguing and extending the Systematic Reference Series of Canada's National Mineral Collection, and for the provision of educational public services that include the preparation and sale of sets of Canadian minerals, rocks and ores, and the identification of specimens of minerals and rocks.

Activities

A scientific highlight of the year was the participation of A.G. Plant and R.J. Traill in a mineralogical-petrological study of some of the first lunar samples to be returned to Earth by the crew of the Apollo XI space mission. This work led to the discovery and complete description of a new mineral species that has been names pyroxferroite, and the finding of an unusual spinel group mineral containing major titanium and chromium. Results of the study are to appear in 4 scientific papers.

M. Bonardi, R.N. Delabio and D. Fong provided the following X-ray diffraction and mineralogical services in support of Branch projects: 2,475 mineral identifications; 52 calculations of unit cell constants; 26 olivine composition determinations; X-ray diffractometer analyses of 91 clays, 20 serpentines, 27 feldspars, 82 rocks, 6 carbonates, 6 pyrophllites and 29 stream sediments; examinations and reports on 125 samples submitted for age determination by the Geochronology Section.

J.C. Paris, B. Machin, R. Charbonneau, A. Brown and M. Huot processed 3,367 samples in the sample preparation and mineral-separating unit and prepared 364 concentrates of minerals. This work required the following numbers of operations: crushed, ground and sized, 3,328; heavy liquids, 2,013: Frantz magnetic, 865; Superpanner, 128; Electrostatic, 40; Stearns magnetic, 31; Wilfley table, 14.

C.H.R. Gauthier, J.M. Larose, J. Turpin and T.R. Racine prepared and shipped 9,354 Prospector's Sets of Minerals and Rocks. The distribution of these throughout Canada was as follows:

Alberta	1,360
British Columbia	1,792
Manitoba	151
New Brunswick	301
Newfoundland	13
Nova Scotia	324
Northwest Territories	104
Ontario	2,073
Prince Edward Island	15
Quebec	504
Saskatchewan	653
Yukon	1,034
Ottawa Office	1,030

Sales of the 120-specimen collections of minerals, rocks and ores representing the raw materials of the Canadian mining industry amounted to 151, and 65 special sets of these collections in wooden cabinets were prepared for display by Canadian Trade Commissioners throughout the world. At the request of the National Film Board, 438 collections were supplied to accompany Earth Science film-strip kits.

C.H. R. Gauthier and R.N. Delabio examined and reported on the identity of 1,275 specimens submitted by the public. Mrs. Ann P. Stenson replied to 31 requests for mineral-collecting information.

R.J. Gravel completed 1,753 quantitative X-ray fluorescence analyses on various rock and mineral samples in support of Branch projects. The chemical elements requested most commonly were: rubidium, 398; strontium, 372; potassium, 146; thorium, 37; uranium, 36 and lanthanum, 32. As part of research into correction factors for matrix effects, 250 precise relative X-ray intensities were measured on synthetic oxides and NBS standards.

Personnel Notes

Dr. F. Aumento, mineralogist and expert in undersea geology, resigned his position as Research Scientist in November to accept a Fellowship at Dalhousie University.

Attendance at Meetings

F. Aumento	American Geophysical Union, Annual Meeting, Washington, D.C., April, 1969.
J.L. Jambor	Prospectors and Developers Association Annual Meeting, Toronto, March 1970.
J. Rimsaite	Mineralogical Association of Canada, Annual Meeting, Montreal, June 1969.
	International Clay Conference, Tokyo, Japan, August, 1969.
Ann P. Stenson	Mineralogical Association of Canada, Annual Meeting, Montreal.
R.J. Traill	Electron Microprobe Society of America, Annual Meeting, Pasadena, California, July 1969.

Membership on Committees

Ann P. Stenson:	Treasurer, Mineralogical Association of Canada.
H.R. Steacy:	Ottawa Branch Committee, Canadian Institute of Mining and Metallurgy.
R.J. Traill:	Branch Technician Appraisal Committee.

Outside Publications

Aumento, F. 1969: The Mid-Atlantic Ridge near 45° N. V. Fission track and ferromanganese chronology. Can. J. Earth Sci., 6, pp. 1431-1440.

Aumento, F. 1969: Diorites from the Mid-Atlantic Ridge at 45°N. Science, 165, pp 1112-3

Aumento, F. 1969 (with R.L. Fleischer, H.R. Hart, I.S. Jacobs, P.B. Price and W.M. Schwarz) Search for magnetic monopoles in deep ocean deposits. Phys. Rev., 184, pp. 1393-1397.

Jambor, J.L. 1969: Dadsonite (minerals Q and QM), a new lead sulphantimonide. Mineral Mag., 37, pp. 437-441.

Jambor, J.L. 1969: Sulphosalts of the plagionite group. Mineral. Mag. 37, pp. 442-446.

Jambor, J.L. 1969: Coalingite from the Muskox intrusion, Northwest Territories. Amer. Mineral., 54, pp. 584-596.

Jambor, J.L. 1969: Muskoxite, a new hydrous magnesium-ferric iron oxide from the Muskox intrusion, Northwest Territories, Canada. Amer. Mineral., 54, pp. 684-696.

Jambor, J.L. 1969: (with D. Fong, and Ann P. Sabina) Dresserite, the barium analogue of dundasite. Can. Mineral., 10, pp. 84-89.

Plant, A.G. 1969: (with B.E. Leake, G.L. Hendry, A. Kemp, P.K. Harvey, J.R. Wilson, J.S. Coats, J.W. Aucott, T. Lünel and R.J. Howarth) The chemical analysis of rock powders by automatic x-ray fluorescence. Chem. Geol. 5, pp. 7-86.

Plant, A.G. 1969: (with J.A.V. Douglas) Amphibole: first occurrence in an enstatite chondrite. Meteoritics 4, pp. 166.

Plant, A.G. and Traill, R.J. (with J.A.V. Douglas and M.R. Dence) 1970: Mineralogy and deformation of Apollo 11 samples. Science, 167, pp. 594-597.

Rimsaite, J. 1969: Evolution of zoned micas and associated silicates in the Oka carbonatite. Cont. Mineral. and Petrol., 23. pp. 340-360.

Rimsaite, J. 1970: Structural formulae of oxidized and hydroxyl-deficient micas, and decomposition of the hydroxyl group. Cont. Mineral. and Petrol., 25, pp. 225-240.

Traill, R.J. 1969: (with P.H. Ribbe, Helen Megaw, W.H. Taylor and R.B. Ferguson.) The albite structures. Acta Cryst., B 25, pp. 1503-1518.

Active Projects

Study of serpentine group minerals.	660041
Geology of the Mid-Atlantic Ridge near 45°N.	660063
Fission Track dating.	690037
Preparation of collections of Canadian rocks and minerals for distribution to the public.	400006
Examination and report on geological specimens received from public.	400007
Systematic Reference Series of the National Mineral Collection and G.S.C. collections of minerals and ore suites.	550101
Studies of new and rare minerals.	610306
Study of non-metallic vein minerals and wall-rock alteration, Cobalt camp.	660040

X-ray diffraction analyses and mineralogical studies.	680023
X-ray Emission Analysis.	600307
Electron Probe Microanalysis.	620308
Study of mica group minerals and associated host rocks.	590309
Study of mineral collecting areas of interest to rock-hounds and tourists.	640048
Reference Collection of Standard X-ray Powder Patterns of Minerals.	690015
Testing field and office collections for radioactive and fluorescent minerals.	660479
Mineralogy Display	670071
Catalogue of Canadian Minerals.	580160

ANALYTICAL CHEMISTRY SECTION

Sydney Abbey

During 1969-70, the Section continued to provide compositional data on geological materials as a contribution to geological studies; to adapt, develop and publish analytical methods; and to provide consultation service on chemical and analytical problems for the benefit of Branch officers, of other government agencies and of other geological groups in Canada and abroad.

Activities

A. General

Available data on international reference samples were subjected to detailed study, both in an effort at assigning values for use as standards and as a measure of the quality of work done in our own laboratories. Studies were also made in the area of analytical costs. Although results are not conclusive, indications are that there is a slight cost advantage in doing our own analytical work, when compared to services available from commercial sources. In terms of quality, our own work appears highly superior. On a cost-benefit basis, there is no doubt that the greatest advantage lies in doing our own analysis. The advantage is even more marked in the case of unusual samples that do not fit into regular categories

Several members of the staff participated in the analysis of three lunar samples from the Apollo XI mission.

In addition to the facilities provided for outside trainees (see below), the Section was consulted on analytical problems by staff of three other federal government agencies, one provincial mines department, six Canadian universities and colleges, two U.S. universities, four private companies and organizations in Ireland, Germany and Australia.

B. Chemical and X-Ray Fluorescence Laboratories.

Production Analysis

The year was marked by a reduction in the number of samples received for analysis but this was offset by an increase in the number of samples containing unusual interferences that required special handling. Matters were further complicated by equipment failures in the x-ray fluorescence methods - involving the x-ray tube, defective crystals, vacuum loss, power cut-offs etc.

Several staff members were trained in the use of newly-developed methods (see below), mainly in the use of the induction furnace and atomic absorption spectroscopy.

Analytical Method Development

The acquisition of an induction furnace led to improved methods for the determination of sulphur and total carbon. In the former case, the procedure using a resistance furnace was modified, and certain distinct advantages were observed with induction heating. With carbon, the modification was extended to the use of a non-aqueous titration, instead of absorption and weighing of the evolved carbon dioxide. This non-aqueous titration was also successfully applied to the determination of carbon dioxide evolved by acid attack. At year end, possible simplification of these methods for routine use were under study, and consideration was being given to applying induction heating in the determination of water.

The lithium fluoborate decomposition scheme was applied to the determination of nine major and minor elements in rocks by atomic absorption spectroscopy, with varying degrees of success. Portions of the same master solution were found to be suitable for colorimetric determination of two additional elements. Work was also begun on a composite scheme for determination of traces of the rarer alkali metals. Instrumental limitations impeded some of the development work.

Most of the new methods described above were applied in the analysis of the lunar samples.

C. Spectrographic Laboratories

General

A detailed review of analytical services provided by the laboratory was made, and estimated costs compared with commercial laboratory services. A significant number of element determinations made in our laboratory are not generally available commercially in equivalent quality, which makes any comparison difficult. However, our cost for analyses is in general quite comparable and often cheaper relative to commercial laboratories, "all things considered".

Revision and improvement of our analytical methods to take advantage of the up-grading of our physical facilities effected during the past year has been continued. Development of new procedures has been somewhat slowed because of the resignation of an assistant spectrographer and the necessity to train a replacement.

Analytical operations

Quantitative determinations increased considerably, and semi-quantitative declined relative to the preceding year, on a larger number of samples submitted. The variety of sample types received continued to be a challenge, demanding increasing element coverage and accuracy over wide ranges in samples much different from the usual silicate rocks.

Four silica "blanks" were analyzed for NASA (U.S.A.), and later were followed by three samples of lunar material gathered on the Apollo XI mission. Analyses were published in the January, 1970, issue of Science.

Methods development

Our air-jet controlled DC arc method for "general analysis" of common rocks has been replaced by the modified and improved version developed last year. New working curves for the determination of some 35 trace elements are now in use.

Similarly, working curves have been established for some 35 elements in iron ores and minerals, by the related new procedure also developed last year. Quantitative determinations of trace elements in iron base samples have not previously been available.

D. Statistics

1. Samples Received and Completed

	Chemical and XRF	Spectrographic
Carried from 1968-69	1,013	361
Received, 1969-70	1,828	2,407
	2,841	2,768
Completed, 1969-70	2,012	1,386
	829	1,382
Withdrawn	0	0
Carried to 1970-71-	829	1,382

The backlog of samples at the end of 1969-70 was distributed as follows:

	Chemical and XRF	Spectrographic
Crustal	664	702
E. G. & G.	159	675
International reference rocks	6	5
	829	1,382

Samples on which work was completed during 1969-70 were distributed as follows:

	Chemical and XRF	Spectrographic
Crustal	544	593
E. G. & G.	1,462	592
All others	6	201
	2,012	1,386

"All others" includes the Quaternary Research and Exploration Geophysics Divisions, the University of Ottawa and international reference samples. The Quaternary Research Division provided more samples than the others combined.

2. Comparison with Preceding Year

	1968-69	1969-70
Samples Received		
Chem. and XRF	2,945	1,828
Spectrographic	1,289	2,407
Samples Completed		
Chem. and XRF	2,763	2,012
Spectrographic	1,171	1,386
Individual spectrographic analyses		
Qualitative	13	17
Semi-quantitative	219	122
Quantitative	1,904	2,575
Backlog at year end		
Chem. and XRF	1,013	829
Spectrographic	361	1,382
Determinations		
Chemical	15,760	12,483
X-ray fluorescence		
Production	16,832	12,080
Controls	4,856	4,272
Rechecks	1,464	1,592
Spectrographic		
Semi-quantitative	3,548	2,279
Quantitative	14,715	18,698
Spectrographic exposures		
Analytical	2,950	2,428
Development	1,422	2,043

Personnel Notes

Professional Staff

F.C. Hill resigned his position in the spectrographic laboratory to accept a position in industry. (The vacancy was subsequently filled at a senior technician level - see below).

Trainees

Dr. K. V. Suryanarayana, a Colombo Plan trainee from India, spent some time studying methods in our spectrographic laboratory.

Calbert Murray, of the Geology Department, Carleton University, worked in our chemical laboratories for some time, in order to become familiar with our methods.

Dr. V.S. Papezik, of the Geology Department, Memorial University of Newfoundland, analysed several of his own samples in our chemical laboratories under the guidance of our staff.

M.A. Qaiser, an International Development trainee from Pakistan, was still working at the year end, learning methods in our spectrographic laboratory.

Miss Aida Espanola, of Brazil, spent several days observing methods in use in our laboratories.

Technical Staff

Paul Arsenault, a casual employee, left at the end of July.

G.P. Bender, previously employed in our chemical laboratories, was transferred from the Inland Waters Branch to fill the vacancy in our spectrographic laboratory.

Mrs. Gisèle Bélanger left on maternity leave at the end of March. She is expected to return within six months.

Gerald Richardson, (Gallaudet College for the Deaf) worked as a summer assistant in the chemical laboratories; Miss Colette Tremblay (Laval University) and John Connolly (Algonquin College) were summer assistants in the spectrographic laboratory.

Richard Charbonneau, of the Mineralogy Section, was temporarily transferred to our spectrographic laboratory.

Attendance at Meetings

Rating Boards and Recruiting Teams

Serge Courville)
Sydney Abbey)

Several times during the year, as requested by the Department and the Public Service Commission.

Annual Conference, Chemical Institute of Canada

(Montreal, May 25 - 28)

Sydney Abbey

Analytical Chemistry Division, Chemical Institute of Canada

(Annual Business Meeting and Executive Meeting, Montreal, May 27.)

Sydney Abbey

Editorial Board, Chemistry in Canada

(Montreal, May 25, 1969; Ottawa, Jan. 12, 1970)

Sydney Abbey

International Conference on Atomic Absorption Spectroscopy

(Sheffield, England, July 14 - 18) and International Symposium on Analytical Chemistry (Birmingham, England, July 21 - 25)

Sydney Abbey

Spectroscopy Symposium of Canada

(Montreal, Oct. 20 - 22)

W.H. Champ
K.A. Church
J.G. Sen Gupta

Planning, Programming and Budgeting Course

(Ottawa, Jan. 26 - 30)

Sydney Abbey

Bureau of Classification and Revision Course

(Ottawa, Feb. 2 - 3)

Sydney Abbey

Special Talks

Sydney Abbey: "Application of Atomic Absorption Spectroscopy in the Analysis of Geological Materials" Spectrex Seminar, Montreal, June 16.

Membership on Committees etc.

Serge Courville: Branch Co-ordinator, Informal French Language Study Groups.

Divisional Safety Officer.

Sydney Abbey: Editorial Board, Chemistry in Canada.

Executive of Analytical Chemistry Division, Chemical Institute of Canada.

Outside Publications

Abbey, S. 1970: U.S. Geological Survey standards - A critical study of published analytical data: Can. Spectroscopy, vol. 15, pp. 10-16.

Maxwell, J.A., Abbey, S., and Champ, W.H. 1970: Chemical composition of lunar material: Science, vol. 167, pp. 530 - 531.

Sen Gupta, J.G. 1968: Abundances of the six platinum metals in some iron and stony meteorites: Relationships to the theories of evolution of parent bodies of meteorites and the origin of these elements: Chem. Geol. vol. 3, pp. 292-305

1970: Rapid combustion methods for determining sulphur in rocks, ores and stony meteorites: A comparative study of the usefulness of resistance type and induction furnaces: Anal. Chim. Acta. vol. 49, pp. 519 - 525.

Active Projects

Analysis of Rocks and Minerals 380077

GEOMATHEMATICS AND DATA PROCESSING SECTION

K.R. Dawson

The functions of the Section in 1969-70 were modified as follows:

1. to develop and apply electronic data processing techniques to the handling of geological data.

2. to provide consultation and advice to Survey Officers and others on the applications of EDP to their problems, including the production of computer-based publications.

3, to carry out mathematical research on the quantitative definition and interpretation of geologic problems.

Activities

The Branch file of source and object computer decks continued to be held in open file as a service to users. A few new programs were added, and copies of existing source decks were supplied in response to requests. The catalogue of the source programs was updated and the documentation files were added to provide support for more programs.

The Section served as the Branch delivery point for computer and unit record work going between the Branch and the Computer Science Division at 588 Booth Street. The frequency of service was increased to 6 deliveries per day making a marked improvement in the turnaround time on computer jobs being run on the Departmental CDC 3100 and the Computel Terminal.

The Photograph Negative Catalogue (PIN) was updated twice during the period and the input cards were stored in the Section. The number of these cards (+100,000) and the number of misspelled concepts indicate the need to develop a further computer program to make deletions and corrections more practical.

Cards Punched (x1000)

Division	A	M	J	J	A	S	O	N	D	J	F	M
Admin.	.05	.12		.01		2.00		4.04		15.00		
CG	.20	.33	.13	.20	.67	.27	.13	.73	.42	1.15	1.91	1.30
EG	.12	.13	.48	.54.	.49		.04			.23	.62	
GMEG-EGG	15.25	17.80	13.38	22.16	20.83	16.65	22.50	7.86	16.84	8.07	9.60	20.60
QRG	1.66	3.08	.90	.68	.14	.64		.21	.10	.54	.97	.70
Totals	17.28	21.55	14.89	23.59	21.64	17.56	23.30	12.84	17.36	24.99	12.55	22.60
										Year		464.06

Personnel Notes

Dr. F.P. Agterberg went on leave of absence in August, 1969 (to May, 1970, inclusive), first as a consultant to the British Columbia Research Council (August) and subsequently as a Visiting Research Scientist with the Geological Survey of Kansas, at the University of Kansas.

P. Cabilio, a winter seasonal assistant to Dr. Agterberg, left the Survey in June, 1969

A.G. Fabbri began work as a seasonal assistant to Dr. Agterberg in May, 1969. During Dr. Agterberg's absence he continued with the work of Project 690038 (Probability models for estimating mineral potential). He also collaborated with Dr. Jan Kutina in the preparation of joint papers relating to the above project, and to Project 690093 which involves the prediction of favourable environments for mineral deposit occurrence in the Timmins-Noranda area.

C. Dawes, student assistant, was employed for the summer doing quality control work on the master file of Geodat.

Attendance at Meetings

F.P. Agterberg: Computer Applications in Earth Sciences, Lawrence, Kansas, June, 1969.

Symposium on Operations Research and Computer Applications in Mining Industry, Salt Lake City, Utah, September, 1969.

K.R. Dawson: SAFFRASS (Self Adapting Free Format Retrieval and Storage System) study seminar at University of Western Ontario, October 5 - 8, 1969.

Federal Institute of Management Data Processing Institute Conference, Ottawa, February, 1970.

Papers, Lectures and Talks Given

F.P. Agterberg: "Statistics in Geology", Part-time lecturer, Univ. of Ottawa, Jan. - May, 1969.

"Ore Estimation Course", Continued Education Program, Queen's University, May, 1969.

Membership on Committees

F.P. Agterberg: Council, Int. Association for Mathematical Geology

K.R. Dawson: Departmental Electronic Data Processing Committee (membership terminated July 1969)

Outside Publications

Agterberg, F.P., and Cabilio, P.
1969: Two-stage least squares model for the relationship between mappable geological variables; Jour. Int. Assoc. Math. Geol. vol. 1, No. 2, pp. 137 - 153

Active Projects

Computer-oriented research on mineral deposits.	640417
Statistical models for geologic processes.	670555
Preparation of book "Introduction to Mathematical Geology"	680147
Probability models for estimating regional mineral potential.	690038
Development and supervision of geochemical data bank (geodat)	640426

NATIONAL INDEX TO GEOLOGICAL DATA

B.A. McGee

Activities

This project, "To develop and coordinate the preparation of an index to geological data as a pilot study for a National Index" (660505) was terminated at the end of the fiscal year and the staff became part of the Canadian Centre for Geoscience Data (Dr. C.F. Burk, Jr., National Coordinator). Dissemination procedures for the products of the Canadian Index to Geoscience Data (15 books of indexes) have been finalized.

Dr. Burk successfully recruited six agencies who are interested in participating in the Canadian Index to Geoscience Data, and meetings were held in June and November, 1969, and in March, 1970. As a result of these meetings, agency representatives were trained in the indexing of documents. The agencies are as follows:

British Newfoundland Exploration Limited

Ontario Department of Mines

Saskatchewan Department of Mineral Resources

Northern Economic Development Branch, Department of Indian Affairs and Northern Development

Newfoundland, Department of Mines, Agriculture and Resources

Mineral Resources Branch, Energy, Mines & Resources

Attendance at Meetings

B.A. McGee: Annual Meeting, Canadian Institute of Mining and Metallurgy, Montreal, April, 1969.

Federal Institute of Management Data Processing Institute Conference, Ottawa, February, 1970.

Papers, Lectures and Talks Given

B.A. McGee: "The Canadian Index to Geoscience Data", Federal Institute of Management Data Processing Institute Conference, Ottawa, February, 1970.

EXPLORATION GEOPHYSICS DIVISION

G. D. Hobson, A/Chief

INTRODUCTION

The main functions of this division are to conduct systematic geophysical surveys in Canada and over the adjacent continental shelves as an aid in mapping the geology; to devise, develop and test instruments for geophysical mapping, prospecting and other geophysical investigations; to assess existing geophysical systems for their usefulness as an aid to geological mapping; and to devise new methods of interpretation of geophysical data in terms of geological parameters, with particular emphasis on quantitative methods.

The report year has seen a continuation of the programs initiated two years ago. At that time, the division embarked on extensive new programs in aerogeophysics - high-resolution magnetometer development, gamma-ray spectrometry and airborne EM. During 1969-70, progress has been made on all these aerogeophysical endeavours.

The SKYVAN project is well launched but not without its frustrations in entering a new technological phase. A precise navigational system has yet to be perfected for accurate and automatic flight path recovery. Airborne geochemical maps (U, K and Th) covering 400 square miles of the Bancroft area, Ontario, were produced during the year. A cross country profile from Ottawa to Yellowknife identified all known uraniferous localities en route and indicated the presence of several other localities of probably comparable importance. The results were placed on open file in March. The project has demonstrated the effectiveness of U/Th and U/K ratios for identifying significant uranium occurrences from the air that will greatly narrow down the areas of search. This program has generated a great deal of interest in the industrial community.

The high-resolution Queen Air magnetometer project has completed the development phase. Testing of all systems will commence next summer. Some test surveys are planned. This installation is the most advanced system of its kind in the world today, and is therefore a significant contribution towards maintaining Canada's leadership in airborne geophysical surveying techniques.

Development of soft-ware analysis of contract high-resolution magnetic data near Timmins, Ontario, and Tathlina Lake, N.W.T. has overcome tremendous complexities in automatic data reduction. This type of work has never before been attempted. One conclusion would appear that the calculated gradient is more accurate than the measured gradient at the present stage of instrumentation. Another important contribution to data handling was the development of a computer program to automatically contour irregularly-distributed data.

A paper showing the remarkable correlation between airborne EM (AFMAG) data and geology in northern Manitoba was an important contribution to the use of reconnaissance EM surveys for detailing geological structure. The method is most applicable to areas where outcrops are scarce.

The hammer seismic production has been kept up to the usual high standard. The work on-shore in Ontario and marine seismic surveys in Lakes Ontario, Erie and Huron are contributing significantly to the Quaternary history of the Great Lakes Basin. There has been much interest associated with the marine seismic surveys in the Gulf of St. Lawrence and the Strait of Belle Isle, especially by oil companies interested in leasing off-shore claims.

In the field of rock magnetism, progress continued with technological and instrumentation developments. Several specific studies yielded high precision points on the polar wander curve. Encouraging results were made toward the future use of rock magnetism as a reliable tool of earth sciences.

The Federal-Provincial aeromagnetic survey program has experienced some set-backs on completion of the 3-year contracts in the north due to weather. Hopefully these will be completed next year. Two 6-year contracts were finalized by Treasury Board and contracts were let to two consortia for Keewatin, southern Baffin Island and all of Labrador. During the year officials of the Division acted as technical advisers to the Quebec Department of Natural Resources regarding a 3-year aeromagnetic contract in Quebec. A 3-year program was contracted out for an area in southern British Columbia.

Progress continued during the year on the 1:5,000,000 magnetic anomaly map of Canada. This is the first such map of its kind in the world and shows remarkable correlation with the known geology. However, it is in those areas where there is not much correlation that there will be the greatest interest.

The Canadian International Development Agency approached the Geological Survey of Canada to act as technical advisers on airborne geophysical surveys in Niger and Cameroun. Several members of the Division were involved in fulfilling this request. Dr. A. Larochelle was appointed manager to supervise these contracts with Mr. E. E. Ready assisting in checking the compilation of the data.

The publication of the Proceedings of the Canadian Centennial Conference on Mining and Groundwater Geophysics held in Niagara Falls, October 1967, was a highlight of the year. This volume was edited by Dr. L. W. Morley and published by the Geological Survey of Canada as Economic Geology Report No. 26.

A highlight of the year was the arrival of lunar samples to the Division from Apollo 11 and 12 flights to the moon. Magnetic properties were investigated by Dr. A. Larochelle, Principal Investigator, and Dr. E. J. Schwarz, Co-investigator. Electrical conductivity was studied by Mr. L. S. Collett, Principal Investigator, and Dr. A. Becker, Co-investigator with assistance from Mr. R. H. Ahrens.

Personnel Notes

L. W. Morley - effective April 1, 1970, Director, Program Planning Office, Resource Satellites and Remote Airborne Sensing, Department of Energy, Mines and Resources, No. 8 Bldg., Ottawa 4, Ontario.

G. D. Hobson - Acting Division Chief, 1969-70.

REPORTS OF SECTIONS

SPECIAL PROJECTS

A. S. MacLaren

Magnetic Anomaly Map of Canada

E. Haley with the assistance of D. Johnston, continued to prepare additions to the 1:5,000,000 magnetic anomaly map of Canada. Areas completed are the Maritimes and Scotian Shelf, Harricanaw River area in Quebec and the rest of northern Ontario. Negotiations have been under way with Gulf Oil to purchase some data over the western provinces.

Canadian International Development Agency

C.I.D.A. approached the Geological Survey to act as technical consultants on aeromagnetic surveys in Niger and Cameroun. A. S. MacLaren and E. E. Ready spent 2 and 3 months respectively working with C.I.D.A. representatives on technical aspects of contracts. Mr. Ready visited both Niger and Cameroun with Dr. Larochelle to inspect the contractor's work and methods.

Federal-Provincial Aeromagnetic Surveys

With the assistance of E. E. Ready, E. J. Derouin, Miss M. B. Chretien, D. Reveler and E. L. Haley, map sheets were inspected and published as follows:

a) At scale of 1:63,360

Newfoundland	53
Quebec	150
Ontario	60
British Columbia	38
Northwest Territories	70
Total	371

b) At scale of 1:253,440

Quebec	23
Ontario	16
British Columbia	7
Northwest Territories	30
Yukon	8
Total	84

This section acted as technical advisers in geophysics in co-operation with others to the Quebec Department of Natural Resources regarding a three-year aeromagnetic contract in Quebec.

A great deal of time was spent on the two 6-year aeromagnetic contracts let to two consortia and finalized by Treasury Board on July 15th.

Inspection trips were made to field operations in Newfoundland, the Northwest Territories and Saskatchewan by E. J. Derouin and to Quebec by E. E. Ready. Numerous trips were made to Aero Photo's compilation office in Quebec City, Photographic Surveys in Montreal and Lockwood Survey Corporation in Toronto by E. E. Ready, E. J. Derouin, Miss M. B. Chretien, D. Reveler and E. Haley. Mr. Derouin and Mr. Haley spent one week in Bethlehem, Pennsylvania retrieving data from the Bethlehem Steel Corporation for an aeromagnetic drafting contract.

Attendance at Meetings

A. S. MacLaren
- Interdepartmental Meeting on Remote Sensing, June 1969
- AGARD-NATO Lecture series 34 on Application Technology Satellites, Ottawa, November, 1969.
- Annual meeting - GSA, Atlantic City - November 1969 followed by visit to USGS remote sensing and airborne geophysics interpretation units, Washington, D. C.

Special Talks

A. S. MacLaren - gave a talk to graduate students from Toronto University, Queens and Western Universities and Toronto mining people on the 1:5,000,000 magnetic anomaly map of Canada in January, 1970.

Active Projects

680073	Magnetic anomaly map of Canada
690066	Fed./Prov. - British Columbia
690067	Fed./Prov. - Yukon, N. W. T.
690068	Fed./Prov. - Keewatin & Mackenzie, N.W.T.
690069	Fed./Prov. - Saskatchewan
690070	Fed./Prov. - Central Baffin Island
690071	Fed./Prov. - Northern Baffin Island
690072	Fed./Prov. - Labrador & South Baffin Island
690073	Fed./Prov. - Quebec
700020	Fed./Prov. - Newfoundland
700021	Fed./Prov. - Quebec (completed)
700022	Fed./Prov. - Mattagami, Quebec (completed)
700023	Fed./Prov. - Central British Columbia
700024	Fed./Prov. - Ontario (completed)

ELECTRICAL METHODS SECTION

L. S. Collett

This section conducts research in electromagnetic, resistivity, telluric and magnetotelluric methods to test their usefulness as aids to geological mapping of surficial and bedrock formations, faults and shear zones. Emphasis is directed toward assessing airborne electromagnetic systems for reconnaissance surveying by developing new survey techniques and efficient handling of large amounts of data. Theoretical interpretation of electromagnetic data and scale modelling are part of the functions of the section. A laboratory is equipped for the measurement of electrical properties of rock samples in the electric and magnetic fields. The section cooperates with the provinces, universities and industry in aiding and stimulating geophysical activity in electrical methods.

Activities and Research Highlights

L. S. Collett: The evaluation of various airborne EM systems continued during the year with the co-operation of Dr. A. Becker and Mr. A. V. Dyck. INPUT surveys were flown in 1968-69 as follows: Ottawa area (500 line miles); Project Pioneer, Manitoba (620 line miles); Winkler, Manitoba (300 line miles); south east of Drumheller, Alberta (1760 line miles) in cooperation with Alberta Research Council. The greater part of the year was spent in digitizing the data from analogue data recorded by a 14-channel FM tape recorder. The data has been compiled in digital form on 9-track computer compatible 1/2" magnetic tape with calibration and drift corrections added. Plots to a scale of 1:50,000 show ten traces of transient data, one of primary field, one of altimeter and one of the average transient field amplitude. Representative decay curve transients are also plotted for each profile. This phase of the work is now completed. The Project Pioneer data was digitized but not plotted because the conductors over the Precambrian were discrete and not continuous as in the other regions cited.

For the AFMAG data in the Upper Nelson River area, Manitoba, and Uranium City area, Saskatchewan, a new technique in compiling the data was developed during the year. The analogue profiles were digitized and some mathematical treatment applied to the data by computer. The filtered profiles were plotted out to coincide with the flight path recover on a scale of 1:50,000. AFMAG is proving to be a useful aid to geological interpretation especially where outcrops are sparse for detecting faults, geosynclines and ultramafic dykes. During August 1969, an AFMAG survey was flown (2000 line miles) over the St. Mary's River area, Nova Scotia. The area is completely covered with overburden. The north and south boundaries of the Horton Group were outlined and some fault structures within the 'graben' were indicated by the method.

He supervised Mr. W. J. Scott, Ph.D. student, McGill University who designed prototype ground AC resistivity equipment to operate from .01-100 Hz. Tests were conducted over approximately 10 sulphide bodies and an aquifer. The purpose of the research was to establish whether induced polarization phenomena produced a phase shift between the transmitter current into the ground and the potential across the receiving electrodes. None was observed over the areas tested. The results are being written up in Scott's Ph.D. dissertation in 1970.

Progress has been made on instrumentation for measuring the electrical properties of rocks and soil samples over the frequency range from DC to 10 MHz. A highlight of the year is the arrival of 3 Apollo 11 lunar samples and 3 from Apollo 12. Mr. R. H. Ahrens has been developing apparatus for measuring the conductivity of lunar samples in a coil (non-contact techniques). Dr. T. J. Katsube (Post Doctorate Fellow) has instrumented the laboratory to measure the conductivity, dielectric constant and power loss factor (complex dielectric constant) of rock samples.

These studies are fundamental to the understanding of the mechanism of electrical current conduction in rocks. Also with the assistance of Dr. A. Becker, he has developed the Q-meter method of measuring the electrical conductivity of Apollo 11 and 12 lunar samples.

Mr. Collett assisted Canadian International Development Agency (CIDA) in technical matters pertaining to the airborne geophysical contracts with Cameroun and Niger.

A. Becker: With the assistance of W. F. King, a student from McGill University, he has been assessing the capabilities and limitations of the VLF (very low frequency) in the 15-20 KHz frequency range as a means of delineating faults and shear zones. The ground tests have shown that the Gloucester Fault near Leitrim, Ontario, can be outlined and a feature parallel to the fault on the NE flank has also been detected.

A laboratory scale model to simulate the airborne INPUT electromagnetic system was designed and constructed with the assistance of Mr. Claude Gauvreau. This scale model system will also be used in the development of the airborne resistivity electromagnetic system (ARES). This model and theoretical studies will be the basis for laying down the specifications for developing the hardware for the variable frequency ARES (Project No. 680089).

He continued to supervise Mr. J. A. Slankis, a McGill Ph.D. student, on the use of the 8 Hz telluric and magnetotelluric method for detecting sulphide conductors, faults and shear zones. Mr. Slankis' investigations will be the subject of his Ph.D. dissertation at McGill University.

He assisted the Quebec Department of Natural Resources in conducting INPUT, VLF and Radioactivity surveys in the area north of Noranda, Quebec. Two reports were written to accompany the maps published of these surveys by the Quebec Government.

He also assisted Canadian International Development Agency (CIDA) on the technical aspects of the airborne geophysical surveys presently being conducted in selected areas in the African countries of Niger and Cameroun.

In October, 1969, he was given leave of absence by the GSC to teach exploration geophysics at the Department of Engineering Geology, Ecole Polytechnique, Montreal.

A. V. Dyck: Under the supervision of Dr. A. Becker, he has been working on the theoretical problem of the transient electromagnetic induction for a thin, horizontal sheet of a vertical magnetic dipole.

Mr. Dyck has also been assisting and checking the INPUT digitizing and compilation of data for the Ottawa, Winkler, Manitoba and Calgary area, Alberta. He will continue to work on this data in preparation for publication next year.

Personnel Notes

Dr. A. Becker - granted leave of absence on October 1, 1969, to teach exploration geophysics, Department of Geological Engineering, Ecole Polytechnique, Montreal.

Dr. T. J. Katsube Post Doctorate Fellow: extension for a second year has been granted to March 1971. He is working with Mr. Collett on the electrical properties of rocks.

Attendance at Meetings

L. S. Collett
- Manned Spacecraft Centre, Houston, Texas, Lunar Sample Principal Investigators Meeting, April 28-May 1, 1969.
- Society of Exploration Geophysicists Annual Meeting, Calgary, Alberta, Sept. 14-18, 1969; Chairman, special session on "Non-seismic Exploration Methods in Sedimentary Areas".
- 7th Canadian Hydrology Symposium, Victoria, B.C.; presented paper "Remote Sensing Geophysical Applications to Hydrology".
- Planning, Programming and Budgeting Systems, Ottawa, Jan. 26-30, 1970.
- Classification Rating Meeting, Feb. 2-3, 1970.

Dr. A. Becker
- Society of Exploration Geophysicists Annual Meeting, Calgary, Alberta, Sept. 14-18, 1969; co-authored paper "8 Hz Telluric and Magneto-telluric Prospecting" with J. A. Slankis and W. M. Telford.

A. V. Dyck
- Society of Exploration Geophysicists Annual Meeting, Calgary, Alberta, Sept. 14-18, 1969.

Special Talks and Projects

L. S. Collett
- Gave 12 hours of lectures on Electrical Methods, Geology 67.484, Carleton University, Feb. 17 - March 12, 1970.
- Reviewed 20 papers for Proceedings of Canadian Centennial Conference on Mining and Groundwater Geophysics, Niagara Falls, Ont. 1967: published in Geol. Surv. Can. Econ. Geol. Report No. 26, 1970.
- Critically reviewed two manuscripts for Canadian Journal of Earth Sciences, one for Inland Waters Branch and one for Geochimica et Cosmochimica Acta.

- Logan Club, Feb. 4, 1970; presented talk on "Electrical Conductivity of Lunar Samples"
- Addressed Joint Seminar, McGill and Ecole Polytechnique, Feb. 12, 1970 on results of lunar sample investigations by the GSC.
- TV interview on "The Scene" by CJOH, Nov. 2, 1969 on lunar samples.
- organized a one-day meeting at the GSC for 9 members of the Japanese Mission of Mining Geophysicists, Nov. 6, 1969.

Membership on Committees

L. S. Collett

- Member, Technician Appraisal Committee, GSC
- Member, Associate Committee on Geodesy and Geophysics (ACGG),NRC.
- Chairman, Subcommittee on Exploration Geophysics, ACGG, NRC.
- Member of two committees of Society of Exploration Geophysicists, Tulsa, Okla:
  1) Mining Committee
  2) Committee for Cooperation with Government Agencies.

Outside Papers

Becker, A., and McNeill, J. D.:
Radiophase survey Rouyn-Noranda, Quebec, explanatory notes: Published by Dept. of Natural Resources, 17 pp., 1969.

Becker, A., and Lazenby, P.:
Explanatory notes INPUT Mark V survey, Rouyn-Noranda, Quebec, November 1968 - June 1969; Published by Dept. of Natural Resources, 13 pp., 1969.

Becker, A.:
Simulation of time-domain, airborne, electromagnetic system response; Geophysics, v. 34, no. 5, pp. 739-752, October 1969.

Collett, L. S.:
Remote sensing geophysical applications to hydrology; Proc. of Hydrology Symposium No. 7, NRC, pp. 237-260, 14 and 15 May, 1969.

Collett, L. S.:
Exploration Geophysics: Can. Geophy. Bull., v. 22, Dec. 1969.

Slankis, J. A., and Becker, A.:
Telluric and magneto-telluric measurement at 8 Hz; AIME Trans., Soc. of Mining Engineers, v. 244, pp. 237-244, June 1969.

Active Projects

620056	Audio frequency studies
670041	VLF mapping
670564	Time domain EM theory
680089	ARES (Airborne electromagnetic resistivity system)
630049	Electrical rock properties
660043	Airborne INPUT surveys
680005	Electrical conductivity lunar samples
680123	AFMAG/VLF surveys
670062	DC resistivity - Ontario
670040	Geophysical investigations
660494	Magnetotelluric investigations

MAGNETIC METHODS SECTION

P. J. Hood

This section is responsible for developing new magnetic instrumentation and survey techniques, conducting and interpreting special aeromagnetic surveys over land and sea; and demonstrating the usefulness of magnetic survey data in geological mapping.

Activities

P. J. Hood with M. E. Bower and P. Sawatzky continued the cooperative ocean aeromagnetic project with the National Aeronautical Establishment. Approximately 11,000 line miles of high-resolution aeromagnetic survey data was obtained in carrying out low-level traverses across the Labrador Sea between Newfoundland and the southern tip of Greenland. The aeromag-

netic data shows that the magnetic stripes in the North Atlantic Ocean, which are indicative of sea-floor spreading having occurred in the past, bend around the southern tip of Greenland. It, therefore, follows that the Labrador Sea and Baffin Bay widened at the same time that the North Atlantic Ocean itself was being formed by the separation of Europe and North America. This movement probably started about 160 million years ago.

The 386-page proceedings of the Earth Science Symposium on Hudson Bay, edited by P. J. Hood, was issued as GSC Paper 68-53 in May 1969. The Symposium, which was sponsored by the National Advisory Committee on Research in the Geological Sciences and the NRC Associate Committee on Geodesy and Geophysics, was held in Ottawa during February 1968. The topics covered included both surficial and bedrock geology, and the various shipborne and airborne geophysical methods used in the exploration of the sedimentary basin which underlies Hudson Bay. Papers were presented by the oil companies, university groups and government agencies, and the results were sufficiently encouraging that a consortium of oil companies spudded the first offshore well in Hudson Bay on August 7, 1969. The proceedings received good reviews in a number of journals, see for instance page 797 of the October 1969 issue of the journal Geophysics.

In view of the success of the first symposium, P. J. Hood is organizing an Earth Science Symposium on Offshore Eastern Canada to be held in Camsell Hall, 588 Booth Street, Department of Energy, Mines and Resources, Ottawa from February 22-24th, 1971. The main objective of the Symposium will be to summarize the present knowledge of the continental shelves and slopes of eastern Canada so that emphasis will be on results rather than techniques, although descriptions of new techniques will be encouraged. Areas to be discussed are the Bay of Fundy, Scotian Shelf, Gulf of St. Lawrence, Grand Banks, Flemish Cap, Labrador Sea, Ungava Bay, Baffin Bay and Greenland Shelf. The topics will include Surficial Geology, Geochemistry, Repetitive-Source Seismic, Bedrock Geology and Tectonics, Seismic Reflection and Refraction, Gravity, Magnetics, Magnetotellurics, Crustal Seismic, Heat Flow, Continental Drift and Offshore Drilling.

During the year, P. J. Hood also completed a review of the geophysical applications of high resolution magnetometers for the Encyclopedia of Physics which is being published by Springer-Verlag of Heidelberg. For the sixth year he reviewed the various trends and developments in mineral exploration which is published in the annual review (February) issue of the Canadian Mining Journal. Reprints of this article are distributed to the various Geological Surveys or their equivalent organizations throughout the world and the article therefore helps to sell Canadian geophysical instrumentation abroad. Other reviews published during the year by P. J. Hood were a review in conjunction with Professor Stanley Ward of the University of California at Berkeley of all the airborne geophysical methods, and a review of recent advances in magnetic surveying instrumentation published in the proceedings of the Canadian Centennial Conference on

Mining and Groundwater Geophysics held at Niagara Falls in October 1967. Mining geophysical statistics for the world during 1968 were also compiled by P. J. Hood and presented at the September 1969 meeting of the Society of Exploration Geophysicists in Calgary. The statistics were subsequently published in the November 1969 issue of the Canadian Mining Journal, the December 1969 issue of Geophysics, and the March 1970 issue of Mining Engineering.

Margaret Bower was the co-author of two papers published in 1969 which concerned high resolution aeromagnetic surveys over continental shelf areas. She is also a co-author of one paper in press and has almost completed an article describing the use of digital filters which she has designed and used to enhance the lower-amplitude higher-frequency components of aeromagnetic profile. Her main work, therefore, continues to be the computer treatment of aeromagnetic data. She is presently perfecting a computer program so that latitudes and longitudes can be calculated in real-time from Omega navigation fixes during offshore survey flights using an inboard computer. Navigation remains the biggest problem in offshore airborne surveys, and the system being designed should permit adjustments of the aircraft track during survey flights of the NAE North Star aircraft.

L. J. Kornik continued his compilation and interpretation of aeromagnetic data of northern Manitoba and Saskatchewan and he has completed a quantitative magnetic study of the Athabasca Formation. An isopach map of the Athabasca Formation was constructed using depth determinations obtained from a computer analysis of magnetic data. The thickness of the Athabasca Formation as indicated from magnetic depth determinations is in general agreement with the thickness as determined from seismic data. A maximum of approximately 5500 feet of non-magnetic sedimentary material was indicated from the magnetic depth determinations.

P. H. McGrath continued his compilation and interpretation of magnetic data of the Canadian Appalachian region. During 1969 in situ susceptibility measurements were made at 307 sites in New Brunswick and Nova Scotia, and 72 oriented rock cores were collected for further laboratory analysis. A computer technique for the investigation of dyke anomalies was submitted for publication in the journal Geophysics. Also other non-linear least squares techniques, i.e. the Marquardt and Powell algorithms, are being tested as tools for the interpretation of magnetic data. A study of the magnetic properties of rocks in southern New Brunswick was published in the GAC Proceedings, P. H. McGrath.

During the past year Peter Sawatzky has completed the development of a light-weight high-resolution digital-recording aeromagnetic survey system which has been installed in a Beechcraft B80 aircraft. The factors involved in the choice of this particular aircraft are discussed in GSC Topical Report 136 published by P. Sawatzky during the year. He has also completed the first draft of a GSC Paper describing the design and fabrication of the complete survey system, which is probably the most advanced

system of its kind in the world today, and is therefore a contribution towards maintaining Canada's leadership in airborne geophysical surveying techniques.

S. Washkurak continued development of the Overhauser magnetometer. A low magnetic field dynamic nuclear polarization spectrometer was assembled to evaluate various stable free radicals and solvents for the high sensitivity Overhauser magnetometer. In liquid solutions the Overhauser effect can be used to produce a continuous proton signal by saturating the electron resonance of a dissolved stable free radical and observing the nuclear magnetic resonance. The magnitude of the proton signal whose Larmor frequency gives the value of magnetic intensity depends on the solvent, free radical, concentration of solution, radio frequency power required to saturate the electron resonance line, amount of dissolved oxygen in solution and temperature. With the organic free radical Tetra Methyl Piperidine Oxyle (TEMPO), a magnetometer sensitivity of 0.03 gammas has been achieved. Scintrex Ltd. has been licensed by Canadian Patents and Development Ltd. to manufacture the magnetometer.

P. J. Hood participated in the Workshop on Offshore Surveys which was convened by DEMR to study the technical and legal aspects of surveying for mineral resource development on offshore Canada lands. He wrote Appendix C, Magnetic Detection of Abandoned Wells, of the final report entitled "Surveying offshore Canada Lands for mineral resource development" which was published by DEMR in February 1970.

Attendance at Meetings

P. J. Hood	- Society of Exploration Geophysicists, Calgary, Alberta, September, 1969: presented paper "Mining geophysical activity in 1968" with W. C. Kellogg as co-author.
	- Second National Oceanographic Symposium, Victoria, B.C., November 1969; presented paper "Aeromagnetic reconnaissance of Baffin Bay, the Labrador Sea and the North Atlantic Ocean" with M. E. Bower and E. A. Godby as co-authors.
	- Planning, Programming and Budgeting Systems, Ottawa, January 19-23, 1970.
	- Prospectors and Developers Convention, Toronto, Ontario, March 1970.
M. E. Bower	- Society of Exploration Geophysicists, Calgary, Alberta, September, 1969.
L. J. Kornik	- Prospectors and Developers Convention, Toronto, March, 1970.
P. H. McGrath	- Geological Association of Canada, Montreal, June 1969; presented paper entitled "Interpretation of selected aeromagnetic anomalies in southern New Brunswick".

Special Talks and Projects

P. J. Hood

- Gave his regular series of lectures on Gravity and Magnetic Methods for the Exploration Geophysics course at Carleton University.
- Aeromagnetic reconnaissance of the Labrador Sea and its bearing on continental drift; presented to the Departments of Physics and Geology, Memorial University, Newfoundland, May 6, 1969 (with E. A. Godby).
- Canadian National Report on Solid Earth Geophysics in Canada during the period 1965-1969, presented in the writer's absence by M. J. S. Innes to the Pan American Institute of Geography and History, June 3, 1969.
- Aeromagnetic reconnaissance of Baffin Bay, Labrador Sea and the North Atlantic Ocean; presented at the GAC-MAC annual meeting, Montreal, June 6, 1969 (with M. E. Bower and E. A. Godby).
- Sea-floor spreading and continental drift, presented to the Geology Department, Ottawa University, February 4, 1970.
- Sea-floor spreading in the North Atlantic Ocean, Labrador Sea and Baffin Bay, presented to the McConnell Club and to Institute of Sedimentary and Petroleum Geology, Calgary on March 12, 1970.
- critically reviewed the following manuscripts for publication:

    1. Seismic studies in the region adjacent to the Grand Banks by J. A. Watson and G. L. Johnson, Canadian Journal of Earth Sciences.
    2. Geophysical investigations in the Ungava Bay - Hudson Strait region by A. C. Grant and K. S. Manchester, Canadian Journal of Earth Sciences.
    3. Magnetic signatures of rock formations in the British Solomon Islands by H. A. Winkler, Geophysics.
    4. Solid-Earth Sciences Study, Science Secretariat. Special Papers on:

        a) Atlantic Continental Margin

        b) Exploration Geophysics

        c) Geomagnetism

        d) Gravity

e) Magnetotellurics

b) Marine Geophysics

- acted as External Examiner for the awarding of the M.Sc. degree to C. R. Somayajulu, Department of Physics, Memorial University, Newfoundland.

Membership on Committees

P. J. Hood

- Chairman, Logan Club, 1969-70
- Program Chairman, Earth Science Symposium on Offshore Eastern Canada (to be held in Ottawa in February 1971)
- Member, Subcommittee on Geomagnetism, NRC Associate Committee on Geodesy and Geophysics.
- Liaison Officer, NRC Industrial Research Assistance (to June 1969)
- Corresponding Member, Geophysical Committee, Pan American Institute of Geography and History (Committee disbanded June 1969)
- Member, Geophysical Activity Committee, Society of Exploration Geophysicists, Tulsa, Oklahoma (resigned November 1969).
- Member, GSC Committee, United Appeal Campaign (Fall 1969)

Outside Publications

Gross, H.: Total magnetic susceptibility meter for field use, Canada Patent 830,076, issued December 16, 1969.

Hood, Peter: Mining geophysical activity in Canada and the Western World in 1968: Canadian Mining Journal, Vol. 90, no. 11, pp. 53-58, 1969.

Hood, Peter & W. C. Kellogg: Mining geophysical activity in 1968: Geophysics, Vol. 34, No. 6, pp. 848-858, 1969.

Hood, Peter: Sea-floor spreading and continental drift: Canadian Geographical Journal, Vol. 80, no. 1, pp. 32-36, 1970.

Hood, Peter: Mineral exploration: trends and developments in 1969. Canadian Mining Journal, vol. 91, no. 2, pp. 185-209, 1970.

Hood, Peter: Geophysical activity surges in the western world: Mining Engineering, Vol. 22, no. 3, pp. 63-64, 1970.

Hood, Peter: Magnetic surveying instrumentation; a review of recent advances; Proceedings of the Canadian Centennial Conference on Mining and Groundwater Geophysics, Niagara Falls, October 22-27, 1967. Mining and Groundwater Geophysics 1967, Editor, L. W. Morley, Economic Geology Series No. 26, GSC pp. 3-31, 1970.

Hood, Peter and S. H. Ward: Airborne Geophysical Methods: Advances in Geophysics, Academic Press, New York, Vol. 13, pp. 1-112, 1969.

Kornik, Leslie J.: An aeromagnetic study of the Moak Lake - Setting Lake structure in northern Manitoba: Canadian Journal of Earth Sciences, Vol. 6, no. 3, pp. 373-381, 1969.

McGrath, P. H. and D. H. Hall: Crustal structure in northwestern Ontario: regional magnetic anomalies: Canadian Journal of Earth Sciences, Vol. 6, no. 1, pp. 101-107, 1969.

McGrath, P. H.: Magnetic investigations of the Charlotte and Pokiok intrusions, southern New Brunswick: Geological Association of Canada Proceedings, Vol. 21, pp. 25-32, 1970.

Active Projects

590258	Sea magnetometer survey compilation
630028	Nakina geologic-magnetic study
630404	Magnetic gradient techniques
650007	Ocean aeromagnetics
660042	Regional aeromagnetic-geologic correlation
660046	Portable susceptibility meter
680081	Queen Air high resolution aeromagnetics
680082	Annual review - exploration techniques
680120	Aeromagnetic interpretation - central B.C.
680121	Aeromagnetic interpretation - Appalachia
690035	Overhauser magnetometer development
690041	Earth Science Symposium on Offshore Eastern Canada.

REMOTE SENSING METHODS

A. G. Darnley

This section is responsible for the development and assessment of techniques for the remote measurement and delineation of rock and mineral properties and structure from airborne data, to facilitate the compilation of geological maps. These aims require the verification of remotely sensed properties by complementary ground and laboratory investigations. A number of techniques employed for airborne remote sensing are also relevant to bore-hole remote sensing, and the data recording and processing problems contain many similarities. However, bore-hole studies present a completely different set of management and planning problems and for this reason have not been initiated in the present manpower situation.

Activities & Research Highlights

Remote sensing embraces a very wide range of scientific, technological and operational activities. These include: computer programming for automatic profile and map plotting, data recording systems, design of equipment for operation in an aircraft, aircraft Doppler navigation and radar altimeter systems, operation of an experimental aircraft from unprepared airstrips, field ground surveys with experimental equipment, calibration of various types of measuring devices and operation of complementary laboratory analytical systems. None of the equipment being used was in existence in its present form 10 years ago and much of it has been developed in the last five years. Consequently, adapting and combining this complex technology to serve the somewhat longer established science of geology presents many problems.

The main highlights of the year have been:

1) production of geochemical maps (U, K & Th) from the air, covering 400 square miles of the Bancroft area of Ontario.

2) a demonstration of the effectiveness of U/Th and U/K ratios for identifying significant uranium occurrences from the air, and greatly narrowing down the area of search.

3) a cross country reconnaissance from Ottawa to Yellowknife with the high sensitivity gamma-ray spectrometer which identified all known uraniferous localities en route and indicated the presence of several other localities of probably comparable importance. For example, in the vicinity of Red Sucker Lake, E. Manitoba, Leland Lakes area E. of Fort Smith, District of Mackenzie; Thubun River area, District of Mackenzie.

Approximately 9,000 line miles of usable high sensitivity gamma-ray spectrometry data were obtained during the year, and 1,500 line miles of usable experimental photography.

Attendance at Meetings

A. G. Darnley
- Canadian Institute of Mining & Metallurgy Annual Meeting, Montreal, April 1969; presented paper "Airborne gamma-ray spectrometry".
- Sixth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan, October 1969.
- Planning, Programming and Budgeting Systems, Ottawa, January 19-23, 1970.
- Prospectors and Developers Annual Convention, Toronto, March 1970; presented paper "Highlights of GSC airborne gamma spectrometry in 1969" with co-authors R. L. Grasty and B. W. Charbonneau.

V. R. Slaney
- Annual convention, American Society of Photogrammetry, Washington, March 1-6, 1970.
- New Horizons in Colour Aerial Photography, New York, June 9-11, 1969.
- Visits to many groups concerned with airphoto interpretation in Vancouver, Calgary, Toronto, Montreal and Quebec City, December 1969.

R. L. Grasty
- Prospectors and Developers Association Convention, Toronto, March 1970; presented paper "Highlights of GSC airborne gamma spectrometry in 1969" with co-authors A. G. Darnley and B. W. Charbonneau.

Membership on Committees

A. G. Darnley
- Member, GSC Uranium Committee
- Member, Organizing Committee NRC Infra-red Workshop.

V. R. Slaney
- Member, Technical Subcommittee of the Interdepartmental Committee on Air Surveys (I.C.A.S.)
- Member, Data Handling Group, Interdepartmental Committee on Resource Satellites and Remote Airborne Sensing.

Special Talks

A. G. Darnley
- Radiometry and geology of the Bancroft area: Grenville Discussion Group, February 1970.
- New techniques in airborne surveying: Canadian Society of Exploration Geophysicists, Toronto February 1970.
- The development of a method - gamma-ray spectrometry: University of Western Ontario, Geophysics Club, March, 1970.

V. R. Slaney
- Image Sensitometry - Infrared Workshop at N.R.C. Montreal Road, February 17, 1970.
- Infrared Applied in Geology - Infrared Workshop at N.R.C., Montreal Road, February 17, 1970.

Outside Papers

A. G. Darnley : Airborne gamma-ray spectrometry, C.I.M. Transactions 73 pp. 20-29, 1970.

Active Projects

670050	Airborne gamma spectrometry
670052	Gamma-ray support
670053	Radioisotope methods
630031	Multispectral Photography
670054	Infrared Scanning

ROCK MAGNETISM SECTION

A. Larochelle

The activity of this section is centered on the development and application of techniques and instrumentation for the study of the magnetic properties of rocks and minerals and is oriented toward the solution of geotectonic, geochronologic and geoeconomic problems.

Activities and Highlights

During the last fiscal year, a number of paleomagnetic studies were completed on rocks from British Columbia, Northern Ontario, Quebec and Nova Scotia as a contribution to the solution of geotectonic and geochronologic problems; a paleointensity study was carried out on rocks of Precambrian and Miocene ages in order to test the validity of the dipole field hypothesis throughout the geological past; fundamental magnetic properties of sulphide minerals were investigated in order to assess their reliability as a paleomagnetic carrier and to test their potential significance as a geothermometer; paleomagnetic instrumentation was further improved in order to improve the speed and accuracy of remanent magnetization measurements; the development of a vibrating-type magnetometer was initiated to extend the range of the already existing thermo-balance to larger rock samples. As a corollary to this work, the above techniques and instruments were used for the study of lunar material supplied by NASA.

Personnel Changes

G. W. Pearce resigned in September 1969 to complete graduate studies toward a Ph.D. at the University of Toronto.

Attendance at Meetings

E. J. Schwarz and D. T. A. Symons attended the AGU meetings in Washington in April, 1969.

A. Larochelle and E. J. Schwarz attended the IAGA meeting in Madrid in September, 1969, where E. J. Schwarz presented a paper; both also attended the Lunar Science Conference in Houston in January 1970, where A. Larochelle presented a joint paper; E. J. Schwarz presented the same paper at the Logan Club, February, 1970.

A. Larochelle was seconded to CIDA as Project Manager for a geophysical survey carried out presently in Niger and Cameroun; this assignment required three trips to Africa since April, 1969.

E. J. Schwarz presented a paper on the "Thermomagnetics of pyrrhotite and possible geological applications" at the Department of Geology, Carleton University.

A. Larochelle attended Planning, Programming and Budgeting Systems Seminar in Ottawa, January 19-23, 1970.

OUTSIDE PAPERS

Larochelle, A. and K. L. Currie:
Paleomagnetic Study of Volcanic rocks from Mistastin Lake, Labrador, Canada, in Earth and Planetary Science Letters, Vol. 6, pp. 309-315 (1969).

Larochelle, A.: Paleomagnetism of the Monteregian Hills: Further New Results: in Jour. Geoph. Res. Vol. 74, pp. 2570-2575 (1969).

Larochelle, A. and E. J. Schwarz:
Magnetic Properties of Lunar Sample 10048-22 in Science, Vol. 167, pp. 700-701 (1970).

Schwarz, E. J.: Thermomagnetic analysis of some Red Beds. Earth Plan. Sci. Letters, 5, 1969.

Schwarz, E. J. and D. T. A. Symons:
Geomagnetic intensity between 100 million and 2500 million years ago. Phys. Earth Planet. Interiors, 2, pp. 11-18, 1969.

Schwarz, E. J.: A discussion of thermal and alternating field demagnetization methods in the estimation of paleomagnetic field intensities. J. Geomag. Geoelec., 21, 3, 1969.

Schwarz, E. J. and D. T. A. Symons:
Paleointensity study of late Miocene igneous rocks from British Columbia, Canada. Cdn. J. Earth Sci. 7, 1, pp. 176-181, 1970.

Schwarz, E. J. and A. Larochelle:
Magnetic properties of Apollo 11 Sample 48-22. Science, 167, 1970.

Symons, D. T. A.: Paleomagnetism of four late Miocene gabbroic plugs in south-central British Columbia: Can. Jour. Earth Sciences, vol. 6, pp. 653-662, 1969.

Symons, D. T. A.: Paleomagnetism of the Nipissing diabase, Cobalt area, Ontario; Can. Jour. Earth Sciences, vol. 7, pp. 86-90, 1970.

Active Projects

660525	Thermomagnetics of pyrrhotite
670044	Paleomagnetic Studies in N.W. British Columbia
670069	Astatic Magnetometer - Blackburn Laboratory

670554	Paleointensities
670565	Laboratory Susceptibility Meter
670566	Identification of NRM Components
680052	Paleomagnetic Studies in S. British Columbia
680053	Paleomagnetic studies in northern Ontario
680058	Paleomagnetism - Appalachian Intrusives
680070	Geology of the Mistastin Circular Structure
680077	Paleomagnetism - Appalachian Volcanics and Sediments
680125	Construction of a Ballistic magnetometer
680126	Thermomagnetic of Chromian Spinels
680127	Construction of vibration type magnetometer
680128	Thermomagnetics - Mid Atlantic Ridge
680059	Magnetic properties of Moon samples

SEISMIC SECTION

G. D. Hobson

This section is responsible for conducting seismic surveys as an aid in defining the geology of Canada and its Continental shelves; for advising other government departments and agencies in matters pertaining to seismic investigations; and for assisting in operational and research training in techniques of seismic prospecting.

Activities and Highlights

G. D. Hobson and A. Overton: The activities of the section are partially reported in GSC Paper 70-1, Part A. Conventional seismic surveys were continued and completed in the Gulf of St. Lawrence in cooperation with the Atlantic Oceanographic Laboratory. During 1969, about 1000 miles of continuous reflection profiling was acquired in the Strait of Belle Isle using an air gun source. The reflection profiles should be of considerable assistance in defining the northerly limit of the Palaeozoic sediments in the Strait.

Cursory examination of the data over the Rocky Mountain Trench indicates that it is not a graben.

Marine seismic surveys using repetitive sources were continued in the Great Lakes in cooperation with the Canadian Centre for Inland Waters, Burlington. Lake Huron saw most of the activity this past year with 2800 miles of echo grams produced with the use of a 5 cu. in. air gun. Previous work in Lake Ontario showed that there are three major basins decreasing in depth to the east. An attempt is being made to tie in these data to the on-shore seismic program. In the western end of Lake Erie, there appears to be a major depression extending from Wheatley in a northwesterly direction through Lake St. Clair to a known channel in Michigan.

The seismic work in the Welland-Port Colborne and Peterborough areas will be an added contribution to the Quaternary history of the Great Lakes Basin. Hammer refraction seismograph surveys were interpreted for a number of areas in Ontario, Quebec and New Brunswick.

Seismic data is being acquired in the Mackenzie Delta - Beaufort Sea area through purchase arrangements with industry. The geologists at the Institute of Sedimentary and Petroleum Geology require the 'third' dimension for their studies of this new potential oil province of the Mackenzie Delta and Basin. Preliminary assessment of these seismic sections indicate some very interesting structures.

Results from the seismic reflection method applied in the Elliot Lake area indicate that there can be as much variation in velocity within a given formation as from one formation to another. It is concluded that the seismic method is not useful for detecting the depth or thicknesses of the geological formations but only for determining bedrock depths in this area.

Personnel Changes

R. M. Youngman	- resigned in November 1969
R. A. Burns	- joined the section in March 1970
G. D. Hobson	- A/Division Chief for the year

Attendance at Meetings

G. D. Hobson	- International Association of Great Lakes Research, Ann Arbor, Michigan, May 5-7, 1969; presented paper "High resolution reflection seismic survey in western Lake Erie" with co-authors C. E. Herdendorf and C. F. M. Lewis.

- Society of Exploration Geophysicists, Annual Meeting, Calgary, Alberta, Sept. 14-18, 1969: Co-chairman of "Arctic Information Seminar"; as Vice President of Society attended many committee meetings during convention and several organization meetings in Tulsa, Okla.
- Planning, Programming and Budgeting Systems, Ottawa, Jan. 19-23, 1970
- Saskatchewan Geological Society Symposium, Regina, Saskatchewan, October 30-31, 1969; presented paper "A review of geophysical methods in the Athabasca Sandstone".

Special Talks and Projects

G. D. Hobson

- Gave 12 hours of lectures on Seismic Methods, Geology 67.484, Carleton University, Jan. 6-22, 1970.
- Gave talk on "Gatineau Park as a test site for exploration geophysics", NCC, Dec. 11, 1969
- Left for India February 24, 1970, as special representative and lecturer for CIDA for 2 1/2 months.

Membership on Committees

G. D. Hobson

- Vice President, Society of Exploration Geophysicists, Tulsa, Oklahoma.

Outside Papers

Hobson, G. D.: Bedrock features of the Mer Bleue area by seismic methods: Can. Field Naturalist, Jan.-Mar, 1970.

Hobson, G. D., and Hunter, J. A.: In-situ determination of elastic-constants in overburden using a hammer seismograph: Geoexploration, v. 7, no. 2, pp. 107-111, June 1969.

Hobson, G. D., Herdendorf, C. E., and Lewis, C. F. M.: High resolution reflection seismic survey in western Lake Erie: Proc. 12th Conf. Great Lakes Res., 1969.

Hobson, G. D.: Seismic methods in mining and groundwater exploration: Geol. Surv. Can., Econ. Report No. 26, pp. 148-176, 1970.

Active Projects

620038	Seismic - Oak Ridge Moraine
630434	Seismic - Beauceville
640049	Marine seismic - Gulf of St. Lawrence
640438	Seismic - Mer Bleue
650420	Seismic - Suffield, Alberta
660050	Seismic - Rocky Mountain Trench
660051	Seismic - Interior Plateau, B. C.
660052	Seismic - Winkler, Manitoba and Frobisher, Saskatchewan
660053	Seismic - Flin Flon, Manitoba
660054	Marine seismic - Great Lakes
660055	Seismic - Elliot Lake
670074	Seismic - Welland-Port Colborne
670075	Hammer seismic surveys
680037	Hammer seismic surveys
680122	Crustal seismic - Logans Line
690040	Seismic - Beaufort-Mackenzie
690081	Classified

THEORETICAL GEOPHYSICS AND DATA PROCESSING SECTION

B. K. Bhattacharyya

This section is primarily involved in the treatment and interpretation of various kinds of geophysical data, particularly aeromagnetic data.

Activities and Highlights

During 1969-70 considerable amount of work was done on the development of new and automatic techniques for handling and interpreting hi-resolution digital aeromagnetic data. The first set of such data became available early in June, 1969 when the high-sensitivity aeromagnetic survey over the area around Timmins was complete. The editing of this data, proper arrangement of flight lines, fixing the coordinates and calculation of drifts and levelling of all the flight line data were

done automatically. To the best of our knowledge, this type of work has never been attempted anywhere before because of the tremendous complexities involved in the reduction of the data. Digital filters were designed for the calculation of vertical gradient from the observed total field data. It is felt that at the present stage of instrumentation, the calculated gradient is more accurate than the measured gradient.

During the last year a computer program was also developed for automatic contouring of irregularly-distributed data. This program is based on bicubic spline interpolation and yields very satisfactory and accurate results.

Residual aeromagnetic maps over a large area in Central Canada covering significant parts of Manitoba, Saskatchewan and Alberta were prepared, published and released in 1969.

Personnel Notes

Messrs. D. J. Teskey and M. T. Holroyd joined the Section on permanent basis in June and July, 1969, respectively.

Special Talks and Projects

B. K. Bhattacharyya
- gave talks on 'potential field theory and applications' in the University of California, Berkeley and Michigan State University, East Lansing.
- critically reviewed 1 manuscript for Science, 1 for Transactions I.E.E.E., 1 for Geoexploration and 4 for Geophysics.

Attendance at Meetings

B. K. Bhattacharyya
- Annual International Meeting of the Society of Exploration Geophysicists held in September, 1969, at Calgary, Alberta. Presented a paper on treatment of high resolution aeromagnetic data.
- Colloquium on "Basement Mapping by Magnetics" held in Aarhus, Denmark in October, 1969. Presented a paper on "Some Important Considerations in the Acquisition and Treatment of High-Resolution Aeromagnetic Data".
- Planning, Programming and Budgeting Systems, Ottawa, January 26-30, 1970.

Membership on Committees

B. K. Bhattacharyya
- Chairman of the Branch Advisory Committee on Data Processing
- Member, Departmental Computer Working Committee

Outside Publications

B. K. Bhattacharyya: Bicubic spline interpolation as a method for treatment of potential field data; Geophysics, v. 34, p. 402-423, 1969.

B. K. Bhattacharyya: A discussion on treatment of non-equispaced two-dimensional data with a digital computer; Geoexploration, v. 7, p. 63-66, 1969.

Active Projects

680139	Quantitative Aeromagnetic Interpretations
680140	High-resolution aeromagnetic data
680141	Pattern recognition
660478	Airborne EM Analysis

INSTITUTE OF SEDIMENTARY AND PETROLEUM GEOLOGY

D.J. McLaren

INTRODUCTION

The Institute of Sedimentary and Petroleum Geology is responsible, through field and laboratory research, for describing the geology of the western and northern sedimentary basins, from the 49th parallel to the Arctic Islands and between the Canadian Shield and the Rocky Mountain Trench. The scientific program of the Institute is carried out by six research sections: Arctic Islands, Structural Geology, Paleozoic Stratigraphy, Mesozoic Stratigraphy, Paleontology, and Petroleum Geology. The sections are supported by laboratories and technicians under the control of the staff geologist.

The scientific program of the research sections and senior research scientists is described below. The emphasis in research continues to stress collaborative programs designed to elucidate and describe the geological history and structure of sedimentary basins with a view to providing geological data and interpretation necessary to the exploration and exploitation of mineral resources.

In addition to its research responsibilities, the Institute is responsible for the custody of drilling cores, samples, and other data resulting from exploration activities by industry in Yukon Territory, Northwest Territories and Arctic Islands and for drilling samples from all provinces and territories of Western Canada. Samples and cores from the northern territories are submitted as required to Federal administration in conformity with regulations. In addition to scientific, administrative, and support staff of the Institute, the building houses units from other divisions and branches of the Department of Energy, Mines and Resources. These include members of the Quaternary Research and Geomorphology Division, the Western Research Section of the Groundwater Subdivision of the Hydrologic Sciences Division, the National Air Photographic Library of the Surveys and Mapping Branch, and the field office of the National Energy Board. The field office of the Resources Management Division of the Department of Indian Affairs and Northern Development moved out of the Institute during the fiscal year. The space vacated has now been occupied by a unit of the Mining Research Centre of the Mines Branch of this Department.

During the year, scientists of the Institute published 4 bulletins, 10 papers, 5 preliminary maps, 1 topical report, and 17 publications in outside journals. As enumerated below, support and service facilities of the Institute continued to expand greatly and the usage of the core and sample display areas, the library, and publications distribution continued to increase rapidly.

Postdoctorate Fellows

Dr. Lubomir Jansa of Prague, Czechoslovakia, joined the Institute as a research fellow in July. His program involves studies of lower Paleozoic clastic sediments in the Rocky Mountains of British Columbia, and Devonian carbonate shelf deposits in central Alberta.

Dr. Graham Davies from Perth, Australia joined the Institute in October, and has undertaken a research program involving Devonian carbonate deposits in the northern Alberta subsurface.

Dr. Kinji Magara of Tokyo ended his tenure as a Fellow during the summer.

Institute Committees

Library Committee:

D.F. Stott (Chairman)
E.W. Bamber
R. Thorsteinsson
N.W. Rutter
M. Jones (Secretary)

Committee on Clay Mineralogy and Chemistry:

D.F. Stott (Chairman)
R.M. Procter
A.E. Foscolos

Exhibits Committee:

N.C. Ollerenshaw (Chairman)
R.W. Klassen
M. Jones
L. MacLachlan

Safety Committee:

G.M. Peterkin (Chairman)
B.G. Delay
G.D. Karg
A.G. Heinrich

Technical Safety Subcommittee:

R.L. Cox
A.E. Foscolos

Committee on Curation of Rocks and Fossils:

B.S. Norford (Chairman)
J.D. Aitken

Beaufort-Mackenzie Program Coordinator:
C.J. Yorath

Northeast B.C. Program Coordinator:
D.F. Stott

Attendance at Meetings

D.J. McLaren

Royal Society of Canada, Ottawa, June 1969.

North American Paleontological Convention, Chicago, September 1969.

Preparatory meeting for an International Geological Correlation Program (I.G.C.P.), organized by I.U.G.S. and UNESCO, Budapest, September 1969.

Geological Society of America, Atlantic City, November 1969.

Special Talks

D.J. McLaren

"Time, Life, and Boundaries". Presidential Address, Paleontological Society, Atlantic City, November; University of Western Ontario, London, March 1970; Princeton University, N.J., March 1970.

"Correlation and Catastrophism". Alberta Society of Petroleum Geologists, March 1970.

"The Moral Responsibility of Science". Professional Development Group, Calgary, March 1970.

Membership on Committees

D.J. McLaren

Paleontological Society, President, and past President.

The Paleontological Association, Overseas Representative.

Silurian-Devonian Boundary Committee of International Commission on Stratigraphy, Chairman.

International Geological Congress, Organizing Committee.

Canadian Journal of Earth Sciences, Associate Editor.

REPORT ON SECTIONS

STAFF GEOLOGIST

B.A. Latour

Activities

The Staff Geologist is responsible for the administration of the core and sample repositories and the ensuring of their efficient accessibility to the public as well as the scientific staff of the Institute in accordance with statutory requirements; the functional and administrative control of the Lapidary, Photography and Sedimentary Petrology Laboratories, and the technicians working in them; the administrative control of all the remaining laboratory areas and the technicians working in them; and the administrative control of the library. In addition, he is responsible for studies of Canada's coal deposits and for maintaining an inventory of the coal reserves of Canada.

At the request of the Department of Indian Affairs and Northern Development the Carmacks Coalfield, Yukon Territory was examined in order to assess the reserve potential of the field and to determine the additional exploratory work required to accurately determine the reserves. He also undertook a study, requested by the Energy Development Sector of this Department, to determine the measured reserves of coal in Western Canada. This resulted in a confidential report for use by the Department in its studies of the energy picture.

Core and Sample Repositories

Construction on the additions to the storage areas was started and completed during the year. This has provided 4,100 square feet and 3,100 square feet more space to the core storage area and the sample storage area respectively. The main activities of this unit are summarized as follows:

Visitors utilizing core and sample facilities	2,088
Number of wells from which samples were examined	980
Boxes of core that were examined	13,315
Samples received from Manitoba	NIL
Samples received from Saskatchewan	81,177
Samples received from Alberta	271,244
Samples received from British Columbia	58,347
Samples received from Northwest Territories, Yukon Territory and Arctic Islands	26,419
Samples received from offshore drilling	2,150
Boxes of core received from Northwest Territories, Yukon Territory and Arctic Islands	2,747
Boxes of core received from offshore drilling	8
Samples transferred from envelopes to vials	20,000
Mechanical logs received	7,443

Lapidary Laboratory

This unit became operative this year. The services of a well qualified technician were obtained and the necessary equipment was acquired and installed. Equipment includes a diamond saw, grinding wheel, hot plate, oven, and an automatic grinding machine capable of grinding twenty standard-sized thin sections in about 10 minutes.

Pertinent production figures are:

Standard thin sections completed	1,374
Large thin sections completed	39
Polished samples	8
Samples crushed for special project	2,000

Photography Laboratory

Production figures from this unit are as follows:

Enlargements, black and white	2,721
Contact Prints, black and white	1,945
Slides prepared, 35 mm, black and white	82
Slides prepared, 35 mm, colour	188
Negatives produced, black and white, 4" x 5"	514
Rolls processed, black and white	56
Work orders processed	176

Sedimentary Petrology Laboratory

Services provided by this unit included mineral separations, thin sectioning, etching of sections and rock surfaces, polishing, preparation of acetate peels, staining of polished rock surfaces and thin sections, determination of insoluble residue content, sieve analyses, preparation of samples for X-ray and microprobe analyses and calculations. In addition, considerable experimentation with new techniques and materials was undertaken to improve the preparation of stained acetate peels and specialized thin sections.

Production figures are as follows:

Standard thin sections	358
Special thin sections and grain mounts	216
Covers installed only	115
Acetate peels	280
Stained sections	334
Insoluble residue determinations	66
Isodynamic separation	6
Polished surfaces	174
Heavy mineral separations	3
Sieve analysis	36
Centrifugal separations	36

Library

The library now has about 50,000 volumes on hand. The work of numbering the collection according to the Library of Congress classification was completed and the books were re-shelved in this order. The cataloguing of the collection was completed as was also the cataloguing of the map collection.

Statistics for the year are as follows:

Acquisitions

Books, etc. acquired by purchase (excluding periodicals)	789
Books, etc. acquired by gift or exchange	1,662

Circulation

Books, periodicals (to staff only)	8,302
Interlibrary loans	
Borrowed from GSC Ottawa library	211
Borrowed from other libraries	332
Loaned	361

Reference

Books, etc. consulted in library (other than staff)	676
Inquiries (quick, less than 5 minutes)	5,696
Information searches (more than 5 minutes)	1,762
Visitors	2,562

Serials

Serial publications received (titles)	517

Personnel Notes

Temporary assistance for the library was provided by Mr. Andrew Murison who started work in December.

Attendance at Meetings

R.R. Barefoot

Training course in atomic absorption spectroscopy sponsored by Perkin-Elmer, Norwalk, Conn., November 1969.

Mrs. M. Jones

Classification Training Seminar, I.S.P.G., May, 1969.

B.A. Latour

Classification Training Seminar, I.S.P.G., May, 1969.

21st Canadian Conference on Coal, Calgary, Alberta, September, 1969.

Special Talks

B.A. Latour

"Coal Deposits of Western Canada"; presented to senior geology classes University of Calgary, March, 1970.

Membership on Committees

B.A. Latour

Departmental Advisory Committee on Coal.

ADMINISTRATIVE SERVICES

A.W. Brusso

Activities

The typing pool was relocated to larger, brighter quarters on the main floor and additional space was provided for the Stationery and Supply Section. The renovations that were necessary before these moves could be made were carried out by the building and engineering staff, who were responsible also for the construction and alterations involved in the relocation of two laboratories, the setting up of a geochemical laboratory and an instrument room.

At the beginning of the fiscal year, arrangements were made to process all accounts with the exception of officers' field accounts through the area Treasury Office in Calgary. This has proven to be beneficial both to ourselves and our suppliers.

Personnel Notes

Mrs. P.D. Brown joined the staff as a clerk in the Central Registry. She replaced Miss D.A. Sime who transferred to the Publication Distribution Unit.

Attendance at Courses

Mrs. L.V. Fiddes

Classification Training Seminar, I.S.P.G., Calgary, May, 1969.

A. Jamieson

Classification Training Seminar, I.S.P.G., Calgary, May, 1969.

Field Accounting Seminar, Ottawa, March, 1970.

A.W. Brusso

Planning, Programming, Budgeting Seminar, Ottawa, January, 1970

MANUSCRIPTS AND CARTOGRAPHY SECTION

E.J.W. Irish

Activities

This Section, responsible to the Chief Scientific Editor, Geological Survey of Canada, consists of a scientific editor, ten draftsmen and two members whose duties involve the distribution of published maps and reports. The Scientific Editor is responsible for the overall organization and co-ordination of the Section, for the distribution of geological information, and for the processing of all manuscripts submitted for publication by officers of the Institute. The main responsibility of the Section, in order to maintain the high standard of Geological Survey publications, is to assist authors to produce accurate and clear maps and reports as well as to co-ordinate all stages in the preparation for publication of both text and illustrative material. Furthermore, members of the section act as compilers for the Division's contribution to various annual publications of the Branch, as consultants on a variety of matters, provide information required by other organizations and the general public, and endeavour to make the public more aware of the large amount of geological and related information available.

The Geological Cartography unit is still two draftsmen short of its full complement (10 positions - 2 unfilled) and is, therefore, not performing at maximum efficiency. It continues to work under the handicap of having no operator for the reproduction equipment; this work being done, necessarily, by the most experienced draftsmen.

A very large percentage of the total volume of GSC publications (all types) and, also, publications of both Surveys and Mapping Branch and Mines Branch are now being distributed through the Institute office in Calgary, and this volume continues to increase each year. In addition, there is a steadily growing demand at this office for topographic maps of the Shield areas and for hydrographic charts of coastal regions of Canada, items which, at present are not stocked at the Institute. Furthermore, there are now 160 active charge accounts that require the preparation of monthly statements along with the necessary bookkeeping, packaging and mailing.

This unit has more work than it can handle efficiently with the present staff. To alleviate the situation and allow the personnel (two clerks) to complete telephone and mail orders and other bookkeeping procedures without interruption, it has been necessary to close the office to the public at 3:00 P.M. each day. At times this has caused considerable annoyance and resentment among customers arriving at the office during the closed period, and this is detrimental to good public relations.

The following table shows the status of reports and maps received between April 1, 1969 and March 31, 1970.

Type of Report or map	Number Received	Prelim. Editing Completed	Editing and drafting completed	To E.M. & R. Ed. Div. and Q.P.	Number Published
Memoir	0	0	0	0	0
Bulletin	4	2	1	1	4
Paper Series	10	5	4	4	10
Map P.S. Series	4	4	4	5	5
Map A Series	1	1	0	0	0
Miscellaneous	1	1	1	0	1
Outside Papers	13	6	5	0	17

Note: P.S. maps listed above do not include those accompanying reports.

Membership on Committees

E.J.W. Irish

Commissioner, American Commission on Stratigraphic Nomenclature.

Geological Cartography Unit

L. MacLachlan

During the past year the unit produced all cartographic work required by the Institute for Geological Survey publications and, in many cases, for publications in outside journals. Numerous drawings were made for the production of 35 mm colour slides used to illustrate talks by officers of the Institute. In addition, the unit supplied a projectionist for McConnell Club meetings and other lectures hosted by the Institute.

Reproduction services are presently performed by the draftsmen because this position in the unit is still vacant. Efforts are now being made to fill it.

Personnel Notes

Mr. G.J. Charbonneau resigned in October, 1969 and his position has remained vacant since that time. At the end of March, 1970 the unit strength totalled 8 with 2 vacant positions.

Attendance at Courses

Miss M.D. Stewart

Evening course, Geology I - Southern Alberta Institute of Technology; winter 1969-70.

Production Data

Maps and figures prepared by the Cartography Unit and returned to Ottawa for printing during the period April 1, 1969 to March 31, 1970.

Preliminary geological maps	9
Figure illustrations (page size)	96
Figure illustrations (pocket size)	26

Miscellanceous drafting totalled 225 items. Of these drawings, 159 were for slides; the balance consisted of office forms, library service lists and signs.

Manuscripts Received

Multicoloured geological maps	1
Preliminary geological maps	5
Figure illustrations (page size)	117
Figure illustrations (pocket size)	26

Maps and Illustrations in progress at March 31, 1970

Multicoloured geological map	1
Figure illustrations (page size)	71
Figure illustrations (pocket size)	5

Backlog of maps and illustrations in the Cartographic Unit

Figure illustrations (page size)	3
Figure illustrations (pocket size)	13

Reproductions Services

Type of print	Number
Xerox prints	131,122
Photostat prints	574
Diazo prints (blueline, blackline, and sepia)	2,408

Contact printing

Film, negative and positive	877
Vandyke prints	524
Drafting keys on scribe	73
Blueline on Cronaflex	93
Colour proofs	7
Colour keys on film	24

Sixty-eight orders for camera work were placed with commercial firms; a total of 207 negatives or positives.

Publications Distribution Office

Mrs. M.H. Brooks

During the year 1969-1970 the volume of business handled by this office continued to increase rapidly. The number of visitors to the office was nearly double and the number of requests for information by mail and by telephone were more than double those of the previous year.

Publications of all types continue to be distributed to the public so quickly that a continuous effort is required to keep stock on hand. This situation could be remedied, in part, by receiving a much larger number of each item in the initial shipment from Ottawa. A larger original shipment would reduce the amount of stocktaking and requisitioning at this end.

Recently, there has been an increasing demand for topographic maps of the Canadian Shield areas and for hydrographic charts of the coastal regions of Canada. Neither of these items are stocked at the Institute.

A system of charge accounts was established as an aid to industry. 206 charge accounts are now open though only 160 are considered active; the others are used infrequently. Many companies are, however, continuing to pay cash for their purchases.

Personnel Notes

During the year Miss W. Elviss accepted a position in industry and was replaced in the unit by Miss Dale Sime.

Attendance at Courses

Mrs. M.H. Brooks

Evening course, Geology I - Southern Alberta Institute of Technology; winter 1969-70.

Evening course, Accounting 100 - Southern Alberta Institute of Technology, winter 1969-70.

Distribution data

During the fiscal year the following amounts were received for the items indicated.

Type	Value (dollars)
Surveys and Mapping Branch	9,031.87
Mineral Resources Branch	458.83
Rock and mineral sets	420.33
Publications (GSC)	22,273.35
Maps (GSC)	12,262.57
Total receipts	44,446.95
Free issues to staff members	4,678.70

Distribution increase

Year	No. of Items	Value (dollars)
1967-68	12,545	9,073.35
1968-69	50,155	21,912.55
1969-70	-	44,446.95

No record is now being kept of the number of publications sold.

Visitors and requests for information	1968-69	1969-70
Visitors to the office (cash sales and others)	2,686	3,482
Number of telephone calls	-	6,672
Letters (requests for publications and information)	-	2,796

The Unit answers about 30 telephone calls each day.

PRINCIPAL RESEARCH SCIENTIST

Dr. H. Frebold

Activities

Since his retirement Dr. Frebold has continued his research on the Jurassic System in association with the Geological Survey of Canada. He continues to represent Canada on the Sous Commission du Jurassique of the Commission on Stratigraphy of the International Union of Geological Sciences. Seven weeks were spent in the southern Rocky Mountains studying Pliensbachian, Toarcian and Bajocian beds; this field work was funded by Dr. Frebold. In association with H.W. Tipper, he has commenced study of Bathonian faunas and rocks recently discovered in British Columbia. Thirteen paleontological reports on referred fossils were completed for members of the Survey. A manuscript of the Pliensbachian was completed during the year; this and other outside papers published during 1969-1970 are listed below.

Frebold, Hans, Subdivision and facies of Lower Jurassic rocks in the southern Canadian Rocky Mountains and Foothills; Geol. Assoc. Canada, Proc., vol. 20, pp. 76-89, 1969.

Pliensbachian ammonoids from British Columbia and southern Yukon; Canadian J. Earth Sci., vol. 7, pp. 435-456, 1970.

Frebold, Hans, and H.W. Tipper, Status of the Jurassic in the Canadian Cordillera of British Columbia, Alberta, and southern Yukon; Canadian J. Earth Sci., vol. 7, pp. 1-21, 1970.

SENIOR RESEARCH SCIENTIST

Helen R. Belyea

Activities

Dr. Belyea continued her studies of the subsurface Devonian formations of Alberta, British Columbia and District of Mackenzie and submitted two manuscripts for publication as follows: "Middle Devonian tectonic history of Tathlina uplift, southern District of Mackenzie" and "Significance of an unconformity within the Chinchaga Formation, northern Alberta and southern District of Mackenzie".

Active projects

610394 - Schedule of wells, N.W.T.
500336 - Devonian of Alberta, British Columbia and District of Mackenzie.

Attendance at Meetings

H.R. Belyea

1969 National Conference on Earth Science (University of Alberta, Banff, Alberta).

Royal Society of Canada, Ottawa, June 1969.

Calgary Core Conference, A.S.P.G., Calgary, Alberta, September, 1969.

Special Talks

H.R. Belyea

"Features of the carbonate front, Sulphur Point Formation, District of Mackenzie"; Calgary Core Conference.

Lecture tour in France on National Research Council of Canada travel grant; part of the program of Exchange of scientists between France and Canada.

Lectures given: (1) "Devonian of Western Canada"; (2) "Banks and reefs in Western Canada; (3) "Middle Devonian tectonic history of Tathlina uplift"; (4) demonstration of Devonian carbonate microfacies using thin sections.

These talks were given to 8 universities and institutes, 3 petroleum companies, the Society of Sedimentologists of France, and the Paleontological Society of France.

SENIOR RESEARCH SCIENTIST

R. Thorsteinsson

Activities

Dr. Thorsteinsson was engaged in the preparation of geological maps of Axel Heiberg Island and western Ellesmere Island. Time was devoted, also, to the preparation of a paper dealing with the Carboniferous and Permian stratigraphy in the area.

Active Projects

610002 - Axel Heiberg and Ellesmere Islands.
650003 - Cornwallis and adjacent smaller islands.

ARCTIC ISLANDS SECTION

R.L. Christie

Activities

The Arctic Islands Section was engaged in both field and office research during the year. Reconnaissance mapping of the Precambrian rocks of eastern Devon Island was completed by R.L. Christie, who also continued stratigraphic studies of lower Paleozoic rocks on southern Ellesmere Island. Stratigraphic and biostratigraphic relationships of Upper Paleozoic rocks of the Sverdrup Basin were studied by W.W. Nassichuk on northern Ellesmere and Axel Heiberg Islands. In addition, Nassichuk studied Paleozoic ammonoids from the Arctic Islands, British Columbia, and Yukon Territory. H.P. Trettin carried to completion his research and writing for a bulletin on the Franklinian geosynclinal rocks of northeastern Ellesmere Island, and compiled lower Paleozoic geology in four quadrangle map-areas of northern Axel Heiberg and Ellesmere Islands, to be published jointly with R. Thorsteinsson. J.W. Kerr completed and published a geologic map of southwestern Ellesmere Island and, using data from that region, furthered his studies of continental drift. A new theory for the origin of the Greenland ice cap was developed, invoking tectonic controls. Kerr also contributed, with R. Thorsteinsson and E.T. Tozer, toward completion of maps and reports on Axel Heiberg and western Ellesmere Islands.

Active Projects

630003 - Operation Grant Land (northeastern Ellesmere Island and northwestern Greenland); R.L. Christie, H.P. Trettin, W.W. Nassichuk.

670016 - Southwest Ellesmere Island and western Devon Island (Operation Grinnell); J.W. Kerr, R. Thorsteinsson.

670557 - Stratigraphy and age of Precambrian sedimentary rocks and contained sills and dykes, east coast of Canadian Arctic Islands and North and Northwest Greenland; R.L. Christie.

680015 - Geological reconnaissance of eastern Devon Island with additional stratigraphic studies on southeastern Ellesmere Island; R.L. Christie.

680039 - Study of Continental Drift; J.W. Kerr

680063 - Permian biostratigraphy, northern British Columbia and northern Yukon; W.W. Nassichuk.

680064 - Stratigraphy and paleontology of upper Paleozoic rocks on parts of Ellesmere and Axel Heiberg Islands; W.W. Nassichuk.

Personnel Notes

H.R. Balkwill resigned his position with the Geological Survey of Canada in the fall of 1969.

Attendance at Meetings

H.P. Trettin

Geological Association of Canada, Annual Meeting, Montreal, Quebec, June, 1969.

J.W. Kerr

Symposium on Recent Crustal Movements, Ottawa, 1969.

Symposium on the Pacific Margin, Vancouver, 1969.

Structural Geology seminar; Department of Geology, University of Alberta, Edmonton, Alberta, 1969.

W.W. Nassichuk

North American Paleontological Convention, Chicago, September, 1969.

Geological Society of America, Annual Meeting, Atlantic City, November, 1969.

Special Talks

H.P. Trettin

"Ordovician-Silurian flysch sedimentation in the axial trough of the Franklinian geosyncline, northeastern Ellesmere Island"; G.A.C., Annual Meeting, Montreal, June, 1969.

"The axial trough of the Franklinian geosyncline; sedimentation and tectonics"; Alberta Society of Petroleum Geologists, October, 1969.

"The axial trough of the Franklinian geosyncline; sedimentation and tectonics"; Edmonton Geological Society, November, 1969.

"The axial trough of the Franklinian geosyncline; sedimentation and tectonics"; Department of Geology, University of Western Ontario, London, Ontario.

J.W. Kerr

"Today's Topography and the tectonics of northeastern North America"; Symposium on Recent Crustal Movements, Ottawa, 1969.

"The intersection of a Mid Oceanic Ridge with North America"; Symposium on the Pacific Margin, Vancouver, 1969.

"Tectonic development of the Canadian Arctic"; Department of Geology University of Alberta, Edmonton, Alberta.

Membership on Committees

J.W. Kerr

Canadian co-ordinator for the 2nd International Symposium on Geology of the Arctic (San Francisco, February, 1971).

Director, Alberta Society of Petroleum Geologists.

Member, Technical Program Committee, American Association of Petroleum Geologists, Annual Meeting, Calgary, June, 1970.

W.W. Nassichuk

Member, Program Committee, International Conference on the Permian and Triassic Systems, Calgary, August, 1971.

H.P. Trettin

Chairman, Link Award Committee, Alberta Society of Petroleum Geologists, 1970.

Outside Publications

R.L. Christie

"The Arctic Islands"; background paper on a Canadian geological province for the Solid Earth Science Study Group of the Science Council of Canada; Can. Mining Met. Bull., vol. 63, No. 693, pp. 31-33, 1970.

H.P. Trettin

"Lower Paleozoic Discussed"; summary of talk given to A.S.P.G. and published anonymously in "Oilweek", vol. 20, No. 40, pp. 19 and 24, 1969.

W.W. Nassichuk

"Permian Ammonoids from Devon and Melville Islands, Canadian Arctic Archipelago"; J. Paleontol., vol. 44, No. 1, pp. 77-97, 1970.

"Christioceras, an Arctic Pennsylvanian ammonoid discovered in west Texas"; J. Paleontol., vol. 44, No. 2, pp. 399-401, 1970.

STRUCTURAL GEOLOGY SECTION

D.K. Norris

Activities

D.G. Cook, in collaboration with members of other sections of the Institute, continued studies of the regional structural framework of the northern Mackenzie Mountains, Franklin Mountains and Interior Plains and has documented increasing complexity of deformation in the Mackenzie Mountains from northeast to southwest. Also, evidence has been recognized for four periods of epeirogenic activity and for pre-Late Cambrian and post Cretaceous periods of orogenic activity.

Mrs. C.J. Havard began preliminary studies of deep reflection seismic profiles from the Beaufort Sea for co-ordination of this information with present drilling in the Mackenzie Delta area, and for planning of field work for the 1970 season. In addition, she continued subsurface stratigraphic and structural studies of southwestern Alberta.

Studies of the stratigraphy and structure of the southern Foothills of Alberta were continued by N.C. Ollerenshaw. A more accurate framework was established for the Rocky Mountain Foothills between Bow and Clearwater Rivers, demonstrating the continuity and relationships of the major structural elements and the structural style of the western flank of the Alberta Syncline in this region.

Studies of the structural style and stratigraphic framework of the northern Rocky Mountains were continued by G.C. Taylor. The results of field investigations (Operation Smoky) in the Pine Pass and Dawson Creek areas have shown the transition in structural style between northern and southern Rocky Mountains, and a major facies change in the stratigraphic column.

D.K. Norris continued his field and laboratory studies on the structural and stratigraphic framework of northern Yukon Territory and western District of Mackenzie, and of the structural geometry of the coal measures of the eastern Cordillera. In conjunction with detailed studies of specific geologic structures in the eastern and northern Cordillera of Canada, kinematic model studies are being made to evaluate the nature, sequence and timing of structural events in the Laramide orogeny. Collaborative studies with the Calgary office of the Mining Research Centre are conducted to evaluate the effects of geologic structure on the strength and stability of rock masses about mining excavations.

Active Projects

670068 - Operation Norman; D.G. Cook.
670577 - Stratigraphy and structure of Lower Cretaceous sedimentary rocks of the Waterton-Castle River area, Alberta; C.J. Havard.
690020 - Mesozoic and Tertiary stratigraphy and sedimentation, Beaufort-Mackenzie area; C.J. Havard.
N.P. - Lithostratigraphic studies of Upper Cretaceous formations encountered in C.P.O.G. Strathmore well; C.J. Havard.
N.P. - Ancient wall reef complex; E.W. Mountjoy.
610007 - Operation Porcupine; D.K. Norris
N.P. - Structural prototypes, scale models and stress analysis; D.K. Norris.
660020 - Structural and paleomagnetic fabric of the Mackenzie arc; D.K. Norris.
680019 - Non-marine Lower Cretaceous of the southeastern Canadian Cordillera; D.K. Norris.
690005 - Structural geology of northern Yukon Territory and northwestern District of Mackenzie; D.K. Norris.

N.P. - Blairmore - Carbondale River map-areas; D.K. Norris
N.P. - IGC field excursion; D.K. Norris
650023 - Operation Bow-Athabasca; R.A. Price
N.P. - Structural relations between Purcell and Rocky Mountains, Brisco area, British Columbia; R.A. Price.
690019 - Structural mechanics of southeastern Canadian Cordillera; M.R. Stauffer.
660486 - Stratigraphy of the Blairmore Group and Kootenay Formation, southern Foothills of Alberta, Bow River to Clearwater River; N.C. Ollerenshaw.
690017 - Rocky Mountain Foothills map and cross-section compilation; N.C. Ollerenshaw.
690018 - Cretaceous and Tertiary conglomerates and sandstones of the eastern Cordillera; N.C. Ollerenshaw.
N.P. - Geology of the Southern Alberta Foothills, Bow River to Clearwater River; N.C. Ollerenshaw.
630017 - Operation Liard; G.C. Taylor.
680084 - Operation Smoky; G.C. Taylor.
700007 - Parsnip (NTS 93) map-area, 1 to 1 million Geological Atlas program; G.C. Taylor.

Attendance at Meetings

D.G. Cook

Rocky Mountain Section of the G.S.A.; Salt Lake City, Utah, May, 1969.

Western Canada Structural Geologists Conference; Calgary, May, 1969.

Cordilleran Section of the Geological Association of Canada, Symposium on the Pacific Margin; Vancouver, February, 1970.

Mrs. C.J. Havard

Annual Meeting of the A.A.P.G.; Dallas, Texas, April, 1969.

A.S.P.G. Calgary Core Conference; Calgary, Alberta, September, 1969

Polarquest Arctic Symposium on Exploration Methods; Calgary, Alberta, December, 1969.

D.K. Norris

Annual Meeting of G.S.A.; Atlantic City, November, 1969.

Planning, Programming, Budgeting Seminar; Ottawa, January, 1970.

Geological Seminar on the North Slope, Alaska; Palo Alto, California, February, 1970.

Third Canadian Conference on Research in Tectonics; Winnipeg, Manitoba, March, 1970.

N.C. Ollerenshaw

Rocky Mountain Section of the G.S.A.; Salt Lake City, Utah, May, 1969.

Stratigraphic Petroleum Exploration of Detrital Sequences, Part I, (A.S.P.G.) Calgary, Alberta, February, 1970.

G.C. Taylor

Rocky Mountain Section, G.S.A.; Salt Lake City, Utah, May, 1969.

Attendance at Courses

Mrs. C.J. Havard

Quantitative Models in Geology; University of Calgary, September to December, 1969.

Problems in Sedimentation; University of Calgary, January to March, 1970.

Special Talks

D.G. Cook

"The Role of Cleavage in Deformation in the western Main Ranges" Western Canada Structural Geologists Conference.

Co-author with J.D. Aitken (speaker) of a talk on "Operation Norman Highlights"; to the Alberta Society of Petroleum Geologists and to the Rundle Club of the University of Calgary.

Membership on Committees

D.K. Norris

Commissioner, American Commission on Stratigraphic Nomenclature.

Chairman, McConnell Club, I.S.P.G. 1970.

Member, Structural Subcommittee, National Advisory Committee for Research in the Geological Sciences.

Member, Organizing Committee, Third Conference on Research in Tectonics.

Member, Coordinating Committee, Beaufort-Mackenzie Project, Institute of Sedimentary and Petroleum Geology.

N.C. Ollerenshaw

Member, Rocky Mountain Map Project Committee, Alberta Society of Petroleum Geologists.

Chairman, Exhibits Committee, Institute of Sedimentary and Petroleum Geology.

G.C. Taylor

Member, Helicopter Safety Committee, Alberta Society of Petroleum Geologists.

Member, Helicopter Committee, Geological Survey of Canada.

Member, Coordinating Committee, Geology of the Liard Basin, I.S.P.G.

Outside Publications

D.G. Cook

"A Cambrian Facies Change and its effect on structure, Mount Stephen-Mount Dennis Area, Alberta-British Columbia"; Geol. Assoc. Can., Special Paper No. 6, pp. 27-39, 1970.

"Eastern and Northern Cordillera"; Can. Mining Met. Bull., vol. 63, pp. 45-49, 1970 (with D.K. Norris, C.J. Havard, N.C. Ollerenshaw, and G.C. Taylor).

D.K. Norris

"Geological Explorations and Outlook, Eastern and Northern Cordillera"; (with D.G. Cook, C.J. Havard, N.C. Ollerenshaw and G.C. Taylor); Can. Mining Met. Bull., vol. 63, No. 693, pp. 45-49, 1970.

N.C. Ollerenshaw

"Geological Exploration and Outlook, Eastern and Northern Cordillera"; Can. Mining Met. Bull., vol. 63, No. 693, pp. 45-49, 1970 (with D.K. Norris, D.G. Cook, C.J. Havard, and G.C. Taylor).

G.C. Taylor

"Regional Geology adjacent to the Alaska Highway between Fort Nelson and Muncho Lake, British Columbia"; Edmonton Geol. Soc. Guidebook, 1969 Field Conference, pp. 16-29.

"Geological Exploration and Outlook, Eastern and Northern Cordillera"; (with D.K. Norris, D.G. Cook, C.J. Havard, and N.C. Ollerenshaw) Can. Mining Met. Bull., vol. 63, No. 693, pp. 45-49, 1970.

PALEOZOIC STRATIGRAPHY SECTION

A.W. Norris

Activities

A preliminary study of Lower, Middle, and Upper Devonian faunas of the Hudson Bay Lowlands by A.W. Norris has shown a few Middle Devonian elements in common with the Devonian of Western Canada. One month spent measuring sections and systematically collecting fossils in the Lake Winnipegosis - Lake Manitoba Devonian outcrop belt resulted in new fossil evidence, dating precisely, for the first time, some of the Devonian rocks in the Winnipegosis area. Norris spent some time, also, in completing a paper summarizing all known areas of Devonian sedimentary rocks in North and South America, Greenland and Antarctica.

Two members of the section are participating in Operation Norman. W.S. MacKenzie and R.W. Macqueen, in collaboration with members of the Paleontology Section, have made considerable progress toward understanding the details of stratigraphy, lithology, and fossil zones of the lower Paleozoic rocks of the District of Mackenzie. In addition, Macqueen completed an electron microprobe study on magnesium distribution in some Mississippian echinoderm limestones (with E.D. Ghent, University of Calgary).

A detailed study by H.L. Martin has shown that the Carboniferous shales and limestones of the Eagle Plain area contain a very large percentage (80%) of silica. Shales and limestones of the Banff Formation in the Wabamun area to the south also contain an anomalously large silica content.

Data from the continuing study, by R.M. Procter, of late Paleozoic and Triassic subsurface rocks of northeastern British Columbia is being compiled in a form for computer processing. Clay mineralogy studies of Lower Cretaceous shales continued in collaboration with A.E. Foscolos and D.F. Stott.

A recently completed study by D.C. Pugh has shown the relationship between Cambrian subsurface units of southern and central Alberta and outcropping Cambrian formations in the mountains.

Active Projects

670014 - Operation Winisk; A.W. Norris.
640032 - Devonian biostratigraphy of Lake Manitoba-Lake Winnipegosis region; A.W. Norris.
700034 - Devonian biostratigraphy of northern Yukon Territory and adjacent District of Mackenzie; A.W. Norris.
610007 - Operation Porcupine; A.W. Norris.
590014 - Stratigraphy of the southern part of the Devonian Ancient Wall reef complex, Jasper National Park, Alberta; W.S. MacKenzie.
610394 - Determination of formation tops for wells drilled in Northwest Territories and Yukon Territory for Schedule of Wells; W.S. MacKenzie.
670068 - Operation Norman; W.S. MacKenzie and R.W. Macqueen.
630021 - Mississippian stratigraphy, sedimentology, and correlation, southern Rocky Mountains and Foothills; R.W. Macqueen.
670562 - Carbonate-evaporite cycles, Souris River Formation (Devonian), Saskatchewan; R.W. Macqueen.
670090 - Geological data and formation tops for wells drilled in Yukon Territory and Northwest Territories for annual Schedule of Wells; H.L. Martin.
660530 - The Banff and Exshaw Formations in the Wabamun Lake area, Alberta; H.L. Martin.
600206 - Subsurface study of Mississippian, Pennsylvanian, and Permian of northeastern British Columbia and adjacent areas; R.M. Procter.
630356 - Subsurface study of Triassic stratigraphy of northeastern British Columbia; R.M. Procter.
670091 - Clay mineralogy of Lower Cretaceous shales of northeastern British Columbia; R.M. Procter.
670082 - Subsurface Cambrian stratigraphy in southern and central Alberta; D.C. Pugh.
690003 - Subsurface Cambrian stratigraphy in north-central Alberta; D.C. Pugh.

Personnel Notes

J.D. Aitken resigned from the Geological Survey of Canada in August, 1969 to join the Department of Geological Sciences at the University of Calgary, Calgary, Alberta.

A.W. Norris was transferred in August, 1969 from the Paleontology Section, Ottawa, to the position of Head, Paleozoic Stratigraphy Section, Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

G.R. Davies from Australia and L.F. Jansa from Czechoslovakia are currently doing research work on Paleozoic sedimentary rocks at the Institute under Postdoctorate Fellowships.

Attendance at Meetings

A.W. Norris

Core Symposium, Alberta Society of Petroleum Geologists, University of Calgary and Institute of Sedimentary and Petroleum Geology, Calgary, Alberta, September 4 - 5, 1969.

W.S. MacKenzie

Earth Science Conference, Banff, Alberta, May 4 - 9, 1969.

Geological Society of America, Annual Meeting, Atlantic City, N.J., November 6 - 12, 1969.

Seminar on 'Stratigraphic Petroleum Exploration of Detrital Sequences', University of Calgary, Alberta, February 11 - 13, 1970.

R.W. Macqueen

American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting, Dallas, Texas, April 14 - 17, 1969.

Geological Society of America, Rocky Mountain Section Meeting, Salt Lake City, Utah, May 7 - 10, 1969.

H.L. Martin

Course on 'Basin Reservoir Engineering Principles', Calgary, March 31 - April 4, 1969.

Seminar on 'Carbonate Buildings in the Geologic Record', Alberta Society of Petroleum Geologists, Calgary, April 22 - 24, 1969.

Geological Society of America, Annual Meeting, Atlantic City, N.J., November 10 - 12, 1969.

Seminar on 'Prospect Analysis and Evaluation of undrilled Acreage', Alberta Society of Petroleum Geologists, Calgary, December 10 - 12, 1969.

Seminar on 'Sedimentation of Detrital Sequences; Environment of Sandstone Reservoirs', Calgary, February 11 - 13, 1970.

R.M. Procter

Five workshops on 'Computer uses in Geology', given by Canadian Stratigraphic Services, 10 days, 1969-70.

Seminar on 'Sedimentation of Detrital Sequences; Environment of Sandstone Reservoirs', Calgary, February 11 - 13, 1970.

D.C. Pugh

Core Symposium, Alberta Society of Petroleum Geologists, University of Calgary and Institute of Sedimentary and Petroleum Geology, Calgary, September 4 - 5, 1969.

Special Talks

G.R. Davies

(N.R.C. Postdoctorate Fellow at I.S.P.G.) "Modern Carbonate Sedimentation. Shark Bay, Western Australia"; McConnell Club, I.S.P.G., Calgary, December, 1969.

R.W. Macqueen

"Recent and Ancient Carbonate Sedimentation"; University of Waterloo, Ontario, and University of Alberta, Edmonton.

Membership on Committees

R.W. Macqueen

National Advisory Committee on Research in the Geological Sciences; member of subcommittee on Stratigraphy, Paleontology and Sedimentology, 1970.

Member of Research and Thesis Award Committee, Alberta Society of Petroleum Geologists.

Vice-Chairman, Geological Society of America, Rocky Mountain Section Meeting, Calgary, 1971.

Chairman, General session of Stratigraphy, International Geological Congress, Montreal, 1972.

Field Trip Co-Leader (with E.W. Bamber and B.L. Mamet), Lower Carboniferous Field Trip, southern Rocky Mountains, International Geological Congress, 1972.

H.L. Martin

Business Manager, Calgary Core Conference; Alberta Society of Petroleum Geologists, Calgary, September 4 - 5, 1969.

Outside Publications

R.W. Macqueen

"Upper Devonian and Lower Mississippian Sedimentary Record, Western Canada Shelf"; (Abstract) Am. Assoc. Petrol. Geol. Bull., vol. 53, No. 3, p. 730, 1969.

R.W. Macqueen and C.A. Sandberg[1]

"Stratigraphy, Age, and Interregional Correlation of the Exshaw Formation, Alberta Rocky Mountains"; Bull. Can. Petrol. Geol., vol. 18, No. 1, pp. 32-66, 1970.

[1] U.S. Geological Survey, Denver Federal Centre, Denver, Colorado 80225, U.S.A.

R.W. Macqueen and E.D. Ghent[2]

"Electron Microprobe Study of Magnesium Distribution in some Mississippian Echinoderm Limestones from Western Canada"; Can. J. Earth Sciences (in press).

[2]Department of Geology, University of Calgary.

A.W. Norris

"Paleobiogeography of the Devonian Period in the Western Hemisphere; "Treatise on Invertebrate Paleontology, Introd. vol., Part A, (in press).

A.A. Petryk[3], B.L. Mamet[4] and R.W. Macqueen

"Preliminary Foraminiferal Zonation, Rundle Group and uppermost Banff Formation (Lower Carboniferous), Southwestern Alberta"; Bull. Can. Petrol. Geol., vol. 18, No. 1, pp. 84-103, 1970.

[3]Gulf Oil Canada Ltd., Calgary, Alberta.

[4]Department de Géologie, Université de Montreal, Montreal, Quebec.

MESOZOIC STRATIGRAPHY SECTION

D.F. Stott

Activities

Members of the section are participating in a major program, Operation Smoky, in northeastern British Columbia. D.W. Gibson is studying Triassic rocks which produce a major portion of the gas in that region. D.F. Stott, in addition to revising the mapping of Cretaceous rocks which contain important coal deposits and reservoirs of oil and gas, is investigating the Jurassic and lowermost Cretaceous succession. F.G. Young, who recently completed studies in an adjacent area, has provided information and advice about the Precambrian and Cambrian succession.

C.J. Yorath and F.G. Young are involved in a long-term multi-disciplinary investigation of the Mackenzie Delta and Beaufort Sea. This program, involving surface, subsurface, and offshore studies will provide basic geologic data for the interpretation of the sedimentary column, the development and structure of one of the world's major deltas and neighbouring basins, and ultimately will result in an evaluation of the natural resources of the region. As part of Operation Norman, a closely related project, Yorath completed field investigations of Cretaceous rocks in the eastern Arctic Coastal Plain and in the Mackenzie basin.

A large amount of scientific data on Mesozoic and Paleozoic stratigraphy has been accumulated by L.L. Price from 8 potash shafts in Saskatchewan. The studies have provided not only detailed descriptions of the rock succession but large and important fossil collections for other scientists.

An extensive program is being developed by A.E. Foscolos in the field of clay mineralogy and several collaborative projects have been initiated with other scientists within the Institute. This research is supported by two technicians in the clay mineralogy and clay chemistry laboratories. Forty-one research reports, covering the analyses of over 900 rock samples were submitted to GSC staff. Qualitative and semiquantitative mineral identifications of clays and clay-size minerals of 800 specimens were provided by analyses of 1,500 X-ray diffractograms; total mineral, organic, and sulphur content of 400 samples, by 1,000 analyses, and major elements of 100 samples by 1,000 chemical analyses.

Active Projects

610014 - Cretaceous stratigraphy, Peace River to 60°; D.F. Stott.
620023 - Triassic stratigraphy and petrology between Smoky River and Crowsnest Pass; D.W. Gibson.
620317 - Cretaceous subsurface studies in northeastern B.C.; D.F. Stott.
640419 - Studies of Cretaceous stratigraphy of the Plains of Saskatchewan, Manitoba, and eastern Alberta; L.L. Price.
640420 - Geological observations at shafts of potash mines, Saskatchewan; L.L. Price.
670014 - Operation Winisk; L.L. Price.
670068 - Operation Norman; C.J. Yorath.
670059 - Stratigraphy of Gog and Cariboo Groups near the Rocky Mountain Trench, McBride, B.C.; F.G. Young.
670086 - Schedule of Wells - Northwest Territories and Yukon Territory; C.J. Yorath.
670091 - Clay Mineralogy of Lower Cretaceous shales of northeastern British Columbia; A.E. Foscolos, D.F. Stott.
670562 - Studies of evaporate-carbonate-clastic suite, Souris River Formation, Saskatchewan; L.L. Price.
680084 - Operation Smoky; D.F. Stott, D.W. Gibson.
680090 - Identification of unknown minerals by X-ray and chemical techniques; A.E. Foscolos.
680091 - Clay Mineral investigation; A.E. Foscolos.
690004 - Triassic subsurface studies in northeastern British Columbia; D.W. Gibson.
690020 - Mesozoic-Tertiary stratigraphy and sedimentation - Beaufort-Mackenzie area; C.J. Yorath.

Personnel Notes

F.G. Young joined the section on October 20 and successfully defended his Ph.D. dissertation at McGill University in December. The field work for his thesis concerning sedimentary cycles in Lower Cambrian rocks was done in east-central British Columbia in conjunction with R.B. Campbell of the Cordilleran Section.

One of the candidates who accepted a position in March, 1969, as Mesozoic stratigrapher later rejected the offer and the position was frozen subsequently.

D.F. Stott was Acting Director of the Institute from September 3 to September 26.

Attendance at Meetings

A.E. Foscolos

International Clay Conference and field trips, Tokyo, Japan, September 1 - 19, 1969.

D.W. Gibson

Geological Association of Canada Convention, Montreal, Quebec, June 5 - 7.

A.S.P.G. Continuing Education Series: Stratigraphic petroleum exploration of Detrital Sequences; Environments of Sandstone Reservoirs; Calgary, February 11 - 13, 1970.

L.L. Price

A.A.P.G.-S.E.P.M. Convention, Dallas, Texas, April 12 - 16, 1969.

National Conference on Earth Science: Diagenesis and geochemistry of carbonate rocks, Banff, Alberta May 4 - 9, 1969.

Core Seminar, A.S.P.G., Calgary, September 4, 5, 1969.

A.S.P.G. Continuing Education Series: Stratigraphic petroleum exploration of Detrital Sequences; Environments of Sandstone Reservoirs; Calgary, February 11 - 13, 1970.

D.F. Stott

Visited Department of Mines and Petroleum Resources in Victoria, Departments of Geology at U.B.C. and offices of GSC in Vancouver, April 14 - 22, 1969, and also the Department of Geology, University of Saskatchewan.

Guide, Edmonton Geological Society Field Conference, Alaska Highway, June 27, 28, 1969.

Course in Planning, Programming and Budgeting at Ottawa headquarters, January 19 - 23, 1970.

A.S.P.G. Continuing Education Series: Stratigraphic petroleum exploration of Detrital Sequences; Environments of Sandstone Reservoirs, Calgary, February 11 - 13, 1970.

Course in French, Department of Extension, University of Calgary, February 4 to April 15, 1970.

C.J. Yorath

A.A.P.G. - S.E.P.M. Annual Meeting, Dallas, Texas, April 12 - 16, 1969.

Visited Esso Production Research Laboratories at Houston and Louisiana State University, Baton Rouge, May, 1969.

North Slope Seminar, Palo Alto, California, February, 1970.

Society of Exploration Geophysicists Annual Convention, Calgary, September, 1969.

Attended planning meetings for Beaumac program at Ottawa in December, 1969, and at Halifax in February, 1970.

F.G. Young

A.S.P.G. Continuing Education Series: Stratigraphic petroleum exploration of Detrital Sequences; Environments of Sandstone Reservoirs: Calgary, February 11 - 13, 1970.

Membership on Committees

D.W. Gibson

Member, A.S.P.G. Committee on Link Awards.

L.L. Price

Member, Earth Science Advisory Committee, A.S.P.G., and University of Alberta National Conference on Earth Science.

Member, A.S.P.G. Committee, expediting group subscriptions to NRC Canadian Journal of Earth Sciences.

D.F. Stott

Member, Canadian National Committee, World Petroleum Congresses.

C.J. Yorath

Member, A.S.P.G. Medal of Merit Committee, 1968-1969.

Special Talks

F.G. Young

"Sedimentary Cycles and Facies in the Correlation and Interpretation of Lower Cambrian Rocks, East-Central B.C.", presented to local members of Geol. Assoc. Can., Vancouver, January 14, 1970 and to the McConnell Club, I.S.P.G., Calgary, January 16, 1970.

Outside Publications

A.E. Foscolos

"Implications of aging and standard techniques of extraction in the study of ion-exchange constants involving H^+ montmorillonites"; Proc. Soil Sci. Soc. Amer., vol. 33, No. 2, pp. 242-247 (1969).

D.F. Stott

"The Southern Interior Plains: Geological Provinces of Canada/ Exploration and Outlook"; Solid Earth Science Study, Science Council; Bull. Can. Min. Met., vol. 63, pp. 191-194 (1970).

WESTERN PALEONTOLOGY SECTION

B.S. Norford

Activities

The Section is responsible for research in paleontology and biostratigraphy in western and northern Canada. The research program is closely co-ordinated with those of all other Sections of the Institute, with those of the Eastern Paleontology Section and the Cordillera and Pacific Margin Section of the Crustal Geology Division and with those of many universities and oil companies in Canada, the United States and the United Kingdom.

The Section, which, during the year, was reduced from eleven to ten members, is supported by three technicians with paleontological laboratories and extensive fossil collections. Four members of this Section are stationed in Ottawa and are supervised by E.T. Tozer.

Field studies in 1969 were carried out by members of the Section in the Arctic Islands, Mackenzie Delta, northern Yukon, Mackenzie Mountains, northeastern British Columbia, Vancouver Island and southern British Columbia. A program of sampling and study of fossils in cores from wells drilled in the Northwest Territories and Yukon was continued.

Active Projects

480191 - Monograph of the Canadian Buchia (=Aucella); J.A. Jeletzky.
490001 - Mesozoic and Tertiary on the west coast of Vancouver Island and in Quatsino Sound; J.A. Jeletzky.
500029 - Identification and biostratigraphic interpretation of referred fossils; all members.
500108 - Conodont biostratigraphy of the Hull Member, Ottawa Formation; T.T. Uyeno.
600011 - Faunal zonation of Triassic rocks of northeastern British Columbia; E.T. Tozer.
600213 - Mid to Late Cretaceous (Hauterivian to Maestrichtian) index fossils of western Cordillera; J.A. Jeletzky.
600218 - Faunal study of Late Ordovician and Silurian rocks of southeast British Columbia and adjacent Alberta; B.S. Norford.
600353 - Dibranchiate volume of the Treatise on Invertebrate Paleontology: J.A. Jeletzky.
610019 - Ordovician and Silurian biostratigraphy of British Columbia, Alberta, Yukon, Mackenzie and Franklin; B.S. Norford.
620318 - Middle Ordovician stratigraphic and faunal study, southern Alberta and southeast British Columbia; B.S. Norford.
630341 - Paleontology and stratigraphy of the Carboniferous and Permian of northern Yukon; E.W. Bamber.

630415 - Lower Cretaceous (Albian) stratigraphy of Peel and Snake Rivers, Yukon Territory; T.P. Chamney.
640024 - Conodont biostratigraphy of the Waterways Formation, northeastern and central Alberta; T.T. Uyeno.
650024 - Cambrian biostratigraphy of the eastern Cordillera; W.H. Fritz.
660503 - Microplankton from the Upper Cretaceous of Saskatchewan and Manitoba; R.L. Cox.
660546 - Lower and Middle Triassic fauna of Nordaustlandet (Spitsbergen); E.T. Tozer.
660552 - Monograph of brachiopod family Trimerellidae; B.S. Norford.
670021 - Conodont biostratigraphy of Middle and Upper Devonian strata of southern and central Manitoba; T.T. Uyeno.
670064 - Cretaceous and uppermost Jurassic biostratigraphy of western Cordillera; J.A. Jeletzky.
670576 - Canadian Triassic Ammonoidea and Bivalvia; E.T. Tozer.
680068 - Mesozoic palynology and biostratigraphy, western and northern Canada; W.S. Hopkins.
680093 - Devonian biostratigraphy, western and northern Canada; A.E.H. Pedder.
680101 - Conodont biostratigraphy of Paleozoic rocks of the Arctic Islands; T.T. Uyeno.
680116 - History of marine Cretaceous biotic provinces of western and Arctic Canada; J.A. Jeletzky.

Members of the Section participate in many team projects led by other scientists of the Geological Survey of Canada. Operations Porcupine (610007), Liard (630017), Winisk (670014), Norman (670068), and Smoky (680084) are the largest of these.

Reports

The Section produced a total of 95 reports identifying and dating 1,305 lots of fossils as follows:

Bamber	3 reports on	7 lots
Chamney	4 reports on	49 lots
Cox	3 reports on	12 lots
Fritz	20 reports on	137 lots
Hopkins	8 reports on	40 lots
Jeletzky	17 reports on	190 lots
Norford	10 reports on	471 lots
Pedder	8 reports on	188 lots

Macropaleontology Laboratory and Curating Facilities

S. Carbone

Services provided by the laboratory include thin-sectioning, casting, acid etching, polishing, mechanical extraction, and other preparatory techniques for the study and identification of fossil specimens. The laboratory is responsible, also, for the curation of all invertebrate fossil material collected by Institute personnel in northern and western Canada and of fossils collected from subsurface samples.

Production

Oriented fossil thin sections (corals, foraminifers, fusilinids)...	580
Larger oriented coral sections (5" x 6" average size).....	65
Plastic embedded ostracod sections	90
Thin sections of lithological samples	250
Plaster replicas of fossils	65
Acid etchings.....	40
Polished samples	12
New collections curated	2,500
Parcels shipped and received	250

The Macropaleontology technician spent one week doing field work in southeastern B.C. and another week visiting a thin section laboratory at the California Institute of Technology.

The laboratory also provided assistance to the Arctic Islands Section and to the Inland Waters Branch.

Micropaleontology Laboratory

G.D. Karg

During the year 468 lots of core and 163 lots of outcrop rocks were sampled by the laboratory. A total of 1,326 samples were curated and disintegrated and 1,648 samples were picked for microfossils by outside contract. Photomicrography, distribution chart plotting, and drafting services were performed as scientific support. Curating, cataloguing, equipment maintenance and purchasing were also part of the activities of the laboratory. Also a student assistant and a technician from Canadian Pacific Oil and Gas Company were instructed in laboratory procedures and preparatory techniques.

The Micropaleontology Technician spent a week at the United States Geological Survey, Menlo Park, and the Chevron Standard Oilfield Laboratory in Los Angeles investigating methods of photomicrography and taking instruction in the operation of the scanning electron microscope.

Palynology Laboratory

S.L. Walker

The laboratory received and processed 185 samples collected by geologists of the Geological Survey of Canada and industry from the Arctic Islands, District of Mackenzie, Eastern and Western Canada, and the Atlantic continental shelf. A photomicrography service was set up as scientific support for R.L. Cox and W.S. Hopkins, Jr. During February two weeks were spent producing chemical safety booklets for all laboratories of the Institute.

Personnel Notes

A.W. Norris left the Section in August on his appointment as Head of the Paleozoic Stratigraphy Section. Miss Sandra Wallace resigned in August to join the staff of Brock University and Miss Sharon Walker joined the Section in November from the research laboratories of Imperial Oil Limited.

Two members of the Section were honoured with medals during the year. J.A. Jeletzky received the 1969 Willet G. Miller Gold Medal from the Royal Society of Canada for fundamental research in geological sciences. E.T. Tozer and R. Thorsteinsson were the joint recipients of the 1969 Founder's Medal of the Royal Geographical Society.

Attendance at Meetings

B.S. Norford

North American Paleontological Convention, Chicago, Illinois.

Systematic Association's symposium on data processing in biology and geology at Cambridge and the field meeting of the Ludlow Research Group, Melrose, Scotland.

Departmental Classification Seminar.

R.L. Cox

North American Paleontological Convention, Chicago, Illinois.

T.P. Chamney

North American Paleontological Convention, Chicago, Illinois.

W.H. Fritz

North American Paleontological Convention, Chicago, Illinois.

J.A. Jeletzky

North American Paleontological Convention, Chicago, Illinois.

T.T. Uyeno

North American Paleontological Convention, Chicago, Illinois.

Geological Society of America, North-central region, Columbus, Ohio.

W.S. Hopkins

North American Paleontological Convention, Chicago, Illinois.

Institute of Petroleum and the American Association of Petroleum Geologists, Brighton, England.

Consultations and study of comparative material

E.W. Bamber - University of Toronto and University of Montreal
W.S.Hopkins - University of Toronto
W.H. Fritz - Laval University and the United States National Museum
T.T. Uyeno - University of Iowa
T.P. Chamney - United States National Museum
B.S. Norford - British Museum (Natural History)

Special Talks

T.P. Chamney

"Cypress Hills region, Alberta"; Alberta Government Parks Board.

"Geology and Paleontology of the Upper Cretaceous of the Red Deer River Badlands"; Palliser Club, Department of Geology, University of Calgary.

W.H. Fritz

"Geological setting of the Burgess Shale"; North American Paleontological Convention, Chicago.

J.A. Jeletzky

"Marine Cretaceous biotic provinces and paleogeography of Western and Arctic Canada, illustrated by a detailed study of ammonites"; North American Paleontological Convention, Chicago, the A.S.P.G. Paleontology Group, and the Department of Geology of the University of British Columbia.

B.S. Norford

"Silurian geology of western Canada"; Ludlow Research Group.

Membership on Committees

T.P. Chamney

Vice-Chairman, Field Program for American Association of Petroleum Geologists, Annual Meeting, 1970.

Judge, annual exhibition of the Calgary Rock and Lapidary Society.

W.S. Hopkins

Member, thesis committee of the Department of Geology, University of Calgary.

E.T. Tozer

Member, Program Committee for the 1970 International Conference on the Permian and Triassic Systems.

Outside Publications

W.S. Hopkins, Jr.

Palynology of the Eocene Kitsilano Formation, southwest British Columbia; Can. J. Bot., vol. 47, pp. 1,101-1,131, 1969.

J.S. Jell and A.E.H. Pedder

Martinophyllum, a new genus of Devonian rugose corals; J. Paleontol., vol. 43, pp. 735-740, 1969.

L.H.B. King, G.A. MacLean, G.A. Bartlett and J.A. Jeletzky

Cretaceous strata on the Scotian Shelf; Can. J. Earth Sci., vol. 7, pp. 145-155, 1970.

A.E.H. Pedder, J.H. Jackson and G.M. Phillip

Lower Devonian biostratigraphy in the Wee Jasper region of New South Wales; J. Paleontol., vol. 44, pp. 206-251, 1970.

A.E.H. Pedder, J.H. Jackson and D. Ellenor

An interim account of the Middle Devonian Timor Limestone of northeastern New South Wales; Linnean Soc., New South Wales, Proc. (in press).

E.T. Tozer

Xenediscacean ammonoids and their bearing on the discrimination of the Permian - Triassic boundary; Geol. Mag., vol. 106, pp. 348-361, 1969.

T.P. Chamney

Geological road logs and stratigraphic sections east of Calgary; Am. Assoc. Petrol. Geol., 1970 Annual Meeting, Guidebook of field trips (in press).

R.L. Cox

Dinoflagellate cyst structures: walls, cavities and bodies; Paleontology (in press).

W.H. Fritz

Geological setting of the Burgess Shale; North Am. Paleontological Convention, Proc., (in press).

contribution in Oriel, S.S. and Armstrong, F.C.; Uppermost Precambrian and lowermost Cambrian rocks in southeastern Utah; U.S. Geol. Surv., Prof. Paper 394.

J.A. Jeletzky

Marine Cretaceous biotic provinces of Western and Arctic Canada; North Am. Paleontological Convention, Proc., (in press).

Gilbert Klapper, T.T. Uyeno and others

North American Devonian conodont biostratigraphy; Geol. Soc. Am., Mem. 127 (part), (in press).

B.S. Norford

Silurian stratigraphic sections at Cape Tyson, Offley Island and Cape Schuchert, northwest Greenland; Medd. om Grønland (in press).

PETROLEUM GEOLOGY SECTION

R.G. McCrossan

Activities

The joint project with Geoservices of Paris - a test of a surface prospecting method for petroleum using traces of hydrocarbons in soils - is nearly complete. McCrossan visited France in conjunction with this project and obtained a complete review of the technique used by Geoservices and, also, inspected their facilities. The computer file on oil and gas data in Western Canada has been completed and it is hoped that programs for utilizing this information will be ready by the end of the year. A by-product of this file is a new oil and gas map showing individual pools with stratigraphic zones in colour. "Future possible petroleum provinces of Canada", a companion study to one being done in the United States, was commenced. It is anticipated that this volume on the oil potential of the sedimentary basins of Canada will be of value in planning continental oil policy. The contributors are from both government and industry.

N. L. Ball was responsible for compiling a new file on oil and gas pools of Western Canada and for the preparation of a new oil and gas map. He was in charge of the sample collecting for the geochemical prospecting project.

Active Projects

680018 - The environment of oil and gas in Western Canada; R.G. McCrossan, N.L. Ball, and L. Snowdon.

680133 - Correlation of coal ranks and hydrocarbon properties in Mesozoic rocks of Western Canada; R.G. McCrossan, N.L. Ball, P.A. Hacquebard and J.R. Donaldson.

690134 - Regional distribution of gaseous hydrocarbons in the Arctic Archipelago; R.G. McCrossan and L. Snowdon.

690029 - Surface geochemical prospecting for petroleum, central Alberta; R.G. McCrossan, N.L. Ball and L. Snowdon.

Personnel Notes

Mr. L. Snowdon, a chemist, joined the staff during the year and is in charge of a new organic geochemistry laboratory.

Attendance at Meetings

R.G. McCrossan

American Association of Petroleum Geologists, Annual Meeting, Dallas, Texas, April 1969.

Association of Professional Engineers of Alberta, Meeting, Banff, Alberta, May 1969.

Attendance at Courses

N.L. Ball

Completed 3, part-time credit courses at the University of Calgary.

Schlumberger Well Log Interpretation course.

"Prospect Analysis and Evaluation of Undrilled Acreage"; Alberta Society of Petroleum Geologists, continuing education course.

"Stratigraphic Petroleum Exploration of Detrital Sequences"; Alberta Society of Petroleum Geologists, Seminar course.

Computer technique for classifying geological data; Canadian Stratigraphic Services Ltd.

Membership on Committees

R.G. McCrossan

Member, Council and Discipline Committee, Association Professional Engineers of Alberta.

Program Chairman for S.E.P.M. Meeting, Calgary, 1970.

Member, Program Committee, International Exploration Geochemistry Symposium, C.I.M., Toronto.

Chairman, District Representative Committee, American Association Petroleum Geologists, Calgary.

Member, Geological Advisory Committee, Research Council of Alberta.

Editor and Co-ordinator of "Future Petroleum Provinces of Canada" volume.

Member, Program Committee, I.G.C. Montreal 1972.

DIVISION OF QUATERNARY RESEARCH AND GEOMORPHOLOGY

J.G. Fyles, Chief

Prepared by B.G. Craig

INTRODUCTION

Scientists in this Division, with backgrounds in several different fields of specialization in aspects of Quaternary research, undertake programs directed towards providing geologic and geomorphic information on the terrain throughout Canada, to assist in the planning, management and conservation of mineral, land and water resources, and of the natural environment. Most of the scientific capacity of the Division is directed towards a Canada-wide terrain inventory involving systematic investigation, description and explanation of unconsolidated deposits and landform features. The scale of these investigations ranges from broad reconnaissance in the north to detailed projects in the heavily populated parts of southern Canada. In addition to areal projects, the inventory program includes investigations into stratigraphy, geochronology and Quaternary paleontology. In order to improve and facilitate the inventory and to make it more useful, developmental research projects of various categories are being carried out. These include prototype investigations in environmental and engineering geology, terrain performance studies documenting geological properties, stability relationships and dynamic processes controlling the behaviour and engineering characteristics of surface and near surface materials, and development of mineral exploration techniques using the unconsolidated drift as a prospecting medium.

Scientific activities are carried out throughout Canada by the three scientific sections as well as officers assigned to divisional headquarters. At the end of the year the staff included 32 research scientists, geographers and scientific officers, 4 term physical scientists, 10 technicians, and 4 administrative support personnel. In addition, about 50 students and 5 professors of geology and geography were associated with the Division, largely during the field season. Twenty-five members of the scientific staff were involved in field projects to which were added projects of the 5 professors, 4 graduate students on Ph.D. programs, and for a few months 1 Postdoctorate Fellow.

During the year the Division was reorganized and at the end of the period covered by this report comprised the following: (1) Divisional Headquarters including Administration, Scientific Services Unit, and Special Projects Unit; (2) Regional and Stratigraphic Projects Section; (3) Engineering Geology and Geodynamics Section; and (4) Paleontology and Geochronology Section.

Although most of the staff of the Division is located in Ottawa, for most of the year six officers were located in the Institute of Sedimentary and Petroleum Geology in Calgary and one officer was based at the Canada Centre for Inland Waters in Burlington.

During the year the program of the Division has received close support and cooperation from various units of the Branch and from the Great Lakes Division of Inland Waters Branch at Burlington and the Polar Continental Shelf Project. Particularly, seismic surveys have been carried out by the Exploration Geophysics Division in direct support of Quaternary projects; in-field logistic support was provided by "Operation Norman and Operation Smoky" of I.S.P.G.; and analysis of samples was carried out in various laboratories, chiefly of the Economic Geology and Geochemistry Division.

Activities

The Pleistocene Discussion Group was chaired by N.R. Gadd prior to, and by D.A. Hodgson following the field season. In addition to talks by various officers of the Division on their scientific projects the following papers by "outside" speakers were given.

Dr. H.C. Fritts, University of Arizona, Laboratory of Tree Ring Research - Recent development in dendroclimatology.

Dr. Maxwell Gage, Department of Geology, University of Canterbury, New Zealand - Aspects of Quaternary studies in New Zealand.

Dr. G.W. Smith, Ohio University - Glacial, interglacial(?), interstadial(?) deposits and stratigraphy of the Mabel Lake region, B.C., and some aspects of postglacial paleoecology and lake and bog deposit stratigraphy.

Dr. Alfred Jahn, University of Wroclaw - Some problems of loess.

Dr. Nils-Axel Mörner, Kvartärgeol. Institute, Stockholm - Late Quaternary sea level changes in the Kattegat Sea area - isostasy vs. eustasy.

The "INQUA volume", a collection of G.S.C. papers by scientists of the Division dealing with various aspects of Quaternary research projects, was compiled by Mrs. M. Larnder to honour the occasion of the VIIIth Congress of the International Association for Quaternary Research in Paris, and was ready for distribution just prior to the end of the year.

REPORTS ON SECTIONS

DIVISIONAL HEADQUARTERS

Administrative staff of the Division include Division Chief, Secretary, Assistant Division Chief, Administrative Officer, stenographer, and 1 draftsman. The Scientific Services Unit provides editorial, mathematical, photogrammetric and related services. The Special Projects Unit comprises 2 research scientists engaged in projects that relate to the program of the Regional and Stratigraphic Projects Section. Details concerning projects being undertaken by scientists assigned to Divisional Headquarters are listed with those of the appropriate Section.

Personnel Notes

Mrs. J.T. Buckley: transferred to the Forest Management Institute of the Department of Fisheries and Forestry to take a position as Scientific Editor.

Attendance at Meetings, Talks

Mrs. J.T. Buckley: attended the Symposium on Glacier Hydrology at Cambridge, England in September.

B.G. Craig: attended the Eastern Friends of the Pleistocene Field Conference at Sherbrooke, Quebec in May, the Lac St-Jean field trip of the Geological Association of Canada in June, and the Symposium on Late Cenozoic Glacial Ages at Yale University in December.

J.G. Fyles: attended the Midwest Friends of the Pleistocene Field Conference at Swift Current-Medicine Hat, the Symposium on Pedology and Quaternary Research at Edmonton, which was sponsored by the Associate Committee on Quaternary Research, the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May, the INQUA Congress at Paris in August, the Symposium on Glacier Hydrology at Cambridge in September, the annual meeting of the Geological Society of America at Atlantic City in November, and the Soil Mechanics Conference at Kingston in December.

Miss G.V. Minning: attended the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May.

V.K. Prest: attended the 12th Conference on Great Lakes Research at Ann Arbor, the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May, the annual meeting of the Royal Society of Canada at Ottawa and the annual meeting and Lac St-Jean field trip of the Geological Association of Canada in June, the annual meeting of

the Canadian Association of Geographers at St. John's, at which he presented a paper "Retreat of the last ice-sheet from the Atlantic Provinces region" and chaired two sessions and the INQUA Congress at Paris in August, the Soil Mechanics Conference at Kingston and the Symposium on Late Cenozoic Glacial Ages at Yale University in December, and a meeting "Geology in the Service of Man" at Brock University in March. He gave a talk "The History of the Great Lakes" at the Department of Geography, University of Ottawa in March.

Membership on Committees

B.G. Craig - Subcommittee for Pleistocene Shorelines of the Americas, International Shoreline Commission, INQUA.

J.G. Fyles
- Chairman, Associate Committee on Quaternary Research
- National Committee on Forest Land
- Subcommittee on Permafrost, Associate Committee on Geotechnics, National Research Council
- Departmental Committee on Recent Crustal Movements and Seismic Regionalization
- Subcommittee of Quaternary Geology, National Advisory Committee on Geological Research
- Associate Committee on Geotechnics, National Research Council
- Editorial board of journal, "Quaternary Research"
- Member of the National Organizing Committee, and Co-Convenor of Section XII, International Geological Congress.

Outside Papers

Bik, M.J.J.
1969: The origin of the prairie mounds of Alberta Canada; Biul. Peryglacijalny, No. 19, pp. 85-130.

Ives, J.D., and Buckley, J.T.
1969: Glacial geomorphology of Remote Peninsula, Baffin Island, N.W.T., Canada; Arctic and Alpine Res., vol. 1, No. 2, pp. 83-95.

King, C.A.M., and Buckley, J.T.
1969: Geomorphological investigations in west-central Baffin Island, N.W.T., Canada; Arctic and Alpine Res., vol. 1, No. 2, pp. 105-119.

Active Projects

G.V. Minning	690056	Bibliography of Quaternary publications.
K. Shimizu	680132	Application of mathematics to Quaternary research and geomorphology.

REGIONAL AND STRATIGRAPHIC STUDIES

The scientific program of this section is largely directed toward a Canada-wide inventory aimed at mapping and explaining the unconsolidated deposits and landforms and establishing their stratigraphic sequence and environmental history. Areal mapping projects are undertaken at various scales, chosen both on the present state of knowledge and the potential use to the mineral industry, including petroleum, forestry, agriculture, and engineering construction. Hence, in the Arctic Islands wide ranging airborne operations are mapping at the scale of 16 to 8 miles to the inch. In the Mackenzie Valley-Mackenzie Delta area and in southern Labrador current mapping projects are categorized as "northern 4 mile" and indicate the distribution of surface materials and landforms. In the more settled and accessible parts of southern Canada more detailed "southern 4 to 1 mile" mapping projects are undertaken. In response to the need for even more detailed information in areas of urban expansion the Section has embarked on a program of one mile or larger mapping in selected areas. Investigations of this type are in the "prototype" stage.

Field work was undertaken during the year in 7 provinces and the Northwest Territories by 14 scientists of the Section, two scientists of the Special Projects Unit, two professors, three Ph.D. students and as part of the program of scientists of other Sections within the Division.

Personnel Notes

D.M. Barnett: completed his field work for his Ph.D. dissertation and returned to the University of Western Ontario on educational leave.

R.J. Fulton: was transferred from Calgary to Ottawa.

V.N. Rampton: obtained his Ph.D. from University of Minnesota and joined the continuing staff of the Division.

D.A. St-Onge: continued on leave at the University of Ottawa where he is a titular professor in the Department of Geography. During the winter he attended a Grid Management Seminar in Cornwall.

Attendance at Meetings, Talks

R.J. Fulton: attended the Eastern Friends of the Pleistocene Field Conference at Sherbrooke and a meeting of the National Committee of Forest Land at Quebec in May, presented a paper (see "Outside Publications") at the INQUA Congress at Paris in August, and attended the Symposium on the problems of Classification of Soils and Sedimentary Rocks at the University of Guelph in March.

N.R. Gadd: with B.C. McDonald organized and led the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May, and gave a talk "Regional Quaternary geology of the St. Lawrence-Ottawa Lowlands" at the Department of Geography, University of Ottawa in March.

D.R. Grant: attended the annual meeting of the Canadian Association of Geographers at St. John's in August, and presented a paper "Recent submergence, Maritime Provinces" and a meeting "Geology in the Service of Man" at Brock University in March.

E.P. Henderson: attended the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May.

D.A. Hodgson: attended the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May.

O.L. Hughes: attended the INQUA Congress at Paris in August, the Pacific Coast Friends of the Pleistocene Field Conference at the Cascade Range, Washington in September and a seminar on the North Slope of Alaska at Pao Alto, California in February.

R.W. Klassen: attended the Midwest Friends of the Pleistocene Field Conference at Swift Current-Medicine Hat, the Symposium on Pedology and Quaternary Research at Edmonton in May, and presented a paper (see "Outside Publications") at the INQUA Congress at Paris in August.

C.F.M. Lewis: attended the Twelfth Conference on Great Lakes Research at Ann Arbor, at which he gave a talk "Late Quaternary history of lake levels in the Huron and Erie Basins" and a meeting of the Michigan Basin Geological Society at Sudbury in May, and the annual meeting of the Geological Society of America at Atlantic City in November. He also participated in a course "Models of Geologic Processes - An Introduction to Mathematical Geology" sponsored by the American Geological Institute at Philadelphia in November.

N.W. Rutter: attended the Midwest Friends of the Pleistocene Field Conference at Swift Current-Medicine Hat and the Symposium on Pedology and Quaternary Research at Edmonton in May, presented a paper jointly authored with J.E. Wyder (see "Outside Publications") at the INQUA Congress at Paris in August, attended the Pacific Coast Friends of the Pleistocene Field Conference at the Cascade Range, Washington in September, and gave a talk on the glaciation of the Canadian Rocky Mountains at the University of Washington in January.

D.A. St-Onge: attended the Midwest Friends of the Pleistocene field conference at Swift Current-Medicine Hat in May, and the INQUA Congress at Paris in August, although not an official G.S.C. delegate, and presented a paper there (see "Outside Publications").

A.M. Stalker: was a co-leader of the Midwest Friends of the Pleistocene Field Conference at Swift Current-Medicine Hat in May, presented a paper (see "Outside Publications") at the INQUA Congress at Paris in August, and attended a meeting "Geology in the Service of Man" at Brock University in March.

Membership on Committees

D.A. St-Onge
- President, L'Association des Géographes de l'Amérique Française
- Corresp. member, Commission on Periglacial Studies, I.G.U.
- Corresp. member, Subcommission on Geomorphological Mapping, I.G.U.
- Member, Committee on Geomorphology, Pan American Institute of Geography and History
- Geological Sciences representative of the Ottawa Geotechnical Group.

Outside Papers

Achard, R.A.
1969: Glacial history, Selkirk and Monashee Mountains, B.C.; Can. Geophys. Bull., vol. 22, pp. 237-238.

Fulton, R.J., and Pullen, M.J.L.T.
1969: Sedimentation in Upper Arrow Lake, British Columbia; Can. J. Earth Sci., vol. 6, No. 4, Pt. 1, pp. 785-791.

Fulton R.J.
1969: Histoire des lacs glaciaires du Plateau interieur dans le sud de la Colombie Brittanique; VIIIe Congres INQUA, Paris, Résumés des Communications, Paris, Sect. 1, p. 18 (abstr.).

Grant, D.R.
1969: Surficial deposits, geomorphic features, and late Quaternary history of the terminus of the Northern Peninsula of Newfoundland and adjacent Quebec-Labrador; Maritime Sediments, vol. 5, No. 3, pp. 123-125.

1969: Late Pleistocene readvance of piedmont glaciers in western Newfoundland; Maritime Sediments, vol. 5, No. 3, pp. 126-128.

Heginbottom, J.A., and Parker, M.L.
1969: Tchaikagan and Friendly Glaciers, British Columbia; Can. Geophys. Bull., vol. 22, p. 237.

Klassen, R.W.
1969: Quaternary stratigraphy and radiocarbon chronology in southwestern Manitoba; VIIIe Congres INQUA, Paris, Résumés des Communications, Sect. 6, p. 213 (abstr.).

Rutter, N.W.
1969: Comparison of moraines formed by surging and normal glaciers; Can. J. Earth Sci., vol. 6, No. 4, Pt. 2, pp. 991-999.

1969: Pleistocene paleosol investigations in parts of western Canada; in Pedology and Quaternary Research, S. Pawluk (ed.), Assoc. Comm. Quat. Res., Natl. Res. Council, pp. 83-102.

1969: A late-Pleistocene glacial advance, Bow River valley, Alberta, Canada; in Quaternary Geology and Climate, H.E. Wright, Jr. (ed.), Natl. Acad. Sci., Publ. 1701, pp. 104-109.

1969: Summary of preliminary work on the Quaternary geology of the Lake Williston area, British Columbia; Edmonton Geol. Soc., Guidebook 1969, pp. 1-3.

Rutter, N.W., and Wyder, J.E.
1969: Une application feconde des techniques de sondages stratigraphiques, dans une region des materiaux de transport glaciaires; VIIIe Congres INQUA, Paris, Résumés des Communications, Sect. 6, p. 240 (abstr.).

St-Onge, D.A.
1968: Application de l'analyse de Horton à la rivière Freeman, Alberta; Cahier Geograph. Québec, vol. 12, No. 7, pp. 445-449.

1969: La stratigraphie du Quaternaire du Centre-Nord de l'Alberta, Canada; VIIIe Congres INQUA, Paris, Résumés des Communications, Sect. 6, p. 242 (abstr.).

Stalker, A.M.
1969: A probable late Pinedale terminal moraine in Castle River Valley, Alberta; Bull. Geol. Soc. Am., vol. 80, No. 10, pp. 2115-2122.

1969: Geology and age of the early man site at Taber, Alberta; Am. Antiquity, vol. 34, No. 4, pp. 425-428.

1969: Stratigraphie Quaternaire et paleoclimats des Prairies canadiennes; VIIIe Congres INQUA, Paris, Résumés des Communications, Sect. 6, p. 248 (abstr.).

Active Projects

R.A. Achard	690011	Quaternary geology, Big Bend Canoe River.
D.M. Barnett	680040	Proglacial geomorphology, Generator Lake, Baffin Island.
M.J.J. Bik	680097	Geomorphology, Cypress Hills and adjoining parts of southern Alberta.
	680098	Surficial deposits and geomorphology, Central Research Forest.
W. Blake, Jr.	620010	Quaternary reconnaissance, northeastern District of Mackenzie.
	670031	Quaternary reconnaissance, southern Ellesmere Island.
J.T. Buckley	680099	Geomorphological map, Gatineau Park.
B.G Craig	630006	Quaternary reconnaissance, northwest Baffin Island.
	670032	Quaternary geology, Hudson Bay Lowland.
	690051	Airphoto interpretation, Coppermine River - Dismal Lakes.
A. Dreimanis	680043	Quaternary geology, Port Stanley.
	690052	Wisconsin stratigraphy, north shore of Lake Erie.
R.J. Fulton	630019	Quaternary geology, Vernon map-area W½.
	650020	Quaternary geology, Columbia River project reservoirs.
	680032	Quaternary reconnaissance, northwest District of Mackenzie.
	690043	Quaternary geology inventory, southern Labrador.
J.G. Fyles	540051	Quaternary reconnaissance, central District of Keewatin.
	640004	Quaternary reconnaissance, western Arctic Islands.
	650011	Quaternary stratigraphy, Mackenzie delta - Arctic coast.

N.R. Gadd	560019	Quaternary geology, Ottawa map-area.
	620039	Quaternary geology, Chaudière River region, Quebec.
	670037	Quaternary geology, southwest New Brunswick.
	680144	32nd Annual field conference, Eastern Friends of the Pleistocene, May 1969.
D.R. Grant	660036	Recent coastal submergence, Nova Scotia and Prince Edward Island.
	690065	Quaternary geology St. Anthony - Blanc Sablon, Newfoundland.
J.E. Harrison	680067	Quaternary geology, North Bay-Mattawa.
G.M. Haselton	690082	Late Quaternary uplift, southeast Hudson Bay.
J.A. Heginbottom	680129	Quaternary geology, Taseko Lakes.
E.P. Henderson	560029	Quaternary geology, Avalon Peninsula, Newfoundland.
	600033	Post-glacial marine shorelines Trinity Bay to White Bay, Newfoundland.
	650039	Surficial geology Brockville-Westport area.
	680062	Quaternary geology, Kingston N½.
D.A. Hodgson	680044	Quaternary reconnaissance, northeastern Baffin Island.
	680045	Submarine morphology off the northeast Baffin Island coast.
O.L. Hughes	600008	Project Klondike, Quaternary geology and geomorphology phase.
	620014	Surficial geology of Operation Porcupine area.
	640016	Operation Keno, surficial geology phase.
	650013	Quaternary geology, Aishihik Lake and southwestern Yukon.
	680031	Quaternary stratigraphy of Old Crow Basin and Porcupine River Valley.
	690046	Quaternary reconnaissance northwest District of Mackenzie, stage II.

P.F. Karrow	650038	Quaternary geology, Stratford-Conestogo.
R.W. Klassen	640029	Quaternary geology, Duck Mountain, Manitoba-Saskatchewan.
	660033	Quaternary geology and geomorphology of the Assiniboine River Valley and its tributaries.
	670034	Bedrock topography and Quaternary stratigraphy, Virden, Manitoba.
	700002	Bedrock topography, southwestern Manitoba.
C.F.M. Lewis	650037	Postglacial uplift of Huron Basin.
	680055	Quaternary geology, Great Lakes.
B.C. McDonald	640041	Quaternary geology, Richmond-Sherbrooke.
	660035	Quaternary geology, Sherbrooke.
	690094	Late Quaternary events in eastern Canada.
G.V. Minning	690055	Quaternary geology, Arnprior.
V.K. Prest	530030	Geology of Prince Edward Island.
	640070	Quaternary geology of Canada.
	680004	Quaternary paleogeographic map of Canada.
	680094	Quaternary map, Stephenville.
V. Rampton	650131	Quaternary geology, Snag-Kluane Lake.
	690047	Quaternary geology, Beaufort-Mackenzie.
N.W. Rutter	660031	Quaternary geology of Peace River reservoir area.
	670061	Quaternary geology, Bow River Valley.
	690048	Soils in glaciated and unglaciated terrain.
	690049	Quaternary geology, Pine Pass-Jasper.
D.A. St-Onge	660032	Quaternary geology and geomorphology of Whitecourt area, Alberta.
	680027	Quaternary geology and geomorphology of Tawatinaw area, Alberta.
R.G. Skinner	690045	Glacial - interglacial stratigraphy, James Bay Lowland.
A.M. Stalker	520024	Surficial geology, Drumheller area.
	650027	Quaternary of southern Alberta.

ENGINEERING GEOLOGY AND GEODYNAMICS SECTION

This unit, headed by J.S. Scott, combines the functions of the former Sedimentology and Geomorphic Processes Section and the Engineering and Indicator Geology Section. Investigations undertaken comprise: evaluation of the geological factors that influence the engineering behaviour of geological materials, including "on site" studies of engineering projects; development of methods and prototype investigations in environmental geology related to areas of high population and population growth; studies of the processes of landscape change involving slope movement and erosion, and frost action (including permafrost, weathering, sediment movement and sediment accumulation); the development of mineral exploration techniques using the unconsolidated "drift" as a prospecting medium; and the development of techniques and provision of service for surface and borehole geophysical studies and borehole sampling and geophysical logging.

Field work was undertaken in 5 provinces and the Northwest Territories by 7 scientists of the Section, 1 term scientist, 1 professor and 2 Ph.D. students.

Personnel Notes

I. Banerjee: completed his term of employment at the end of September.

J.G. Bisson: came to the Section in March from the Dominion Observatories Branch to replace R.A. Hodge in the geophysical unit who resigned in January.

J.A. Heginbottom: became a member of the continuing staff in July. He had occupied a term position for the previous year.

H.A. Lee: resigned in June.

J.S. Scott: rejoined the staff of the Geological Survey in July, after a 2-year period in private industry. He became head of the Section in September.

W.W. Shilts: came to the Section as a Postdoctorate Fellow in September and became a member of the continuing staff in March.

Sedimentology Laboratories

B.C. McDonald

Sedimentology laboratories are maintained at 601 Booth Street and 45 Spencer Street in Ottawa and at the Institute of Sedimentary and Petroleum Geology in Calgary. Most routine analyses are performed at Spencer Street; the Booth Street laboratory is used for work of a special

nature and the development of new techniques. Just prior to the end of the year work started on the installation of a recirculating sedimentation flume in the N.C.C. building on Carling Avenue. The Calgary laboratory provides special services to officers of the Division housed there. Analyses and preparations performed during the past year in the Ottawa laboratories and the Calgary laboratory are summarized in the accompanying tables.

Calgary Laboratory

A. Vilonyay

"Long" A.S.T.M. hydrometer analysis	14
Short (2 hours) hydrometer analysis	161
Short hydrometer analysis with carbonate digestion	281
Sieve analysis	14
Heavy mineral separation	50
Chittick analysis (Saskatchewan Research Council method)	356
Chittick calibration analysis	15
Hydrometer calibration	25
Miscellaneous analyses for I.S.P.G. staff	40
TOTAL	956

GSC SEDIMENTOLOGY LABORATORIES: ANALYSES AND PREPARATIONS; APRIL, 1969 to APRIL, 1970

Personnel	Spencer St. Lab.								Booth St. Lab.						
	Grain-size								Heavy minerals				Dendrochronology		
	Detailed analysis (sieve and pipette)	Short analysis (sand-silt-clay)	Sieve only	Sample pretreatment	Natural water content	Carbonate analyses	Atterberg limits	Suspended sediment ashing test	Separation	Microscopic slides	Guinier mounts for X-ray	Clay mounts for X-ray	Core mounts	Block preparations	Trunk cross-section preparation
Achard, R.A.	3		3		6	6									
Banerjee, I.	48														
Barnett, D.M.	23		9			44		16							
Bik, M.J.J.	22			22		22									
Dreimanis, A.	31														
Harrison, J.	6		4												
Heginbottom, J.A.	33	13				5	13								
Karrow, P.F.	25					25									
Lengellé, J.	117					82									
McDonald, B.C.	16		2			45			8						
Mott, R.J.						2									
Parker, M.L.													280	7	1
Rampton, V.	21														
Richard, S.H.	2					2									
Shilts, W.W.	80					80			205	10	12	80			
Skinner, R.G.	20	19				39			78						
Experimentation with lab. method						200									
TOTALS	447	32	18	22	6	552	13	16	291	10	12	80	280	7	1

Attendance at Meetings, Talks

R.A. Achard: attended the annual meeting of the Geological Society of America at Atlantic City in November, the 22nd Canadian Soil Mechanics Conference at Kingston in November, and the Soil Dynamics Research Seminar, sponsored by the Associate Committee on Geotechnical Research of the National Research Council, at McGill University in March.

I. Banerjee: attended the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May.

B.C. McDonald: attended the meeting of the North-Central Section of the Geological Society of America at Columbus, Ohio and was co-leader with N.R. Gadd of the Eastern Friends of the Pleistocene Field Conference at Sherbrooke in May, and chaired a session at the Symposium on Late Cenozoic Glacial Ages at Yale University in December. He gave a talk "Some geological aspects of eskers" at the Department of Geology, Syracuse University in September and another "The geology of eskers" at the Department of Geology, University of Ottawa in November.

E.B. Owen: attended the 22nd Canadian Soil Mechanics Conference at Kingston in November and gave a talk on the geology of the Welland Canal area with special reference to the Welland Canal By-pass at a symposium on the Welland Canal sponsored by the Toronto Geotechnical Society in January.

J.S. Scott: attended the Alaska Science Conference at Fairbanks in August, presented a discussion at the 22nd Canadian Soil Mechanics Conference at Kingston in December and attended the Soil Dynamics Research Seminar, sponsored by the Associate Committee on Geotechnical Research of the National Research Council, at McGill University in March.

J.E. Wyder: attended the Midwest Friends of the Pleistocene Field Conference at Swift Current-Medicine Hat in May.

Membership on Committees

J.S. Scott - Member, Solid Earth Sciences study group
- Co-convenor, Section XIII, International Geological Congress.

Outside Papers

Agterberg, F.P., and Banerjee, I.
1969: Stochastic model for the deposition of varves in glacial Lake Barlow-Ojibway; Can. J. Earth Sci., vol. 6, No. 4, Pt. 1, pp. 625-652.

Rutter, N.W., and Wyder, J.E.
1969: Une application féconde des techniques de sondages stratigraphiques, dans une région des materiaux de transport glaciaires; VIIIe Congres INQUA, Paris, Résumés des Communications, Sect. 6, p. 240 (abstr.).

Active Projects

R.A. Achard	690012	Landslides in southern British Columbia.
I. Banerjee	670036	Research on varved clays.
M. Church	680042	Ekalugad outwash plain, Baffin Island.
P.P. David	670035	Sand dunes and sand movement.
J.T. Gray	670033	Mass wasting forms and processes in a mountain environment.
J.A. Heginbottom	690054	Erosion in a permafrost environment.
H.A. Lee	620035	Mineral indicator techniques of mineral exploration.
C.P. Lewis	680046	Geomorphology of delta lakes, Mackenzie delta.
J.R. Mackay	680047	Geomorphic processes, Mackenzie Valley - Arctic coast.
B.C. McDonald	660030	Sedimentology and morphology of eskers.
	670032	Quaternary geology, Hudson Bay Lowland.
	680017	Sedimentology laboratory development and operation.
E.B. Owen	620052	Engineering geology and mapping, Welland Canal.
	670038	Engineering geology of dam sites and other construction projects, northwestern Ontario.
J.S. Scott	700013	Sources of aggregate, Montreal airport site.
W.W. Shilts	690095	Properties and provenance of till.
	700014	Mineral indicator tracing, southern Keewatin.
J.E. Wyder	680035	Borehole and related geophysical techniques.
	680036	Sidewall sampling and geophysical service.
	690062	Buried Missouri and Red River Valleys in Manitoba.

PALEONTOLOGY AND GEOCHRONOLOGY SECTION

W. Blake, Jr.

This unit, comprises Quaternary Paleoecology and Radiocarbon Laboratory. It provides radiocarbon dates and analyses of fossil materials (particularly pollen, mosses, and wood) as a service to other units and individuals. The unit also determines variations in radiocarbon content of modern materials as background for other research, and investigates the chronology of fossil-bearing deposits. Research on changes in environment and in plant distribution during the Quaternary is being conducted, as is a program of dendrochronological investigations, both applied and in the development of techniques.

Personnel Notes

Mrs. L. Wilson, previously employed as technician in the Palynology Laboratory on a casual basis, became a permanent staff member in July 1969.

W. Blake, Jr. became head of the Paleontology and Geochronology Section in September 1969.

Paleoecology

Organization and maintenance of the Palynology Laboratory is under the supervision of R.J. Mott. Laboratory and supporting field investigations were carried out during the year by M. Kuc, R.J. Mott, and M.L. Parker. S. Federovich carried out laboratory work in support of field projects by D.A. St-Onge, O.L. Hughes, and W. Blake, Jr. During the year R.J. Mott produced 23 reports on wood identifications of 208 samples, and 3 palynological reports. M. Kuc made 31 bryological reports, which included data on vascular plants and other organic remains as well as on mosses.

Radiocarbon Dating

Laboratory: Under the supervision of J.A. Lowdon both the two litre and five litre counters were operated routinely during the period April 1, 1969 to March 31, 1970. For one 2-month period the five litre counter was operated at high pressure (4 atms.), and for 1 month the two litre counter was operated at 1 atm. The counter background levels remained constant throughout the year although a slight seasonal fluctuation was again noticed.

Program: Samples for age determination in the Radiocarbon Dating Laboratory were selected by an informal committee. Currently, the committee includes W. Blake, Jr. (Chairman), J.G. Fyles, and J.A. Lowdon, together with other members of the staff as appropriate to the samples under consideration. Most of the samples analyzed were selected to provide data for current research projects in the field of Quaternary chronology and related glacial events; to shed light on crustal movement; and to provide information on the rates of geological processes such as sedimentation. A total of 198 age determinations were carried out; of these 175 were on geological samples, 23 were on samples from archeological sites (mostly submitted by the National Museum of Canada), in addition to 16 analyses carried out on geochemical samples. One hundred and seventy-five samples of CO_2 gas were sent to Isotopes Inc. for C^{13}/C^{12} determinations in order to determine the possible effects of carbon isotope fractionation. Most samples submitted were younger than 5,000 years and were derived from wood, charcoal, peat, gyttja, soil, bone and shell. In addition, a number of C^{13}/C^{12} determinations were carried out by Geochronology Section, Crustal Geology Division, under the supervision of Dr. R.K. Wanless.

Results of age determinations from the laboratory continue to be published in Radiocarbon and are reprinted by the Geological Survey in the paper series. Date list IX, which includes 145 determinations on 134 geological samples has been published; date list X, which includes 26 determinations on archeological samples, has been submitted.

Attendance at Meetings, Talks

W. Blake, Jr.: attended the Symposium on Late Cenozoic Glacial Ages at Yale University in December, a meeting of the North Water Project Advisory Committee at Montreal in February, and was a discussant dealing with problems of radiocarbon dating of archeological samples at the annual meeting of the Canadian Archaeological Association at Ottawa in March.

R.J. Mott: attended the 12th Conference on Great Lakes Research at Ann Arbor in May, and presented a paper with J. Terasmae "Studies of postglacial palynology on Sable Island, Nova Scotia" at the annual convention of the American Association of Stratigraphic Palynologists at State College Pennsylvania in October.

M.L. Parker: attended a Conference on Tree Ring Analysis at the University of British Columbia in February and gave two papers "Methods of measurement of tree rings used at the Geological Survey of Canada" and "Tree-ring chronology building in Canada - approach and objectives".

Membership on Committees

W. Blake, Jr. - Chairman, Geological Survey Radiocarbon Dating Committee
- Subcommittee on Glaciers, Associate Committee on Geodesy and Geophysics.

J.A. Lowdon - Geological Survey Radiocarbon Dating Committee.

Outside Papers

Blake, W., Jr.
1969: Les ponces des plages soulévees du Spitzberg et du Canada arctique; VIIIe Congres INQUA, Paris, Résumés des Communications, Sect. 6, p. 181 (abstr.).

Heginbottom, J.A., and Parker, M.L.
1969: Tchaikazan and Friendly Glaciers, British Columbia; Can. Geophys. Bull., vol. 22, p. 237.

Lowdon, J.A.
1969: Isotopic fractionation in corn; Radiocarbon, vol. 11, No. 2, pp. 391-393.

Lowdon, J.A., and Blake, W., Jr.
1970: Geological Survey of Canada radiocarbon dates IX; Radiocarbon, vol. 12, No. 1, pp. 46-86.

Active Projects

W. Blake, Jr.	680065	Pumice on raised beaches, eastern Arctic Canada.
M. Kuc	690044	Fossil mosses in the Arctic.
J.A. Lowdon	590457	Radiocarbon laboratory development and operation.
R.J. Mott	650030	Palynological studies, central Saskatchewan.
	690064	Quaternary palynology.
M.L. Parker	680026	Dendrochronological investigations.
J. Terasmae	610042	Quaternary stratigraphic palynology of Canada.

MANUSCRIPTS AND CARTOGRAPHY SECTION

Peter Harker

All manuscripts submitted for publication by the Geological Survey are processed through the office of the Chief Scientific Editor who is also head of the Manuscripts and Cartography Section and has a functional responsibility for the scientific editing carried out by E.J.W. Irish at the Institute of Sedimentary and Petroleum Geology and by Mrs. Margaret Larnder for the Division of Quaternary Research and Geomorphology.

During the year a major study of all aspects of publication and distribution in the Geological Survey was carried out by the Bureau of Management Consultants by Mr. Alan R. Needham. Mr. Needham consulted Departmental and Branch officials, scientists, commercial and provincial agencies and also visited the United States Geological Survey. The report was issued in March; many of the recommendations are now being implemented including a production control system to commence with the beginning of the new fiscal year. During the latter part of the year major reorganization was in process to include a grouping of all information processing activities in the Geological Survey under a single divisional organization also to be established at the beginning of the 1970-71 fiscal year.

As a result of internal and external scrutiny and pending reorganization, the year was one of major transition, however the routine of normal operations was preserved and the final totals for published items were near records.

E. Hall was assigned to Economic Geology and Geochemistry Division as Acting Assistant Division Chief and the maintenance of a technical information service was carried out by the staff of the section. Miss M.J. Corrigall resigned as editorial assistant but was able to complete most of the compilation of the ten year index of publications. Miss W. Havard joined the staff as a replacement.

Membership on Committees

R.G. Blackadar	- Geological Survey of Canada History Committee.
C.E. McNeil	- Member, E.M. & R. Advisory Board on Draftsmen and Compilers.

P. Harker	- American Commission on Stratigraphic Nomenclature. - Departmental Committee on Information Services. - Information Study Group, Arctic Institute of North America. - Geological Survey of Canada History Committee.
M.G. Bernard	- Secretary, Cartography Suggestion Awards Subcommittee.
J.B.F. Williams	- Member, Cartography Suggestion Awards Subcommittee.

Lectures, Conventions, Courses, etc.

P. Harker	- American Commission on Stratigraphic Nomenclature; and Geological Society of America, Atlantic City, November 1969.
L. Touchette	- Prospectors and Developers Association Annual Meeting, Toronto.

STATUS OF GEOLOGICAL MANUSCRIPTS ON MAR. 31, 1970

WITH COMPARABLE FIGURES FOR 1967-68 AND 1968-69

Type of Report	In process						Published during year			Total Active during year		
	Scientific Editing			Cartography and EM&R Ed. Div. & Q.P.								
	1969-70	1968-69	1967	1969-70	1968-69	1967	1969-70	1968-69	1967	1969-70	1968-69	1967
Memoirs	1	1	1	8	9	14	3	6	3	12	16	18
Bulletins	4	4	2	18	36	30	13	10	9	25	50	41
Econ. Geol. Reports	0	0	0	2	4	4	2	2	1	4	6	5
Misc. Repts. etc.	0	0	1	0	0	0	0	2	2	0	2	3
Multicolour maps[1]	0	0	0	10	20	41	18	9	7	28	29	48
P.S. Papers	4	8	9	37	34	38	75	67	73	116	109	120
P.S. Maps[1]	0	6	0	2	6	5	7	9	9	9	21	14
Topical Reports	0	0	0	0	0	0	4	5	6	4	5	6
Catalogues	0	0	0	1	2	0	1	1	0	2	3	0
Open File Reports	0	0	0	0	0	0	11	6	0	11	6	0

[1] Does not include maps illustrating Memoirs, Bulletins, Econ. Geol. Reports and Papers.

GEOLOGICAL CARTOGRAPHY UNIT

C. E. McNeil

The past year saw the completion of the text figures for the new edition of Geology and Economic Minerals of Canada. By the end of March the English version of the 1:5,000,000 Maps of Canada were completed with the exception of the Isotopic Age Map. French version of the Geological, Tectonic and Mineral Deposit maps were also completed.

Production was maintained on maps and illustrations for Survey Reports, publications in outside journals, and slides for illustrating lectures with a noticeable reduction in backlog.

PERSONNEL

G. S. Daughtry, Superintendent of Cartography, retired in October after forty-two years service. L. A. Williams, senior supervisor in charge of drafting also retired in January after over forty years of service. The untimely death in November of M. G. Bernard left a further gap in our supervisory staff. I. A. Coulthart returned to the staff after serving with the Division of Quaternary Research and Geomorphology. L. Champagne and Mrs. Z. Mokry were new additions and Miss J. A. Sinclair resigned in March.

PRODUCTION DATA

Maps and illustrations completed by the Cartography Unit during the period from April 1, 1969 to March 31, 1970 comprise the following:

	Ottawa	Calgary	Total
Multicoloured geological maps	22	0	22
Preliminary geological maps	15	9	24
Figure illustrations (lithographed)	86	26	112
Figure illustrations (page size)	440	96	536
Preliminary maps reprinted (lithographed)	10	0	10
Preliminary maps reprinted (blueline)	2	0	2
Aeromagnetic maps reprinted (lithographed)	60	0	60
Aeromagnetic maps reprinted (blueline)	228	0	228
Miscellaneous (index maps, etc.)	2	0	2

Maps and illustrations in progress at March 31, 1970

	Ottawa	Calgary	Total
Multicoloured geological maps	20	1	21
Preliminary geological maps	14	2	16
Figure illustrations	148	66	214

Manuscripts received

	Ottawa	Calgary	Total
Multicoloured geological maps	20	1	21
Preliminary geological maps	18	5	23
Figure illustrations	183	143	326

Work completed in photo-mechanical section

Mapping camera

Film negatives and positives	4,228

Contact processes

Film negatives and positives	9,876
Colour keys on film	1,248
Peelcoats	477
Scribe-etch	113
Colour proofs	75
Vandyke prints	3,089
Blueline map prints	17,565
Whiteprints	824
Xerox prints	427,346
Xerox prints collated	159,859

Miscellaneous drafting included covers for all preliminary papers, business cards for field staff, GSC calendars, office forms, etc.

PUBLICATIONS DISTRIBUTION OFFICE

L. Touchette

During the year the following publications were received and made available for distribution.

Economic Geology Series	2
Memoirs	3
Memoirs (reprinted)	1
Bulletins	13
Preliminary Papers	77
Preliminary Papers (reprinted)	4
Misc. Report Series (reprinted)	1
Misc. Geol.	15
Preliminary Maps	9
Preliminary Maps (reprinted)	4
Geological Maps "A" Series	23
Mineral Map of Canada 900A (E. & F.)	2
Derived Series	26
Aeromagnetic maps (new issues)	395
Aeromagnetic maps (reprinted)	403
Indices to G. S. C. Maps (revised)	19
Indices to aeromagnetic maps (revised)	18

DISTRIBUTION DATA

Maps	263,472
Reports	107,406
Indices, listings, brochures, etc.	59,969
Total distribution	430,847

OTHER DATA

Requests for publications, information, R & M	21,937
Visitors (cash sales 1644)	
(others 1999)	3,643
Notification Lists (including O. F. Lists)	60
Total publications advertised	651

NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES

J.F. Henderson, Secretary

The Geological Survey published on behalf of the National Advisory Committee, its annual report and certain other reports and symposia sponsored by the Committee. The annual report for 1968-69 was published in February, 1970 (Geol. Surv. Can., Paper 69-6, 1969). It gives a summary of the work of the Committee from September 1, 1968 to August 31, 1969 and includes the reports of the Subcommittees that cover the different fields of the geological sciences, including developments over the year in these fields, and suggestions of further problems for study. An appendix lists the research grants awarded to Canadian univestities by the Geological Survey in 1969-70 which are awarded on the basis of recommendations by the National Advisory Committee.

The annual compilation of current research projects in the geological sciences in Canada for 1968-69 was published in December, 1969 (Geol. Surv. Can., Paper 69-5, 1969); it records information on current research by the universities, federal and provincial departments of mines and research councils. Other publications of the National Advisory Committee in 1969 include Proceedings of the First Conference on Research in Tectonics - Kink Bands and Brittle Deformation (Geol. Surv. Can. Paper 68-52, 1969); Proceedings of the Earth Sciences Symposium on Hudson Bay (Geol. Surv. Canada, Paper 68-53, 1969 and the final report on the comprehensive study of the Geology of the Coronation Mine (Geol. Surv. Can., Paper 68-5, 1969).

Papers presented at a symposium on the Structure of the Southern Canadian Cordillera, sponsored by the Geological Association of Canada in Vancouver in 1968, were published in February, 1970 as Special Paper No. 6 of the Association; this volume contains the results from the Cordillera Structure Project, initiated and sponsored by the National Advisory Committee. The second Canadian Conference on Research in Tectonics, held at McMaster University, March, 1969, was organized on behalf of the Structural Subcommittee of the National Advisory Committee by P.M. Clifford and M. Stauffer on the general theme Plastic Deformation of Rocks; many of the papers are being published in the Canadian Journal of Earth Science. The third Conference on Research in Tectonics held at the University of Manitoba in March, 1970 was organized by D.K. Norris, M. Stauffer and W.C. Brisbin on the general theme Cataclastic Deformation and Shear Zones in Metamorphic Terrane.

Research Grants to Universities

In 1969-70 the Geological Survey of Canada on the advice of the National Advisory Committee awarded a total $225,242 general (undirected) grants-in-aid of geological research in Canadian universities - an increase

of a little over $5,000 over the previous year. An additional $50,000 was provided for special grants for research in the development of computer processable files of geological data, as recommended by the National Advisory Committee. The names of the recipients of all the grants, the titles of their research projects and amounts awarded are listed as an appendix to the Nineteenth Annual Report of the National Advisory Committee for 1968-69.

The National Research Council of Canada awards grants-in-aid of geological research on a much more substantial scale. In 1969-70 National Research Council grants to our universities for research in the geological sciences (including geophysical projects applied to solution of geological problems) totalled about $2,100,000.

Storage and Retrieval of Geological Data

In 1965 the National Advisory formed an ad hoc Committee to develop a National System for storage and retrieval of geological data in Canada. The final report of the ad hoc Committee which was adopted in 1967 recommended a program for implementation and continued development for a National System. A Subcommittee on Storage and Retrieval of Geological Data was formed by the N.A.C. in 1968 to implement the recommendations of the ad hoc Committee. The Subcommittee recommended that an independant body to be called the Canadian Geoscience Data Institute be established and be funded jointly by the provincial and federal governments and industry. A program to establish such an institute was presented by the Honorable J.J. Greene, Minister of Energy, Mines and Resources to the Mines Ministers' Conference in September 1968. This program was not accepted but the Mines Ministers' agreed to study it further, and at the September 1969 Conference accepted in principle the concept of a National System and recommended that the Geological Survey maintain a national index. To carry on in the meantime a Secretariat for Geoscience Data had been formed by the Geological Survey. On April 1st, 1970 the Geological Survey established the Canadian Centre for Geoscience Data which replaced the Secretariat.

The Canadian Centre for Geoscience Data is in the Geological Survey Building, 601 Booth Street, Ottawa. Dr. C.F. Burk, Jr. is National Coordinator and Mr. B.A. McGee is Supervisor, Canadian Index to Geoscience Data.

The Centre will be responsible for development of the National System for Geological Data as proposed by the National Advisory Committee. Its principal tasks will be creation of the national index to sources of Canadian geoscience data; development of a computer-based network of geoscience data files; and to assist Canadian organizations in building computer-based files. The Centre will not store or otherwise control data.

SECRETARIAL SERVICES

Mrs. B. Richard

Summary of work executed by the Secretarial Services Section for the year 1969/1970.

Letters from stenorette	209
Letters from manuscript	4,361
Pages of reports from stenorette	24
Pages of reports from manuscript	10,454
Pages of Preliminary reports	6,982
Publication lists	324
Tabulated pages	1,454
Envelopes and labels	2,377
Cards and forms	4,356
Total of carbon copies produced	18,189
Secretarial relief supplied - days	286
Daily average number of operators in pool	7.02) = 8.17
Daily average of personnel on secretarial relief duties	1.15)
Daily time factor for assembling, elucidation of difficult manuscripts, and corrections	15% approx.

Approximate assessment of work:

Letters = 30 to 40 lines single spacing, 1 ½" margin, including address and salutation.

Reports = 6" line, double spacing, 30/32 lines (6" x 10" approx.).

Tabulated pages = numerical statistics, correlation tables, etc.

Cards and forms = IBM type cards, geological records, technical indices, requisitions etc.

Total output of work was higher than ever; the demands for typing in French has increased but we now have an official bilingual typist to handle the extra work.

Three IBM Selectric typewriters have been installed; they provide a means of interchanging founts which allows the use of italicised words; they have been used for photo-copy typing for published reports and have taken some of the load off the IBM Executive typewriters.

PHOTOGRAPHIC SECTION

J.B. Emslie

As in previous years the Photographic Sections' operations continued to run well during the year, with overall production up to a slightly higher level than in the preceding 12 month period. The production of projection slides was almost double the total produced in the previous year.

This level of production was achieved despite the fact that the total staff complement was still held at a bare minimum, without any latitude to allow for the effect of any sudden or unforseen staff absences such as sick leave or special leave. There were numerous occasions when work pressure was at a very demanding and critical level, and no small thanks are due to all members of the photographic staff for the Section continuing to meet important commitments and dead-lines while still maintaining a high standard of service and quality.

Two field trips were undertaken by J.B. Emslie during the year, one trip to Uranium City in August of 17 days duration, and the second trip was to Prince Edward Island in October for 10 days. Both trips were made in the company of Mr. Roy Slaney of Exploration Geophysics Division, and were for the purpose of rendering practical assistance to Mr. Slaney in experimental multi-spectral aerial photography, and involved the installation and operation of single and multi-aerial camera systems in the G.S.C. Skyvan aircraft.

PHOTOGRAPHIC SECTION PRODUCTION TOTALS 1969 - 1970

PRODUCTION

Black & White Negatives	6395	
Colour Negatives	210	
Autoradiographs	42	
Black & White Positive Transparencies	14	
Colour Positive Transparencies	52	
Black & White Projection Slides	1362	
Colour Projection Slides	849	
Contact Prints	17134	
Enlargements	22570	
Colour Prints	54	
Total;	48682	48682
(Total for previous 12 months 1968 - 69 :	47785)	

PROCESSING & PHOTO FINISHING JOB TOTALS

Field Work		
Black & White Roll Films Processed	441	
Colour Roll Films Processed	76	
Total No. of Field Photographs	6730	
Section Work		
Black & White Negatives Processed	6440	
Colour Negatives Processed	169	
Colour Transparencies Processed, Rolls & Sheets	329	
Colour Prints Processed	55	
Negatives Opaqued or Retouched	2805	
Prints Spotted	391	
Prints Mounted	424	
Slides Mounted	3190	
Total;	21050	21050

PRODUCTION BY THE CANADIAN GOVT. PHOTO CENTRE

Black & White Prints	4336	
Colour Prints	246	
Total;	4582	4582
Grand Total;		74314
(Grand Total for previous 12 months 1968 - 69 ;		74224)

INSTRUMENT DEVELOPMENT SHOP

G.A. Meilleur

We have this past year completed the re-organization of services into two different areas. General operations in Room G-64 and special operations in Room G-63. The main object was to minimize contamination hazards during fabrication of highly sensitive instruments.

The loss of a new position affected seriously the normal operation of the section, also the termination of Mr. McFarlane's position in October, 1969, has reduced the total available man hours by 1056, compared to 1968-69. The reduction of Drafting and Engineering services has automatically reduced the amounts of work contracted to industry.

A.Y. Cregheur attended a one week training session at the Elox Training Centre in Detroit. This session was created for the formation of specialized technicians for the operation of Electrical Discharge Machine. Progress and final inspection of equipment constructed for G.S.C. by industries has been conducted when required by G.A. Meilleur.

Following is a summary of 1969-70 Projects and Developments:

1. Completion of 15" radius solid source mass spectrometer main components.

2. Development of special wood coring bits, used in conjunction with Geologist Sampling Drill.

3. High Pressure Equipment.

4. Hydrothermal Equipment.

5. Geophysic, Electrical Rock Properties Study Equipment.

During 1968-69, 60% of total available services were alloted to Crustal Geology Division.

1969-70 time requisitions:

Total man hour available	7368
contracted	480
Estimated Back log	2560
Total	10327

1970-71 Total man hour available 6312

LIBRARY

Mrs. D.M. Sutherland

Activities

The operation and supervision of the Central Technical Files was transferred to this section during the year. At the same time the files and staff were moved to within the library, occupying the space formerly allotted to the maps. New shelving was bought and the vertical files removed so that all the material was housed in much less space than before.

The Cataloguing Librarian devised a questionnaire on the use of the catalogue which she hoped would guide her in future plans for revision, etc. Users have responded well and as a result, new guidelines for subject headings to be used and new methods of filing are planned.

The Circulation Staff have been concerned by the outside borrowers who do not return publications and so for the past year we have required that everyone be registered before being allowed to take a book out. Students are being documented more fully and groups from both universities were instructed in the use and arrangement of the library.

The load of Xeroxing translations and open files for users proved too heavy for the limited staff time available and this year all orders have been filled by a commercial firm which also does the billing. This has proved much more satisfactory as the only way the work could be completed before was by use of overtime.

Personnel

Mrs. MacGuire of the Central Technical Files retired during the year and her position was eventually filled by Harold Eyre who had been working in the library as a casual.

Miss Jane Oswald left in the summer and Miss Gisele Groulx has been with us as her replacement since August.

The new position in the map library and one casual were lost as a result of the freeze.

Miss Marguerite Dubois assisted the cataloguer for a few months and four summer students provided the usual summer assistance.

Attendance at meetings and courses

The meeting of the Special Libraries Association was held in Montreal in June 1969 and all the professional staff attended various sessions.

Miss M. Williams visited the Calgary office from December 2-5, 1969 for consultations regarding translations and exchanges.

Miss Swirsky attended the Workshop in Computer Processing of Geological Data in London, Ontario from October 6-8, 1969.

Miss Christensen attended a Supervisory Course given by the Department from November 17-21, 1969.

Committees

D.M. Sutherland: Member of Geological Information Society Guidebook Committee.

Chairman Standing Committee of Chief Librarians of Energy, Mines and Resources.

STATISTICS, 1969-70

I ACQUISITIONS (received by purchase, exchange or gift)

Periodicals and Serials	16,833
Books	648
Reports	117
Maps	2,023
Total	19,621
CTF reports	320

II CIRCULATION

Loans	
Books, Periodicals, etc.	
Loaned to GSC staff	28,074
Loaned to individuals other than staff	3,413
Loaned through interlibrary loan	1,836
Articles Xeroxed in lieu of loans (including staff, interlibrary loan, etc.)	10,180
Maps	639
Total	44,142
Borrowed or obtained Xerox from other libraries for GSC staff	516
CTF Reports loaned	101

III CATALOGUING

Books, periodicals and serials	494
Analytics prepared for the catalogue	974
Maps	511
	1,980

IV CLERICAL

Letters and memoranda	940
Catalogue cards printed	17,501
Pages Xeroxed	77,520
Requisitions prepared	734
Subscriptions ordered	573

V REFERENCE AND INTERLIBRARY LOAN

Inquiries		
-under 5 minutes	(estimate)	5,720
-over 5 minutes	(estimate)	1,435

Interlibrary loan requests received

Forms	3,489
Telex or letter	460
Telephone	680
	4,629

Documents translated by Secretary of State	95

APPENDIX I

STAFF LIST

Geological Survey of Canada

(as supplied by Personnel Office and as of June 1970)

DIRECTOR'S OFFICE

Fortier, Y.O., Director
Lord, C.S., Chief Geologist
Derry, Miss G.E., Secretary
Dawson, Mrs. M., Secretary
Wright, G.M.
Hall, E., Tech. Exec. Asst.

Special Projects

Douglas, R.J.W.

Secretary Natl. Adv. Comm.

Henderson, J.F.

Canadian Centre for Geoscience Data

Burk, C.F.
McGee, B.A.

Internatl. Geol. Congress

Armstrong, J.E.

Administrative Services

Pollitt, K.
Bigras, Mrs. B.D., Secretary

Financial Services

Hickson, J.R.
Going, Mrs. M.I.
Koops, Mrs. M.F.
Roe, Mrs. B.A.

Office Services

Lajoie, L.J.

Branch Registry, Messenger Service

Robillard, R.D.
Begin, G.M.
Casey, A.J.
Lajoie, Mrs. G.M.
Roussel, J.P.

Secretarial Services

Richard, Mrs. B.G.
Abouassali, Mrs. C.M.J.
Bond, Miss C.
Cantin, Mrs. L.S.
Hodges, Miss D.A.
Kapusto, Miss E.I.
Lauzier, Miss P.K.
McMillan, Miss J.M.
Meehan, Miss C.L.
Wylie, Mrs. B.A.

Equipment Office

Rozon, R.

Stationery and Office Supplies

Bowes, G.R.
Cayer, H.H.
Charlebois, G.J.
Lisle, Mrs. A.E.
Moreau, V.
Smith, D.D.

Instrument Shop

Meilleur, G.A.
Cregheur, A.Y.
Fournier, J.P.

GEOLOGICAL INFORMATION PROCESSING DIVISION

Harker, P., Acting Chief
Di Millo, Mrs. M., Secretary
Blackadar, R.G.
Mahoney, Mrs. L.R.

Publications and Information

Touchette, J.L.
Clarke, C.R.
Drapeau, Mrs. G.M.
Letang, E.G.
McNabb, Mrs. S.W.
Murphy, B.P.
Rail, E.J.
Wade, Mrs. V.E.

Photographic Services

Emslie, J.B.
Beckstead, D.C.
Cooke, F.J.
Kempt, J.W.
Skuce, C.A.
Stafford, W.G.
White, J.I.

Library, Central Tech. Files, Data Processing

Sutherland, Mrs. D.M.
Christensen, Miss C.J.
Cooper, Miss S.M.
Eyre, W.H.
Ganim, T.N.
Laurendeau, P.E.
Maheral, Mrs. L.
Segall, Miss C.D.
Stewart, Miss T.
Swirsky, Miss L.
Williams, Miss M.
Wistaff, Mrs. C.M.

Cartography

McNeil, C.E.
Ainsworth, Mrs. H.B.
Champagne, L.

Compiling

Nunn, E.P.
Barbary, G.J.
Daugherty, R.F.
Debain, P.
Hill, R.S.
Howe, K.G.
King, J.A.
Lavigne, G.H.
Mainville, B.
McCracken, S.N.
McKenzie, N.M.
Mokry, Mrs. Z.
Raddatz, Miss M.
Sauvageau, J.R.

Drafting

Babcock, L.W.
Dumbrell, E.A.
Auger, M.R.
Bencik, K.
Brown, D.
Cooke, Miss B.J.
Corriveau, J.P.
Crepin, G.J.
Coulthart, I.A.
Daley, L.A.
Enright, M.L.
Fairfield, R.D.
Finn, H.J.
Fouchard, G.
Gagnon, J.G.E.
Grenier, N.
Heney, F.J.
Heyendal, H.
Hill, B.G.
Kovachic, Mrs. H.
Leader, R.E.
Nichol, H.S.
Papps, T.L.
Perron, R.
Potvin, R.Y.
Saffin, R.
St. Pierre, M.

Drafting (Cont'd)

Thomson, H.A.
Williams, J.B.F.
Wylie, W.G.
Yeager, F.
Yelle, J.S.
Young, G.

Photomechanical

Buck, N.E.
Foshay, G.N.
MacKenzie, R.J.G.
Major, A.C.
McNeill, D.G.
Snyder, W.M.
Wilson, G.B.

CRUSTAL GEOLOGY DIVISION

Duffell, S., Acting Chief
Gougeon, Mrs. C.L., Secretary
Arnold, J.G.
Stevenson, I.M., Acting Staff Geologist

Special Projects

Eisbacher, G.H.

Precambrian Shield

Baer, A.J.
Baragar, W.R.A.
Bell, C.K.
Bostock, H.H.
Davison, W.L.
Davidson, A.
Eade, K.E.
Ermanovics, I.F.
Fahrig, W.F.
Frarey, M.J.
Fraser, J.A.
Henderson, J.B.
Heywood, W.W.
Hoffman, P.F.
Jackson, G.D.
McGlynn, J.G.
Morgan, W.C.

Precambrian Shield (Cont'd)

Reinhardt, E.W.
Riddler, R.
Taylor, F.C.
Tremblay, L.P.

Appalachian Eastern Lowlands and Atlantic Margin

Poole, W.H.
Anderson, F.D.
Benson, D.G.
Colletta, S.P.F.
Cumming, L.M.
Helmstaedt, H.
Howie, R.D.
Sanford, B.V.
Seguin, R.J.G.
Skinner, R.
ter Haar Romeny, W.U.

Petrology

Reesor, J.E.
Beaulne, M.
Currie, K.L.
Demers, A.Y.
Douglas, J.A.V.
Emslie, R.F.
Froese, E.
Gordon, T.M.
Irvine, T.N.
Whitehead, A.E.

Geochronology

Wanless, R.K.
Bisson, J.C.
Loveridge, W.D.
MacRae, J.L.
Quigg, F.B.
Santowski, K.
Stevens, R.D.
Sullivan, R.W.
Swerdfager, M.J.

Cordillera and Pacific Margin

Wheeler, J.O.
Blusson, S.L.
Cameron, B.E.B.
Campbell, R.B.
Gabrielse, H.
Hutchison, W.W.
Lane, Mrs. P.D.
Leaming, S.F.
Marble, Mrs. A.
Monger, J.W.H.
Muller, J.E.
Roddick, J.A.
Russell, Mrs. B.D.
Shurben, Mrs. P.K.
Souther, J.V.
Tempelman-Kluit, J.D.
Tipper, H.W.

Coal Research

Hacquebard, P.A.
Barss, M.S.
Birmingham, T.F.
Cameron, A.R.
Donaldson, J.R.

Eastern Paleontology

Bolton, T.E.
Botte, B.J.
Callahan, J.J.
Camfield, Mrs. M.
Copeland, M.J.
Dean, W.T.
Jarvis, D.C.
McCregor, D.C.
Murphy, Mrs. F.M.
Nash, D.K.

EXPLORATION GEOPHYSICS DIVISION

Hobson, G.D., Acting Chief
Goodman, Mrs. N.D., Secretary
Artichuk, G.
McDowell, Mrs. J.K.

Special Projects

MacLaren, A.S.
Chretien, Miss M.B.
Derouin, E.J.
Haley, E.L.
Ready, E.E.

Electrical Methods

Collett, L.S.
Ahrens, R.H.
Becker, A.
Butterfield, D.C.
Dyck, A.V.
Frechette, J.P.
Gauvreau, C.
Stauffer, W.J.

Magnetic Methods

Hood, P.J.
Bower, Miss M.E.
Dicaire, A.
Knapp, H.W.C.
Kornik, L.J.
Lajoie, M.
McGrath, P.H.
Owens, K.H.
Reveler, D.
Sawatzky, P.

Remote Sensing Methods

Darnley, A.G.
Charbonneau, B.W.
Flint, T.R.
Grasty, R.L.
Gross, H.
Parker, J.
Slaney, V.R.
Washkurak, S.

Theoretical Geophysics and Data Analysis

Bhattacharyya, B.K.
Abbinett, D.D.

Theoretical Geophysics and Data Analysis (Cont'd)

Dods, S.D.
Holroyd, M.
Langlois, R.J.
Teskey, D.J.
Zieman, F.W.

Seismic Methods

Hobson, G.D.
Burns, R.A.
Gagne, R.M.
MacAulay, H.A.
Overton, A.

Rock Magnetism

Larochelle, A.
Christie, K.W.
Freda, G.N.
Schwarz, E.J.
Symons, D.T.A.

ECONOMIC GEOLOGY AND GEOCHEMISTRY DIVISION

Robinson, S.C., Chief
Gorman, Mrs. M., Secretary
Maxwell, J.A., Asst. Chief
Jones, E.W.
Lapp, J.H., Admin. Officer

Mineralogy

Traill, R.J.
Bonardi, M.
Delabio, R.N.
Gravel, J.
Jambor, J.L.
Lachance, G.R.
Plant, A.G.
Rimsaite, Miss J.
Stenson, Mrs. A.P.
Steacy, H.R.

Mineral Separation Laboratory

Paris, J.C.
Brown, A.G.
Charbonneau, R.
Huot, J.M.R.
Machin, D.B.

Mineral and Rock Sets

Gauthier, C.H.R.
Larose, J.M.
Racine, T.H.
Turpin, J.

Mineral Deposits

Gross, G.A.
Burke, R.D.
Burns, Miss E.M.
Eckstrand, O.R.
Edmond, Mrs. K.L.
Johnston, A.
Kindle, E.D.
Kirkham, R.V.
Leech, G.B.
McLeod, C.R.
Mulligan, R.
Rose, E.R.
Sangster, D.F.
Thorpe, R.I.
Whitmore, D.R.

Analytical Chemistry

Abbey, S.

Chemical Analysis

Courville, S.
Belanger, Mrs. G.C.
Bouvier, J.L.
Grushman, Mrs. V.E.
Sen Gupta, J.G.
Seymour, Miss L.J.
Vickers, G.
Watson, Mrs. F.J.

Instrumental Analysis

Champ, W.H.
Crook, Mrs. J.
Bender, G.
Brown, D.A.
Church, K.A.

Geomathematics Program

Agterberg, F.P.
Lepinis, J.

Special Projects

Lang, A.H.
Boyle, R.W.
Dawson, K.R.

Uranium Program

Little, H.W.
Bottrill, T.J.

Geochemistry

Cameron, E.M.
Allan, R.J.
Bristow, Q.
Durham, C.C.
Dyck, W.
Garrett, R.G.
Gauthier, G.
Hobbs, J.D.
Hornbrook, E.H.W.
Horton, R.E.
Lavergne, R.J.
Lynch, J.J.
Nigrini, A.
Pelchat, J.C.

INSTITUTE OF SEDIMENTARY AND PETROLEUM GEOLOGY

McLaren, D.J., Institute Director
Cascadden, Mrs. M.B.I., Secretary

Staff Geologist

Latour, B.A.

Technical Services

Barefoot, R.R.
Carbone, S.
Hamnett, H.S.
Heinrich, A.G.
Karg, G.D.
McEwan, W.O.
Michie, R.B.
O'Keefe, Mrs. S.L.
Semeon, Mrs. A.
Snowdon, L.R.

Library

Jones, Mrs. M.
Walters, Miss P.L.

Logs and Cores Services

Banning, W.J.
Bjarnason, O.A.
Penley, Miss W.L.

Geological Editor

Irish, E.J.W.

Geological Cartography

MacLachlan, L.A.
Browne, J.A.
Ortman, B.H.
Siewert, Mrs. S.M.
Stewart, Miss M.D.
Thomson, J.W.
Vermette, W.P.
Walter, D.J.

Distribution

Brooks, Mrs. M.H.
Sime, Miss D.

Administrative Officer

Brusso, A.W.

Office Services

Jamieson, A.
Brown, Mrs. P.D.
Barefoot, Mrs. K.L.
Charke, S.R.
Fiddes, Mrs. L.V.
Gates, Mrs. K.M.
Kraft, Mrs. R.
Sortland, Mrs. G.C.

Building and Energy Services

Peterkin, G.M.
Delay, B.G.
Pippenger, G.E.
Linnemoller, U.

Stationery and Supply

Peatman, D.
Maiden, F.

Senior Research Scientist

Belyea, H.R.
Thorsteinsson, R.

Arctic Islands

Christie, R.L.
Kerr, J.W.
Nassichuk, W.W.
Trettin, H.P.

Structural Geology

Norris, D.K.
Cook, D.G.
Havard, Mrs. C.J.
Ollerenshaw, N.C.
Taylor, G.C.

Paleozoic Stratigraphy

Norris, A.W.
MacKenzie, W.S.
Martin, H.L.
Macqueen, R.W.
Procter, R.M.
Pugh, D.C.

Geology of Petroleum

McCrossan, R.G.
Ball, N.L.

Mesozoic Stratigraphy

Stott, D.F.
Foscolos, A.E.
Gibson, D.W.
Price, L.L.
Yorath, D.J.
Young, F.G.

Western Paleontology

Norford, B.S.
Bamber, E.W.
Chamney, T.P.
Fritz, W.H.
Hopkins, W.S.
Jeletzky, J.A.
Pedder, A.E.H.
Tozer, E.T.
Uyeno, T.

QUATERNARY RESEARCH AND GEOMORPHOLOGY DIVISION

Fyles, J.G., Chief
Morency, Miss L.S., Secretary
Craig, B.G., Acting Assistant Chief

Administration and Finance

Jackson, L.A.
Davey, Miss P.
Miller, Mrs. D.

Scientific Services

Minning, Miss G.V.
Mizerovsky, Mrs. G.
Shimizu, K.

Special Projects

Prest, V.K.
Bik, M.J.J.

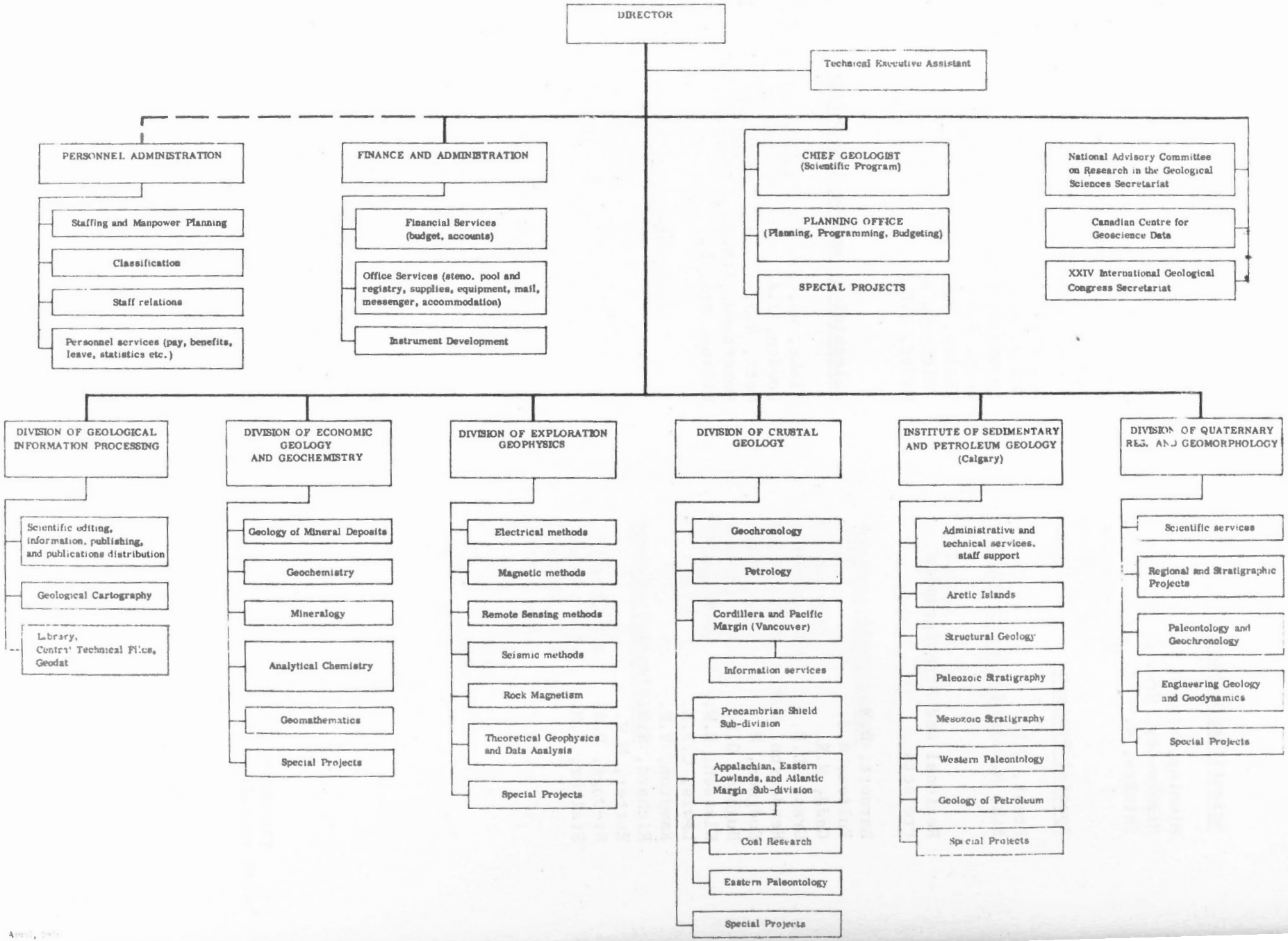
Regional and Stratigraphic Projects

Barnett, D.M.
Fulton, R.J.
Gadd, N.R.
Grant, D.R.
Henderson, E.P.
Hodgson, D.
Hughes, O.L.
Klassen, R.W.
Lewis, C.F.M.
Rampton, V.N.
Richard, S.H.
Rutter, N.W.
St-Onge, D.A.
Stalker, A.M.

Engineering Geology and Geodynamics

Scott, J.S.
Achard, R.A.
Bisson, J.G.
Code, J.A.
Field, D.E.
Heginbottom, J.A.
Kelly, R.G.
McDonald, B.C.
Owen, E.B.
Shilts, W.W.
Vilonyay, A.
Wyder, J.E.

Paleontology and Geochronology

Blake, W., Jr.
Lowdon, J.A.
Mott, R.J.
Robertson, I.M.
Wilson, Mrs. L.

GEOLOGICAL SURVEY OF CANADA