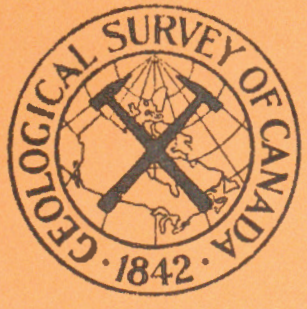
CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT

APRIL 1, 1970 TO MARCH 31, 1971



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OTTAWA
1971

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OTTAWA

1971

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GEOLOGICAL SURVEY OF CANADA

INTRODUCTION

Y.O. Fortier, Director

This report, intended for departmental use but not for public distribution, is an accounting of all the components which make up the branch. As internal reporting procedures now provide a readily available annual statement for each one of the more than 450 active approved projects, these data are not included in this report.

The Geological Survey's activities are designed to support two of the department's programs, the Mineral and Energy Resources Program (MERP) and the Earth Sciences Program (ESP). A principal subobjective of the MERP activities is to ascertain the mineral and energy resources potential available to Canada and thus considerable branch effort is directed to such objectives as the estimation of the potential abundance and probable distribution of mineral and fuel resources available to Canada. This is accomplished by providing the necessary systematic geological framework, by establishing the geoscientific settings favourable to the occurrence of the various types of mineral commodities and fuels, by correlating the geoscientific settings favourable for mineral deposits and for pools and deposits of fuel resources, by appraising foreign mineral and fuel resources, and by providing standards and controls to ensure consistent terminology, description and correlation.

The departmental program is also concerned with improving the means of discovery, extraction, processing, transportation and use of mineral and energy resources available to Canada and in this we are concerned with the discovery aspect. Our endeavours in developing or improving methods and instruments suitable to Canadian conditions comes to mind in this regard.

The departmental Earth Science Program (ESP) includes activities designed to assist in effective use and conservation of resources and in the management and preservation of man's environment throughout Canada. To assist in this the Geological Survey provides geologically-based information on land resources and terrain performance which is derived from geological, geomorphic, geophysical, geotechnical and related investigations of earth and rock materials, landforms and associated dynamic processes.

The information and expertise derived from our activities under both MERP and ESP enable us to provide scientific and technical advice and management services to other federal departments and agencies on behalf of domestic and foreign governments and to provide government, industry and the public with geoscientific information relating to Canada's mineral and energy resources.

During 1970-71 the Branch's authorized strength was 588 man-years (including 112 casuals) and the budget was $12,040,000. During the report period we had 473 active projects of which 174 had a field component. Although most field studies were directed by staff members some were led by temporary members including university professors and postdoctoral fellows. Some work, such as the aeromagnetic surveys was carried out under contract.

To stimulate and support research in the solid earth sciences at Canadian universities the Geological Survey, on the advice of the National Advisory Committee on Research in the Geological Sciences awarded a total of $228,000 general (undirected) grants-in-aid. In addition $50,000 was provided for research in the development of computer processable files.

During 1970-71 the branch published 3 economic geology reports, 1 memoir, 7 bulletins, 60 papers, 23 coloured (final) geological maps and 21 preliminary maps (including those that accompanied publications), and 354 aeromagnetic maps. In order to keep older information readily available 24 publications were reprinted as were 205 aeromagnetic maps. The report period saw the publication of the 5th edition of our report "Geology and Economic Minerals of Canada" the preparation of which has occupied much of the time of many of both the professional and support staff for the past few years. As of mid-June more than 3,500 copies had been distributed.

More than 308,000 items were distributed through the Ottawa office. The dollar value of publications sold through the Institute of Sedimentary and Petroleum Geology in Calgary exceeded $45,000 of which GSC publications accounted for 78%. Nearly $21,000 worth of GSC publications were sold through the Vancouver office where 11,008 visitors were assisted by the staff of the Information Services Unit. More than 8,100 standard sets of minerals and rocks were sold and in addition 179 sets of the 120-specimen collections were sold. Slightly more than 1,000 specimens submitted by the public were examined and identified.

Members of the staff published 166 papers in outside journals, gave 108 presentations to scientific meetings, seminars etc. and delivered 85 university lectures. Four staff members participated on a part-time basis in the presentation of university courses.

The 4th edition of "Prospecting in Canada" (the 3rd edition was a departmental best seller) was released early in June 1971 and thus we now have available two comprehensive reports one primarily for the professional geologist and the other for both professional and layman alike.

In August 1972 Canada will be host to the 24th International Geological Congress and during the report period our involvement in the planning for the meetings was greatly accelerated. Many staff members are involved in organizing or assisting in organizing field trips, others in planning for the formal sessions and others in the innumerable details that are involved in an international meeting. The coming 18 months will indeed be a busy time for all members of the Survey.

THE 24th INTERNATIONAL GEOLOGICAL CONGRESS

J. E. Armstrong, Secretary General

The Secretariat of the Congress is located at 601 Booth Street and in the fiscal year was staffed by 3 permanent employees of the Geological Survey: J. E. Armstrong, Secretary General; I. M. Stevenson, Assistant Secretary General; and Mrs. Pauline Moyd, Organizing Secretary and 3 full time employees paid for by the Congress.

The Congress issues bilingual circulars outlining its proposed program for 1972. The First Circular, which is 101 pages long, was distributed early in 1970 to about 155,000 geologists throughout the world and contained questionnaire seeking information from geologists planning to attend the Congress. The Second Circular, of 147 pages, was issued in March 1971 and was mailed to more than 8500 geologists in 115 countries who responded to the First Circular. Approximately 5000 additional pieces of mail were handled by the Congress in the fiscal year.

During the year staff members attended numerous I.G.C. business meetings in Ottawa and Montreal. Meetings were also held in Calgary and Vancouver. In addition to these business meetings the following annual meetings were attended:

C.I.M.M.	Toronto	- Armstrong, Moyd
G.A.C.	Winnipeg	- Moyd
A.A.P.G.	Calgary	- Armstrong, Moyd
A.I.M.E.	New York	- Moyd
I.A.E.G.	Paris	- Armstrong
I.L.S.G.	Thunder Bay	- Armstrong

An I.G.C. exhibit was displayed at meetings of the A.A.P.G., G.A.C. and C.I.M.

Eighteen G.S.C. staff members are on the National Organizing Committee of the Congress and 54 G.S.C. geologists are acting as leaders, co-leaders, or guides on geological excursions.

CANADIAN CENTRE FOR GEOSCIENCE DATA

C. F. Burk, Jr.

National Coordinator

The Canadian Centre for Geoscience Data was established 1 April 1970 in response to recommendations of the National Advisory Committee on Research in the Geological Sciences, the Provincial Ministers of Mines Conference, and several industrial organizations, for the purpose of coordinating development of a national computer-oriented system for data storage, and retrieval, to be called the Canadian System for Geoscience Data. The Centre is administered by the Director's Office, but receives policy recommendations from an outside Advisory Board (Dr. J. M. Harrison, Chairman) with representation from both federal and provincial agencies, from industry and from the universities.

The Canadian System will consist primarily of a network of privately controlled, computer-based data files which will enable companies, government agencies and other institutions to exchange and disseminate geoscience data in computer-processable form. A national computer-based index to these and all other public Canadian data will also form part of the system.

In pursuit of the goals, the Centre coordinated the indexing of about 20,000 documents by seven government agencies and published the first edition (70-1) of the Canadian Index to Geoscience Data in June 1970. About 1,000 volumes were sold to the public, valued at about $25,000, which included 10 indexes to the major political divisions of Canada and a thesaurus of about 40,000 authorized keywords used for indexing. The Centre provided numerous technical training sessions to representatives of contributing agencies in order to ensure national uniformity and consistency in indexing. A workshop was co-sponsored with the University of Calgary 3-7 May 1970, which attracted 18 registrants.

In order to provide assistance in creating computer-processable data files, the Centre installed the SAFRAS system at an Ottawa service bureau for use by the public. The generality and flexibility of SAFRAS allow users to design and build computer files which may include any types of computer-readable information, without additional programing or systems support, and at low computer running costs (e.g. $25 per file). A one-day workshop for 14 Survey officers was held on 27 May to demonstrate the system. The Centre worked closely with the designers of SAFRAS at the University of Western Ontario in order to further improve its capabilities and to promote its use at other Canadian institutions.

The Centre was active in assisting with the development of data standards being prepared by various working committees in Canada and abroad. The development of a multilingual thesaurus for structural geology and standards for the description of mineral deposits were among the more active projects during the year.

In addition to issuing the Canadian Index, a manuscript for a world-wide bibliography of computer-based storage and retrieval of geoscience information was under preparation in collaboration with Geofond Praha, Czechoslovakia.

Staff of the Centre included Dr. C. F. Burk, Jr., National Coordinator, Mr. B. A. McGee, Index Supervisor, and Mrs. R. D. Wright, Secretary.

DIVISION OF CRUSTAL GEOLOGY

J.O. Wheeler, Chief
S. Duffell, Assistant Chief

The principal objective of the Division is to study, map and interpret the folded, metamorphosed and igneous rocks that form the earth's crust under Canada and the sedimentary basins of the Atlantic and Pacific continental shelves, Hudson Bay and the Eastern Lowlands to provide a systematic geological framework to consistent standards as the essential basis for estimating the potential abundance and probable distribution of mineral and fuel resources in those regions.

The publication of maps and reports derived from the Geological Surveys and analyses activity aids in improving the means of discovery of mineral and fuel deposits by delineating ground with favourable and unfavourable potential for such resources and by providing information that enhances the strategy of mineral exploration. Thus by helping to promote the development of the mineral industry geological surveys and analysis may be a useful tool in aiding regional development in Canada in this and many other ways. Furthermore the favourability or otherwise of terrain for mineral development is an essential factor to be considered for effective land management and to reduce conflicting potential uses. Finally the publication of results provides scientific knowledge on the origin and 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 approximately 84 student assistants and other casual help to bring the total man years to 131. This does not include 12 other students hired under special Government student programs. One Post Doctorate Fellow continued his project with the Division during the year. Active projects in the Division during the year numbered 157.

The top priority task of the Division is the completion of the National Geological Reconnaissance of Canada at scales of 1 inch to 4 miles and 1 inch to 8 miles. At the present rate it is anticipated that this task will be completed by about 1976. Major gaps exist in Melville Peninsula, northernmost Quebec, Labrador, and in parts of British Columbia and Yukon.

As the National Geological Reconnaissance draws to a close greater effort and manpower will be devoted to Regional Multidisciplinary Analysis of Geological sub-provinces. This activity is the most economical and scientifically efficient means of properly identifying the geological framework. Integrated teams of scientists, each pursuing a theme, concentrate on features of the geological framework that transcend map-boundaries, establish regionally their character, variance, and correlation and determine the main geological architecture and its interrelations with mineral occurrences and concentrations. Such integrated regional studies, from which high quality 4-mile maps will be derived, will be applied mainly in Federal Territories where the standard of the National Reconnaissance needs upgrading. The initial phases of Multidisciplinary regional studies have begun in the Bear-Slave sub-province with regional

studies on Archean sediments and on Aphebian, Helikian and Hadrynian stratigraphy.

The insurance of a consistent standards of description and portrayal of the geological framework of Canada requires the development of standards, These include the calibration of geological time scale and polar wandering curves; the establishment of the chronology and correlation of the deposition, emplacement, metamorphism, deformation and mineralization of rock units; and consistent application of classification and nomenclature of fuel and mineral deposits, rocks and fossils and of their diagnostic and characteristic properties. Material from which the standards are derived are incorporated in Reference Collections.

Systematic studies and mapping in many cases must be preceeded by control studies by which local problems or relationships must be solved or understood in order to apply the results regionally or for systematic mapping. Similarly pilot projects are undertaken to determine the feasibility, scientifically and economically, of certain methods before adopting them for systematic studies.

The National Geological Reconnaissance and the embryonic Regional Multidisciplinary Analysis are the principal activities of the Precambrian Subdivision, Cordilleran and Pacific Margin Section, Appalachian Subdivision, and newly formed Eastern Petroleum Geology Section.

Standards and control activities are undertaken mainly by the Geochronology, Eastern Paleontology, Petrology and Coal Research Sections, and the Paleomagnetic Section.

Three new organizational units were established within the Division . The Marine Geology Group of Marine Sciences Branch in Vancouver was transferred to the Cordilleran Section to form a Marine Geology unit under Dr. D.L. Tiffin and including B.E.B. Cameron, micropaleontologist, of the Cordilleran Section. The unit will be responsible primarily for delineating the geological framework of the Pacific Continental Shelf and Slope.

The Eastern Petroleum Geology Section under B.V. Sanford was formed in January to undertake Basin Analysis mainly for subsurface data on the Atlantic Continental Shelf and in Hudson Bay.

The Paleomagnetic Section was transferred from the Exploration Geophysics Division in order to integrate the activities of this section as closely as possible with the scientists concerned with regional geology. The section is under the leadership of Dr. W.F. Fahrig of Crustal Geology Division.

The Division mounted 62 field projects varying from small topical investigations to large helicopter supported regional reconnaissance surveys. The Division is heavily involved in preparing regonal compilations to be published at a scale of 1:1 million. Several officers were also engaged in the preparation of field trips and guide books for the International Geological Congress in 1972.

Staff of the Division continue to be involved in foreign assignments for CIDA. Dr. K.E. Eade spent the month of November 1970 in Ethiopia advising on a mineral exploration program. Dr. L.P. Tremblay spent about a month in January-February 1971 in Niger advising on phosphate resources in that

country and in Upper Volta where he was advising on an airborne geophysical survey.

During the year members of the Division published 1 memoir, 3 bulletins, 22 papers including 15 maps, 6 A Series maps, 1 topical report and in addition 76 papers in outside journals. They also gave a total of 51 talks to various meetings and institutions.

PERSONNEL NOTES

J.O. Wheeler was appointed Chief of the Division to suceed C.H. Smith who became Director of Departmental Planning. He was succeeded as Head of Cordilleran and Pacific Margin Section by Dr. H. Gabirelse.

T.E. Bolton was transferred to the staff of the Director to succeed J.F.Henderson as Secretary of the National Advisory Committee on Research in the Geological Sciences. He continues as Curator of the National Type Collection of Invertebrate and Plant Fossils but was succeeded by W.T. Dean as head of the Eastern Paleontology Section.

W.F. Fahrig was appointed head of the Paleomagnetic Section and B.V. Sanford head of the Eastern Petroleum Geology Section.

I.M. Stevenson was seconded to the staff of the International Geological Congress as Assistant Secretary General.

R.K. Wanless was seconded to Laval University, Quebec City early in September 1970 to organize and set up a K-Ar dating laboratory. K.L. Currie spent from January until April

at L'Ecole Polytechnique, Montreal in connection with his study of alkaline rocks.

D.C. Findlay and J.A.V. Douglas resigned from the staff to take employment elsewhere and G.W. Sinclair retired on account of ill health.

MEMBERSHIP ON COMMITTEES

J.O. Wheeler

1. PRESIDENT, Geological Association of Canada 1970-71
2. DIRECTOR, Canadian Geological Foundation
3. MEMBER, Canadian Geodynamics Committee
4. MEMBER, Visiting Committee, Dept. of Geology, Memorial University of Newfoundland.

ATTENDANCE AT MEETINGS

J.O. Wheeler

1. CIMM Annual Meeting, Toronto, April 1970
2. "Evolution of Deformed Belts" conference, Banff, May 1970
3. GAC Annual Meeting, Winnipeg, Aug.-Sept. 1970
4. Prospectors and Developers Association, Annual Meeting, March 1971.

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.

A new Section was formed on January 23, 1971, and named Eastern Petroleum Geology Section. R.D. Howie and B.V. Sanford of the Appalachian Section were transferred to the new Section, and B.V. Sanford was appointed Head. The Section will ultimately comprise seven scientists who will be responsible for geological evaluation of the potentially prospective (oil and gas) sedimentary basins of eastern Canada including Hudson and St. Lawrence Platforms, Atlantic Shelf and Carboniferous basins of Atlantic Provinces and Gulf of St. Lawrence. The Section will be relocated to offices of the Atlantic Oceanographic Laboratory, Dartmouth, Nova Scotia during the summer of 1971.

Geological studies of a mainly stratigraphic and structural nature, carried out by the Appalachian 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 a few areas in insular Newfoundland where field work on one of the remaining areas is in progress (680130). The project has two parts. During the year, detailed studies in the Grenvillian metamorphic rocks of the Great Northern Peninsula were completed (H.H. Bostock, Precambrian Sub-division) in preparation for reconnaissance 4-mile mapping during 1971. Stratigraphic field studies at 2-mile scale of the Strait of Belle Isle region were continued (L.M. Cumming) and will be completed during 1971. Within the eastern lowlands region, the Paleozoic stratigraphy of Coats, Bencus and Walrus Islands in northern Hudson Bay were studied during two weeks by helicopter from the DOT icebreaker CCGS Labrador (B.V. Sanford, 700080).

Problem studies in the field were restricted to New Brunswick. Two parties operated within the central mineral belt. Field work on the regional geology of the Plaster Rock map-area, east half, was completed (R. Skinner 700016). The last area to be similarly covered within the belt will be completed during 1971. Field studies of the structural style within the metalliferous Bathurst-Newcastle district was completed (H. Helmstaedt, 690015). The project has succeeded in identifying the sequence and geometry of penetrative structures in the host rocks and sulphide bodies, and has resulted in a much clearer understanding of the stratigraphic and volcanic controls on the sulphide mineralization. In southern New Brunswick, field work was completed on the surface and subsurface investigation of the oil shales of the Albert Formation (R.D. Howie, 600456).

Preliminary plans and designs were made for two field excursions to be conducted for participants of International Geological Congress meeting in

Montreal in 1972. They are trip AC45 to demonstrate the stratigraphy and paleontology of the Paleozoic strata of southern Ontario (B. V. Sanford) and trip AxAC63 to demonstrate the geotectonic elements of the Appalachian region (W. H. Poole).

In the office, preparation of terminal manuscript maps and reports were continued for the regional geology of the Antigonish Highlands and Antigonish Basin areas (D. G. Benson, 640043, 660019) and for the study of the Catamaran Fault in central New Brunswick (F. D. Anderson, 690013). A number of Section personnel were involved with compilation of 1:1,000,000 geological maps of the Appalachian and eastern lowlands regions.

Throughout the year, geologists of the Section were consulted by many geologists and geophysicists of 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 six geologists (F. D. Anderson, D. G. Benson, L. M. Cumming, H. Helmstaedt, W. H. Poole, and R. Skinner), and three technicians in the well sample preparation laboratory and repository (J. M. Greer, R. J. G. Seguin and W. U. ter Haar Romeny).

Summary accounts of most of these investigations are contained within Geological Survey Paper 71-1A. During the fiscal year 1970-71, the Section published within the Geological Survey, 3 Papers with maps, and contributions to 4 chapters of Economic Geology Report No. 1, fifth edition. In scientific journals, the Section published 12 papers and abstracts. In addition, compiled maps of one project-area were put on Open File, and a manuscript compilation of Ontario well cutting-samples and core, supplemental to GSC Paper 63-46, was passed to Ontario Department of Mines and Northern Affairs 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. Two geologists of Ontario Department of Mines and Northern Affairs are housed at the Geological Survey Ottawa office to study the samples and consult in the Section geologists. It is anticipated that the samples and core from Ontario will be transferred to the care of the Ontario department during the summer of 1971, and in preparation for the move, much of the Ontario core is being slabbed with a diamond saw by Ontario employees.

Several functions are performed by the 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, 46,402 samples were thus prepared. Duplicate sets of bottled samples are generally made by arrangement for provincial

authorities in Atlantic Provinces and Quebec. Some 5,806 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.

Throughout the year, 29 geologists from industry examined samples from the repository during 81 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. 10,293 feet of core were received during the year and 7,497 feet were slabbed.

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 in industry and other agencies. During the year, 14 collections were added.

Annual report of the Well Sample Preparation Laboratory 1970-71

	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
Hudson Bay Low-lands (Que., Ont., Man., N. W. T.)	267 (N.W.T.)	1	626	17	332 (Ont.)	2	626	17	-	-	-	-
Ontario	9782	254	39724	253	5947	40	39724	253	6279	42	4173	6
Quebec	244	15	2986	8	-	-	2986	8	-	-	1301	5
New Brunswick	-	-	96	1	277	3	96	1	277	3	-	-
Nova Scotia	-	-	21	1	-	-	21	1	-	-	-	-
Prince Edward Island	-	-	2949	11	941	5	2949	11	1065	6	332	3
Newfoundland	-	-	-	-	-	-	-	-	-	-	-	-
Other areas	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	10293	270	46402	291	7497	50	46402	291	7621	51	5806	14

Operating days ..... 251 days
Staff available during this period ..... 4.7 men per days
Total operating man-days ..... 1171 man-days

Utilized as follows:

	men	man-days		%
Drill chip preparation	1.3	324		31.3
Core Set preparation	1.0	225		15.8
Related work	1.7	422		36.3
a) Service examination facilities (SEF)	32		2.8	
b) Representative rock collection (RRC)	20		2.0	
c) General divisional work (GDA)	370		31.5	
Leave, etc.	0.7	200		16.6
Total	4.7	1171		100

PERSONNEL CHANGES

S.F.P. Colletta resigned from the Public Service on September 11, 1970 to enter university.

W.L. White resigned from the Public Service on January 1, 1971.

B.V. Sanford and R.D. Howie transferred to the newly formed Eastern Petroleum Geology Section on January 23, 1971. B.V. Sanford was named head of the new Section.

ATTENDANCE AT MEETINGS

International Symposium, Upper Mantle Committee, Flagstaff, Arizona - June 24 - July 1, 1970.

—H. Helmstaedt.

American Association of Petroleum Geologists, Calgary, Alta. - June 22-24, 1970.

- B.V. Sanford.

Geological Association of Canada, Winnipeg, Man. - Aug. 31 - Sept. 2, 1970.

- L.M. Cumming.

New England Intercollegiate Geological Conference, Rangeley, Me. - Oct. 1-4, 1970.

- F.D. Anderson, H. Helmstaedt, W.H. Poole, R. Skinner.

Ontario Petroleum Institute, Ottawa, Ont. - Oct. 5-7, 1970.

- L.M. Cumming, R.D. Howie, B.V. Sanford.

Geodynamics Symposium, Ottawa, Ont. - Oct. 6-7, 1970.

- L.M. Cumming, W.H. Poole.

Earth Science Symposium on Offshore Eastern Canada, Ottawa, Ont. - Feb. 22-24, 1971.

- R.D. Howie, L.M. Cumming, W.H. Poole, B.V. Sanford.

Geological Society of America, Northeastern Section, Hartford, Conn. - March 17-20, 1971.

- F.D. Anderson, H. Helmstaedt

Canadian Symposium on Research in Tectonics, Edmonton, Alta. - March 25-27, 1971.

- H. Helmstaedt

MEMBERSHIP ON COMMITTEES

F.D. Anderson	- Chairman, Northeastern Section, Geological Society of America.
D.G. Benson	- Chairman, Scientific Research Group, Professional Institute of Public Service of Canada.
L.M. Cumming	- Associate editor for eastern Canada, American Association of Petroleum Geologists.
R.D. Howie	- Member, Canadian Committee on Statistics of Drilling.
W.H. Poole	- 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.

- Chairman, Founding Committee, Appalachian Section, Geological Association of Canada.

B. V. Sanford - Member, American Commission on Stratigraphic Nomenclature.

- Member, Ontario Stratigraphic Committee.

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

R. Skinner - Branch representative, Departmental Field Equipment Committee.

SPECIAL TALKS

Cumming, L. M. - "Precambrian - Phanerozoic contacts and Ordovician sedimentation in the Hudson Bay area", G. A. C., Winnipeg, September 1970.

- "Abraham Gesner - author, inventor, and pioneer Canadian geologist," G. A. C., Winnipeg, September 1970.

Helmstaedt, H. - "Elastic properties of eclogite xenoliths from diatremes of the East Colorado Plateau and their implication to the upper mantle structure" (prepared by M. Kumazawa, H. Helmstaedt and K. Masaki), International Symposium, Flagstaff, Arizona, June 1970.

- "Structural geology of Bathurst-Newcastle district, N. B.", Univ. Ottawa, January 1971.

- "Microfabrics of eclogite nodules from kimberlite pipes of the Colorado Plateau and some geophysical implications", McGill Univ., February 1971.

- "Structural history of the Tetagouche volcanic belt, northern New Brunswick", G. S. A. Northeastern Section, Hartford, Conn., March 1971.

Sanford, B. V. - "Geology and oil and gas possibilities of the Hudson Platform", A. A. P. G., Calgary, Alberta, June 1970.

OUTSIDE PUBLICATIONS

Cumming, L. M.

1970 - Precambrian-Phanerozoic contacts and Ordovician sedimentation in the Hudson Bay area (abstract); Geol. Assoc. Can., Program Annual Meeting, Winnipeg, p. 17.

1970 - Silurian - Devonian boundary: possible stratotype locality, Gaspé Peninsula, Quebec, Canada; Quart. J. Intern. Union Geol. Sciences, vol. 1970, no. 4, pp. 361-375 (with P.A. Bourque, C.F. Burk, Jr. and P.J. Lespérance).

1971 - Abraham Gesner (1797-1864) - author, inventor and pioneer Canadian geologist; Proc. Geol. Assoc. Can., vol. 23, pp. 5-10.

Helmstaedt, H.

1970 - Deformation history in part of the Lubec-Belleisle zone of southern New Brunswick; Can. J. Earth Sci., vol. 7, pp. 748-767 (with R.L. Brown).

1970 - Geology of map-area O-6, head of Middle River and Wildcat Brook, northern New Brunswick; N.B. Mineral Resources Branch, Map series 70-1, 18 p., 1 map.

1971 - Elastic properties of eclogite nodules from diatremes of the East Colorado Plateau and their implication to the upper mantle structure; J. Geophys. Res., vol. 76, pp. 1231-1247 (with M. Kumazawa and K. Masaki).

Helmstaedt, H., and Skinner, R.

1971 - Tectonic evolution of the Tetagouche volcanic belt, northern New Brunswick (abstract); Geol. Soc. Am., Northeastern Section, Program Annual Meeting, vol. 3, no. 1, p. 37,

Howie, R.D.

1970 - Developments in eastern Canada in 1969; Bull. Am. Assoc. Petrol. Geol., vol. 54, pp. 922-935 (with J.V. Hill). Also published in shortened form in Can. Petroleum, vol. 11, pp. 34-38 (1970); and abstracted in International Oil Scouts, and Can. Petroleum Assoc. Yearbook.

1970 - Oil and gas exploration-Atlantic coast of Canada; Bull. Am. Assoc. Petrol. Geol., vol. 54, pp. 1989-2006. Also published in shortened form in Offshore, vol. 30, pp. 84-96.

1971 - Regional geology of offshore eastern Canada (abstract); Earth Science Symposium on Offshore Eastern Canada, program, Ottawa (with G.H. Austin).

Sanford, B.V.

1970 - Palynology and correlation of Devonian formations in the Moose River Basin, northern Ontario; Proc. Geol. Assoc. Can., vol. 22, pp. 45-59 (with D.C. McGregor and A.W. Norris).

1970 - Toronto-Windsor area, Ontario; Ont. Dept. Energy and Resources Management, Map 69-1 (with R. J. Beards and D. D. McLean).

ACTIVE PROJECTS DURING REPORT-YEAR

580159	Sanford, B. V.	Subsurface studies of each of the Paleozoic systems of southwestern Ontario (Cambrian, Orodvician, Silurian and Devonian).
600032	Anderson, F. D.	Belleoram map-area.
600456	Howie, R. D.	Subsurface and regional studies in Eastern Canada as relation to oil and gas.
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 fault.
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).
700008	Poole, W. H.	St. Mary's River (NTS 11) map-area. 1:1,000,000 Geological Atlas Program.
700009	Sanford, B. V.	S. Ontario (NTS 30, 31, 40, 41) map-area. 1:1,000,000 Geological Atlas Program.
700011	Poole, W. H.	St. John River (NTS 21) map-area. 1:1,000,000 Geological Atlas Program.
700016	Skinner, R.	Plaster Rock map-area, N. B.
700038	Poole W. H.	IGC field trip AC63 "Appalachian tectonic elements."

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, which include determinations of coal rank, are carried out to obtain information on coal geology, coal mining and coal utilization (particularly the evaluation of coking coals), as well as on changes in regional and organic metamorphism of clastic rocks (with application towards the search for oil and gas). 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 preparing the text and slides of a paper on "Coal rank studies in the Rocky Mountain Foothills Belt" for presentation at the 1970 G.S.A. Meetings in Milwaukee. He has completed a topical report dealing with the correlation of coal seams at Carmacks, Y.T., and has examined three additional wells drilled for coal in the Springhill coalfield. He also participated (with A.R. Cameron) in the Departmental meetings on coal resource evaluation, carried out in connection with formulating a new energy policy for Canada.

A.R. Cameron has completed a manuscript on a petrographic study of a lignite seam from Estevan, Saskatchewan, and has updated Paper 70-52 by including data on molybdenum and vanadium in coal. He has also assisted with the compilation of the reports on the Smoky River and Lukunka River coalfields (See under Birmingham) and has carried out microscopic analyses for evaluation of coking properties on five seams from the Crowsnest area. In addition he has made progress 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 carried out a large number of rank determinations by means of reflectance measurements on coals of the Rocky Mountain Foothills Belt. He has also made a petrographic study of four seams from the Telkwa coalfield of British Columbia.

T.F. Birmingham has written a report on the Chamberlain seam of the Lukunka River coal area (B.C.) and has carried out petrographic analyses on the productive coal seam at Luscar, Alberta. He has also revised the technical report on four seams of the Smoky River coalfield, which was submitted in the previous year.

M.S. Barss has continued with his palynological studies of the Carboniferous type sections in the Atlantic Provinces. The biostratigraphy of the Horton Group has formed the main effort. In addition he has prepared 13 reports on age determinations of 102 rock samples submitted by G.S.C. and outside geologists. He also prepared a paper for the 1970 A.A.S.P. Meetings in Toronto, dealing with Pennsylvanian - Permian palynology of samples from the Yukon Territory.

C. Gange Harris has prepared coal for microscopic studies by cutting, grinding, and polishing samples and has produced 564 grain mounts and 472 polished sections. He also made 12 macerations for concentration of organic debris in clastic sediments, and has assisted with the compilation of diagrams for reports.

During the report year the following highlights can be mentioned:

(1) The rank studies in the Rocky Mountain Foothills Belt have shown that a) coal rank increases regularly with stratigraphic depth, but not with geologic age, depth of mining or degree of tectonic disturbance; b) the coalification gradient varies between the different coal areas, and those with a low gradient contain more seams in the coking range than those with a high gradient; c) in the Canmore coalfield the coal rank as determined by reflectance can be utilized to correlate coal seams.

(2) The petrographic evaluation of the R.M. Foothills coals has shown that the Chamberlain seam of the Lukunka River area is a premium coking coal.

(3) The observation that the lower coals at Fording River and Line Creek area have the same high content in fusinite and semifusinite as was previously noted in other parts of the Crowsnest coalfield.

(4) The lignite seam from Estevan showed: a) a greater variation in petrographic composition than was expected in such a relatively immature coal; b) low contents of molybdenum, vanadium and uranium (1 to 10 ppm on total coal basis). The latter appeared to be highest in the parts of the seam adjacent to roof and pavement, and the vanadium showed a concentration in the high ash bands.

(5) The petrographic study of the coals from Telkwa B.C. showed that not two, but three separate seams are represented by the Betty and the No. 3 and No. 4 seams. Moreover, a correlation could be established between the 5 Foot and McNiel seams.

(6) A new coal operation has been started at Springhill based on favourable drilling results obtained in the area indicated by P.A. Hacquebard, following request for geological assistance by the Nova Scotia Department of Mines.

(7) The recognition of seven spore zones in the Horton Group of the Atlantic Provinces, extending its known age from Lower Carboniferous to Middle Devonian.

ATTENDANCE AT MEETINGS

1. Coal symposium - Am. Chem. Society - Toronto, May : A.R. Cameron

2. Canadian Advisory Committee on Coal Research, Ottawa, - May 29: P.A. Hacquebard and A.R. Cameron.

3. 22nd Canadian Conference on Coal, Vancouver - Sept. 30 - Oct. 2: P.A. Hacquebard

4. American Association of Stratigraphic Palynologists, Toronto, Oct. 19-21: M.S. Barss.

5. Geological Society of America, Milwaukee, Nov. 11-13: P.A. Hacquebard.

MEMBERSHIP ON COMMITTEES

M.S. Barss - Several working groups of the I.C.M.P.
- Member, Organizing Comm. for 1970 Toronto Meeting of A.A.S.P.

A.R. Cameron - Member, Canadian Adv. Comm. on Coal Research
Member, Coal Petrology Comm. of Coal Geology Div. of G.S.A. Member, Industrial Application Subcomm. of I.C.C.P.

P.A. Hacquebard - Member, Nomenclature Subcomm. of I.C.C.P.
Member, Canadian Adv. Comm. on Coal Research
Member, Symposium Comm. of Coal Geology Div. of G.S.A. for 1970 meeting.
Member, Departmental Advisory Comm. on Coal

PRESENTATION OF PAPERS AND TALKS

1. P.A. Hacquebard and A.R. Cameron - "Petrology and tonstein occurrences in coals at Carmacks, Y.T." and "Occurrence and distribution of uranium in Canadian lignites", at Ottawa meeting of Canadian Advis. Comm. on Coal Research.

2. P.A. Hacquebard - "Coal rank studies in the Rocky Mountain Foothills Belt of Canada", at Milwaukee meeting of G.S.A.

3. M.S. Barss - "A problem in Pennsylvanian - Permian palynology of Yukon Territory" at Toronto meeting of A.A.S.P.

OUTSIDE PUBLICATIONS

Hacquebard, P.A. and Barss, M.S. - 1970
Palaeogeography and facies aspects of the Minto coal seam, New Brunswick, Canada. - Compte Rendu 6th Carb. Congress, Vol. III, pp. 861-872.

Hacquebard, P.A. and Donaldson, J.R. - 1970
Coal metamorphism and hydrocarbon potential in the Upper Paleozoic of the Atlantic Provinces, Canada - Can. Jr. Earth Sci., 7, pp. 1139-1163.

Hacquebard, P.A. and Donaldson, J.R. - 1970
Coal rank studies in the Rocky Mountain Foothills Belt of Canada - Abstract in Program with abstracts of 1970 Ann. Meeting of G.S.A., p. 564.

OTHER ACTIVITIES

1. A.R. Cameron examined sixteen samples of Australian coking coals provided by the Broken Hill Propriety Co. for comparison purposes.

2. A.R. Cameron reviewed the proofs of G.S.C. - Bulletin 175 - (Petrological aspects of the Harbour seam, Sydney coalfield).

3. P.A. Hacquebard prepared a report on the rank of carbonaceous material encountered with the deep sea drilling of Orphan Knoll by the Glomar Challenger in June 1970.

FIELD ACTIVITIES

P.A. Hacquebard and A.R. Cameron spent the month of June 1970 visiting the coal areas in the R.M. Foothills Belt and at Carmacks collecting coal samples for petrographic and rank studies. From Aug. 28 - Sept. 4 P.A. Hacquebard visited the Springhill coalfield to examine coal cores and mark borehole locations.

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	P.A. Hacquebard T.F. Birmingham	Petrography of coal seams in the Rocky Mountain 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.

CORDILLERAN AND PACIFIC MARGIN SECTION

H. Gabrielse

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

GEOLOGICAL RESEARCH UNIT

This unit, comprising 12 officers and 1 clerk, is based in Vancouver, B.C. and conducts geological research in the 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 to help guide future mineral exploration and to provide an aid for planning the orderly development of land utilization in the region. It supports by contract a submarine geology program on the Pacific Continental Shelf by the Department of Geology at the University of British Columbia and provides micropaleontological assistance for this work. A Marine Sciences group is currently being transferred to the Section and it will continue a long range program of geological and geophysical investigation of the Pacific Continental Shelf to provide information on hydrocarbon and other resource potential. The investigations are supplemented by, or supplement, 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. Current activities of the Section are directed towards two interrelated objectives; the completion of the reconnaissance phase of regional investigations to provide a broad geological and tectonic framework for the Cordilleran region, and, detailed studies of specific problems to further the understanding of the nature and sequence of geological processes, with particular reference to the formation and localization of mineral deposits. Reconnaissance studies were concerned with large areas in western Yukon Territory, north-central British Columbia, the Coast Range, and Northern Vancouver Island. More detailed projects involve studies of Upper Cretaceous and Lower Tertiary Sustut Group rocks and Permo-Carboniferous Cache Creek Group rocks in northern British Columbia, Tertiary rocks of the west coast of Vancouver Island, Mesozoic and Tertiary to Recent volcanic rocks in northern B.C. and some local areas of plutonic rocks in the Coast Range.

Ten members of the Section undertook field work in 1970. S.L. Blusson completed 4-mile mapping on Operation Stewart, an area of about 20,000 square miles in Yukon and adjacent District of Mackenzie. G.H. Eisbacher continued his detailed stratigraphic, sedimentological, and structural studies of Sustut Group rocks in northern British Columbia. H. Gabrielse began the 4-mile mapping in Omineca and Rocky Mountains on Operation Finlay. J.E. Muller devoted 5 weeks to investigations on Vancouver Island in preparation for a 1972 International Geological Congress field excursion. J.A. Roddick and W.W. Hutchison continued 4-mile mapping of Coast Mountains in the Bute Inlet, Pemberton, and northeastern Alberni areas. J.G. Souther continued an investigation of Mesozoic volcanic rocks between Telegraph Creek and Atlin areas and did preparatory work for an International Geological Congress field excursion in the region in 1972. H.W. Tipper continued 4-mile mapping supplemented by detailed stratigraphy of Mesozoic rocks in the Smithers area. J.O. Wheeler devoted several weeks to checking structural relations in the Big Bend area.

The remainder of the staff was engaged in office and laboratory studies. A Section office project, including most members of the Section, consisted of a compilation of 1:1,000,000 geological maps.

The Section maintains its close rapport with the mineral industry and officers are called upon for frequent consultation. Lectures were given at the Universities of British Columbia, Alberta, and Calgary, and the Section served a leading role in organizing and participating in the Cordilleran Section of the Geological Association of Canada's symposium on "Metamorphism in the Canadian Cordillera". One member of the section was invited to participate in the Geological Society of America Penrose Conference on the Precambrian held in the Medicine Bow Mountains near Laramie, Wyoming. In conjunction with its Coast Range project the Section continues to develop the application of computer techniques to geological data. The concerned staff members have been consulted on several occasions for advice on the use of computer programs.

During 1970-71 officers of the Cordilleran published 2 papers, 3 maps, and 15 outside papers: submitted 4 papers, 1 preliminary maps, 1 memoir, 2 final maps, and 7 outside papers: and made 24 oral presentations.

PERSONNEL CHANGES

J.O. Wheeler left the Section in October to assume duties as Chief of the Crustal Geology Division in Ottawa.

ATTENDANCE AT MEETINGS

National Conference on Earth Sciences; The Evolution of Deformed Belts, Banff, Alberta, May 4 - 8, 1970

- R. B. Campbell

AAPG-SEPM, Annual Convention, Calgary, Alberta, June, 1970

- B.E.B. Cameron

Symposium on Geophysics and Geology of the Bering Sea Region, University of Alaska, Fairbanks, Alaska, June 27, 1970

- J. G. Souther

Symposium on Economic Importance of Sandstones, Wyoming Geological Association, Casper, Wyoming, September, 1970

- G.H. Eisbacher

Penrose Meeting on Precambrian, Geological Society of America, Laramie, Wyoming, September 19 - 24, 1970.

- H. Gabrielse

American Geophysical Union, Pacific Northwest Division, Tacoma, Washington, October 15, 1970

- J.W.H. Monger

NAGGS/AGGG Geodynamics Symposium, Carleton University, Ottawa, Ontario, October 26, 1970

- J.W.H. Monger

CIMM, Western Meeting, Kamloops, October, 1970

- S.L. Blusson, R.B. Campbell

Open Pit Stability, Centre for Continuing Education, University of B.C., Vancouver, B.C., November, 1970

- G.H. Eisbacher

7th Annual Interuniversity Western Conference, Edmonton, Alberta, November, 1970

- D.J. Tempelman-Kluit

World Lead-Zinc Symposium, AIME, St. Louis, Missouri, November, 1970

- D.J. Tempelman-Kluit

Symposium - Offshore Eastern Canada, Ottawa, Ontario, February, 1971

- B.E.B. Cameron

Symposium on "Metamorphism in the Canadian Cordillera", Cordilleran Section, Geological Association of Canada, Vancouver, B.C., February 26 - 27, 1971

- S.L. Blusson, R.B. Campbell, G.H. Eisbacher, H. Gabrielse, W.W. Hutchison, J.W.H. Monger, J.E. Muller, D.J. Tempelman-Kluit, H.W. Tipper

NACRGS, Subcommittee on Computer Applications, Calgary, Alberta, February, 1971

- W.W. Hutchison

ERTS Satellite, Remote Sensing Program, Victoria, B.C., March 1971

- S.L. Blusson, W.W. Hutchison

Storage and Retrieval of Geologic Field Data, NAC Subcommittee, Vancouver, B.C., March 1971

- W.W. Hutchison

Geological Society of America, Cordilleran Section Meeting, Riverside, California, March, 1971

- D.J. Tempelman-Kluit, J.A. Roddick

Applications of Structural Geology to Rock Mechanics, NAC and University of Alberta, Edmonton, Alberta, March 1971.

- G.H. Eisbacher

MEMBERSHIP ON COMMITTEES

B.E.B. Cameron	- Co-Chairman, Palaeontology, SEPM; AAPG-SEPM Convention, June, 1970, Calgary, Alberta
	- Assist with organization of east coast subsurface geology group under B.V. Sanford, G.S.C., Ottawa, Ontario
R.B. Campbell	- Technical Programme Committee Chairman, CIM Annual Western Meeting, Vancouver, B.C., October, 1971
G.H. Eisbacher	- Member, NAC Subcommittee on Structural Geology
H. Gabrielse	- Regional Chairman, Field Excursion Committee, 24th International Geological Congress
W.W. Hutchison	- Chairman, Subcommittee on Recording Geological Field Data
	- Chairman, Geological Association of Canada, Public Information Committee
	- Secretary-Treasurer, Cordilleran Section, Geological Association of Canada
	- Editor, GEOLOG, Geological Association of Canada
	- Member, Subcommittee on Computer Applications
	- Member, Vancouver Committee on Computer Applications in the Mineral Industry

J.W.H. Monger - Member, Programme Committee for Symposium on Metamorphism in the Canadian Cordillera, Geological Association of Canada, Cordilleran Section, February 1971

J.A. Roddick - Member, Pacific Science Association Committee on Solid Earth Sciences

J.G. Souther - Member, Advisory Committee on Satellites and Remote Sensing, NRC

SPECIAL TALKS

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

Campbell, R.B. - "Structure and Metamorphism of Cariboo Mountains, B.C.", delivered to Cordilleran Section, Geological Association of Canada, Vancouver, May, 1970; Geology Department, University of Alberta, Edmonton, Alberta, December, 1970; Geology Department, University of Calgary, Calgary, Alberta, December, 1970; Symposium on Metamorphism in the Canadian Cordillera, Cordilleran Section, Geological Association of Canada, Vancouver, B.C., February, 1971.

Eisbacher, G.H. - "Mapping of Structural Rock Defects", presented at meeting of NAC and University of Alberta, Edmonton, Alberta, March 1971.

- 'Influence of Mesozoic Tectonics on Deposition of Late Cretaceous-Tertiary Sustut Group", presented at McConnell Club, Calgary, Alberta, March, 1971.

Gabrielse, H. - "Precambrian of the Canadian Cordillera", presented at the Penrose Conference on the Precambrian, Geological Society of America, Laramie, Wyoming, September, 1970.

- "Regional Metamorphism and 'Orogeny' in Part of the Northern Canadian Cordillera", presented at the Symposium on Metamorphism in the Canadian Cordillera, Cordilleran Section Geological Association of Canada, Vancouver, B.C., February 1971.

Hutchison, W.W. - "Major aspects of metamorphism in the Canadian Cordillera", presented at Symposium on Metamorphism in the Canadian Cordillera, Cordilleran Section, Geological Association of Canada, Vancouver, B.C., February 1971.

- 'Computer based systems for recording geologic field data", University of British Columbia, Vancouver, B.C., March 1971.

Monger, J.W.H. - "Tectonism in the Pacific Northwest", Panel Member, American Geophysical Union, Pacific Northwest Division, Tacoma, Washington, October 1970.

- 'Oceanic crust in the Canadian Cordillera?", Geodynamics Symposium, NAGGS/AGGG Geodynamics Symposium, Carleton University, Ottawa, Ontario, October 1970.

- "Metamorphic Map of the Canadian Cordillera" (with W.W.Hutchison), and on "Low Temperature metamorphism; distribution and recognition" presented at the Symposium on Metamorphism in the Canadian Cordillera, Cordilleran Section, Geological Association of Canada, Vancouver, B.C., February 1971.

Roddick, J.A. - 'Data recording, processing and retrieval of the Coast Mountains Project", NACRGS Subcommittee on Computer Applications, Vancouver, B.C., March 1971.

Souther, J.G. - 'Natural History of Mt. Edziza Volcano, Calgary Field Naturalists' Society, Calgary, Alberta, April 22, 1970.

- The Cordilleran System, Invited lecture, University of Oregon, Eugene, Oregon, May 6, 1970.

- Tectonic Implications of Volcanism in the Cordillera of Western Canada, Symposium on Geophysics and Geology of the Bering Sea Region, University of Alaska, Fairbanks, Alaska, June 27, 1970.

- Physical Evolution of Mt. Edziza Volcano; McConnell Club, I.S.P.G., Calgary, Alberta, January 26, 1971.

- Physical Evolution of Mt. Edziza Volcano; Logan Club, G.S.C., Ottawa, Ontario, January 27, 1971.

- Mt. Edziza; CBC, T.V. 1/2-hour educational program, February 5, 1971.

- Volcano Park; CBC, T.V. 1/2-hour educational program, February 8, 1971.

Tempelman-Kluit, D.J. - 'Geological setting of mineral deposits in Yukon", presented at 7th Annual Interuniversity Western Conference, Edmonton, Alberta, November, 1970.

- 'Effects of metamorphism on sulphide bodies with special reference to metamorphic effects on zinc-lead deposits in Anvil Range", presented at Geological Society of America, Cordilleran Section meeting, Riverside, California, March, 1971.

OUTSIDE PAPERS

Campbell, R.B.

- Structural and metamorphic transitions from infrastructure to superstructure, Cariboo Mountains, British Columbia; Geol. Assoc. Canada, Special Paper No. 6.

- Geology and Mineral Exploration Potential of the Quesnel Trough, British Columbia; CIMM Bull., vol. 63, pp. 785 - 790. (with H.W. Tipper)

- Geology of the region between Prince George and Jasper; Edmonton Geol. Soc. Field Conference Guide Book, 1970, pp. 84-93 (with H.A.K. Charlesworth).

Eisbacher, G.H.

- Contemporaneous faulting and clastic intrusions in the Quirke Lake Group, Ontario; Can. Jour. Earth Sci. vol. 7, No. 2, pp. 215 - 225.

- Deformation mechanics of mylonitic rocks and fractured granites in Cobequid Mountains, N.S., Canada; Geol. Soc. Am. Bull., vol. 81, pp. 2009 - 2020.

- Elastic-strain-Recovery in Proterozoic Rocks near Elliot Lake, Ontario; Jour. Geophys. Research, (March, 1971)(Co-authored with H. Bielenstein).

Hutchison, W.W.

- Metamorphic framework and plutonic styles in the Prince Rupert region of the Central Coast Mountains, British Columbia, Can. Jour. Earth Sci. vol. 7, pp. 376 - 405.

Monger, J.W.H.

- Distribution of fusulinaceans in the western Canadian Cordillera, Can. Jour. Sci., v. 8, no. 2, pp. 259 - 278 (with C.A. Ross).

Roddick, J.A.

- Computer based system for recording geological field data in the Coast Mountains, B.C.; National System for Geological Data Progress Report No. 1 (with W.W. Hutchison).

Souther, J.G.

- Volcanic studies suggest potential exploration tool: The Northern Miner, Annual Rev. No. 26, 1970, p. 88 (with W.R.A. Baragar)

- Tectonic implications of volcanism in the Cordillera of Western Canada; abstract, Inaugural Symposium, The Geophysics and Geology of the Bering Sea Region, 1970, Geophysical Institute of the University of Alaska.

Tempelman-Kluit, D.J.

- The relationship between sulphide grain size and metamorphic grade of host rocks in some stratabound pyritic ores, Jan. Jour. of Sci., vol. 7, no. 5, pp. 1339 - 1345, 3 figs.

ACTIVE PROJECTS DURING REPORT YEAR

490038	Gabrielse, H.	Miscellaneous field investigations by staff at Vancouver Office.
580009	Tempelman-Kluit, D.J.	Operation Pelly
620019	Hutchison, W.W.	Prince Rupert- Skeena map-areas
630016	Roddick, J.A.	Coast Mountain Project

650010	Blusson, S.L.	Operation Selwyn
650015	Souther, J.G.	Geology of Mt. Edziza Volcano
660002	Monger, J.W.H.	Atlin Horst Project
670009	Tempelman-Kluit, D.J.	Stratigraphic-structural study of the Anvil-Vangorda district
680038	Muller, J.E.	Geology of Northern Vancouver Island
680066	Campbell, R.B.	Geology of the Cariboo Mountains, British Columbia
680118	Gabrielse, H.	McMillan River map-area, 1:1,000,000 Geological Atlas Program
680119	Blusson, S.L.	Operation Stewart
690009	Tipper, H.W.	Smithers map-area
690023	Monger, J.W.H.	Upper Paleozoic Rocks of Stikine Arch
690032	Eisbacher, G.H.	Tectonic Framework of Sustut and Sifton Basins
690063	Souther, J.G.	Volcanic Stratigraphy of Telegraph Creek map-area
690075	Cameron, B.E.B.	Tertiary Foraminiferal Succession of Western Cordillera and Pacific Margin
690083	Tipper, H.W.	Investigation of the Lower Jurassic genus Weyla as a guide fossil in British Columbia
700004	Roddick, J.A.	Fraser River map-area, 1:1,000,000 Geological Atlas Program
700005	Souther, J.G.	Iskut River (NTS 104+114) map-area, 1:1,000,000 Geological Atlas Program
700006	Hutchison, W.W.	Skeena River (NTS 103) map-area, 1:1,000,000 Geological Atlas Program
700007	Tipper, H.W.	Parsnip (NTS 93) map-area, 1:1,000,000 Geological Atlas Program

700025	Tempelman-Kluit, D.J.	Operation Snag
700026	Souther, J.G.	Cordilleran Volcanic Project
700044	Monger, J.W.H.	I.G.C. Field Trip A03, C03, Guidebook preparation
700047	Gabrielse, H.	Operation Finlay

INFORMATION SERVICES UNIT

S. Leaming

Sales from the Vancouver office reached a new peak in the year 1970 - 1971. The highest sales occurred in January 1971 when the release of E.G. 1 and a very large sale to a mining company building up a reference library, boosted the monthly sales to $6,390.70.

January is not normally the busiest month. In past years peak sales occurred in April reflecting to a great extent field preparations by hundreds of mining companies and individual prospectors, consultants, etc.

Table II shows the monthly sales in the general categories of items and the number of visitors. For comparison the 1969 - 1970 totals are included.

Increase of activity since 1963 is shown on the appended graph which shows only the sales of topographic maps and Geological Survey publications. It is apparent that there has been a three fold increase in volume.

There has been an increasing awareness of our presence as a source of information by the general public and many calls are received relating to matters pertaining to other departments and agencies. Enquiries regarding employment has noticeably increased over former years.

Activities

Mr. Leaming spent 26 days in the field visiting properties with the object of collecting minerals for:

(1) an office collection
(2) supplementary to Mr. Stacey's requirements

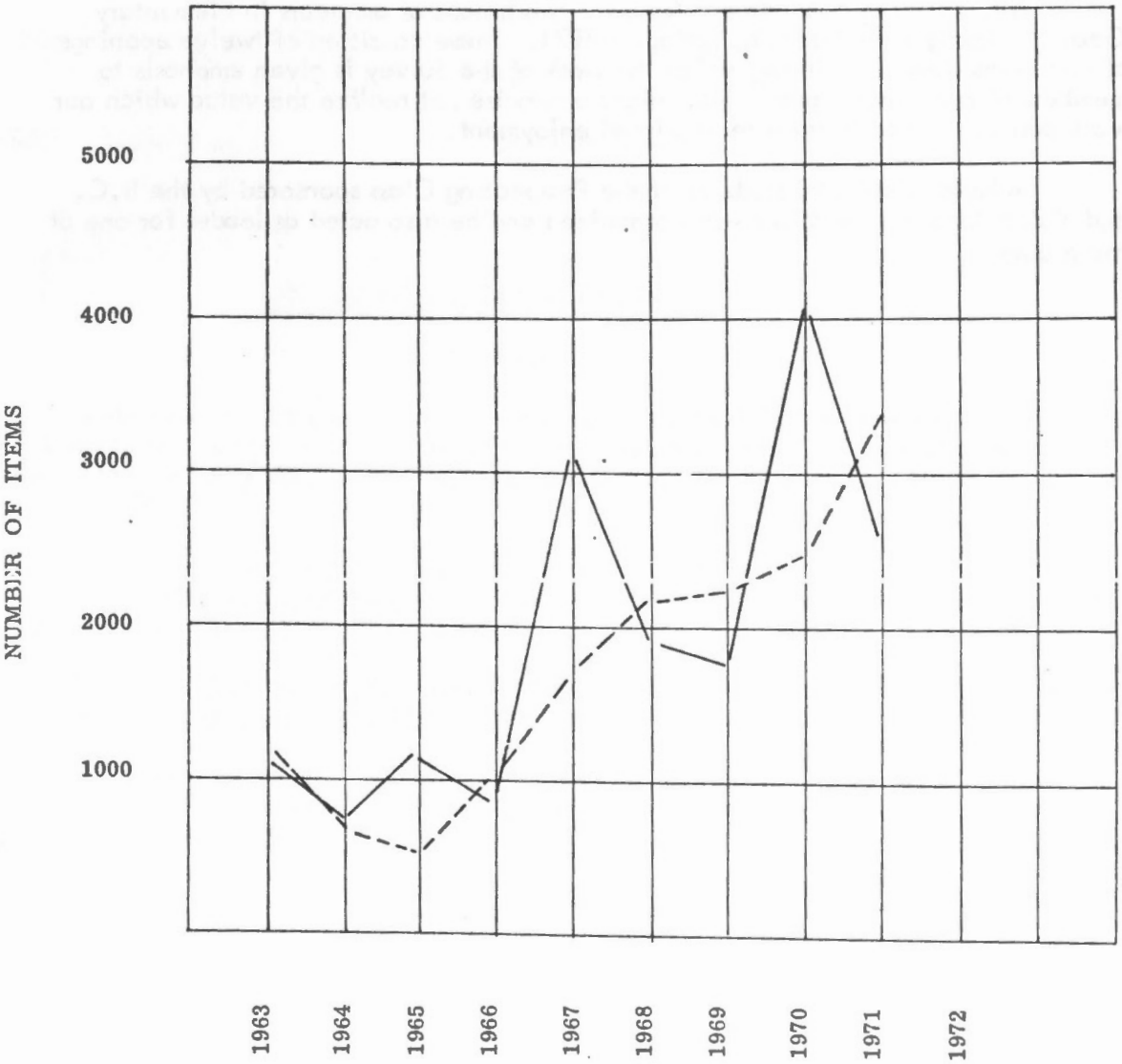
A second objective was to become familiar with new prospects and field activities of mining companies. A third objective was to visit new jade-producing properties as a continuing necessity in advising the Department of Industry, Trade and Commerce in respect to Certificates of Origin for export purposes, and the geological environment of in situ jade deposits with the aim of producing a paper on this subject.

Trips were made to Mt. Ogden where jade is being mined for the first time and to Bridge River area where development on several properties are being followed.

Mr. Leaming's office time is divided between public information matters outside the scope of the clerical staff, some section administrative work, the completion of a paper on Rocks and Minerals in B.C., and preparation for a report on Jade in B.C.

Mr. Leaming conducted classes for two groups of amateurs in Elementary Geology during the winter and spring of 1971. These consisted of twelve evenings of two hours duration, during which the work of the Survey is given emphasis to members of the general public who might otherwise not realize the value which our work can contribute to their recreational enjoyment.

A field trip for 90 students of the Prospecting Class sponsored by the B.C. and Yukon Chamber of Mines were organized and he also acted as leader for one of the groups.



GRAPH SHOWING INCREASE
IN VOLUME OF SALES
1963 - 1971 DURING JANUARY

——— Topographic Maps
– – – – – Geological Maps

TABLE I

	Visitors	Sales	Topo Maps	G. S. C. publications	Rock and Mineral Sets	Photo copies(1)	British Columbia Dept. Mines(2)	Mines Branch
April '70	1,038	$ 4,660.35	4,778	1,742	114	483	$ 684.50	$ 16.30
May	1,157	5,998.95	4,936	2,723	114	417	393.80	9.50
June	1,171	4,071.15	4,846	1,563	55	471	276.20	5.75
July	917	3,407.00	4,460	1,666	29	205	186.90	11.85
August	886	2,974.30	3,708	1,059	27	297	778.50	78.75
September	929	3,257.35	3,485	1,269	48	135	311.00	35.35
October	941	2,990.65	2,704	1,585	80	157	329.00	15.35
November	782	3,198.65	2,021	1,516	158	187	253.00	43.55
December	589	2,203.20	1,687	1,372	47	154	269.00	18.00
January '71	759	6,073.70	2,609	3,403	93	229	317.00	22.85
February	902	4,663.30	2,631	1,404	183	365	296.50	54.90
March	937	4,606.05	3,389	1,633	191	256	324.00	17.75
TOTALS 1970/71	11,008	$48,104.85	41,254	20,935	1,112	3,356	$4,419.40	$329.90
1969 - 1970 for comparison	11,363	$43,142.50	40,053	27,441	1,000	3,546	$3,701.20	$259.30

(1) Not including staff use.

(2) Not shown in total sales.

EASTERN PALEONTOLOGY SECTION

W.T. Dean

ACTIVITIES

The work of the Eastern Paleontology Section is concerned primarily with the establishment of biostratigraphical standards in eastern Canada by means of the identification and description of fossil faunas and floras, particularly those obtained from rock successions with good stratigraphical control. By these means it is hoped eventually to achieve detailed correlations not only within eastern and other regions of North America, but also with other parts of the world. Investigations to this end are carried out partly by members of the Section and partly in collaboration with, and as a service to, GSC field geologists, as well as scientists outside GSC.

During the year the scientific staff was reduced to three, supported by a technical staff of six whose duties include also the sorting, curation and storage of specimens collected by geologists both inside and outside the Section.

Members of the Section carried out field investigations in a variety of areas, including southwestern Ontario; Coats and Southampton Islands, Hudson Bay (Bolton), Anticosti Island, P.Q. (Bolton and Copeland), Newfoundland and New Brunswick (Dean), and Gaspé, P.Q. (McGregor).

TYPE COLLECTION

T.E. Bolton continued as Curator of the National Type Collection of Invertebrate and Plant fossils. A total of 1208 types described in both Survey and outside publications was added to the Type Collection in 1970. Publications in which these types were reported are as follows:

GSC Bull. 182	- Cambrian trilobites to Permian bryozoans, Eastern and Arctic Canada.....	327 types
GSC Paper 68-30	- Cretaceous Mollusca, Alberta.....	4
69-39	- Precambrian stromatolite	1
70-19	- Ordovician trilobites, Newfoundland	9
70-21	- Carboniferous forams, Nova Scotia	90
70-44	- Ordovician trilobites, Newfoundland	14
EG 1	- Cambrian-Silurian faunas	57

Types in Outside Publications:

Boucot, A.J. et al (Oregon), GSA Sp. Paper 119	1
Delorme, L.D. (Inland Waters), Can. J. Zoology, 48:2	54
Fahraeus, L.E. (Memorial), Bull. GSA, 81	11
Ferguson, L. (Mount Allison), Int. Union Geol. Sci., A:1	1
Frebold, H. (GSC), Can. J. Earth Sci., 7:2	38
Johnson, J.G. (Oregon), Bull. GSA, 81:7	13

Lenz, A.C. (Western), J. Pal., 44:3 ..... 82 types
Logan, A. (New Brunswick), J. Pal., 44:3, 44:5 11
Ludvigsen, R. (Inexco Oil), Bull. Can. Petrol. Geol., 18:3 59
McGregor, D.C. et al. (GSC), Proc. GAC, 22 36
Mitchell, S.W. (Wayne State), Michigan Acad., 2:3 11
Mosher, L.C. (Florida State), J. Pal., 44:4 10
Nassichuk, W.W. (GSC), J. Pal., 44:1 31
Rigby, J.K. (Brigham Young), J. Pal., 44:1 4

An additional 120 fossil specimens were deposited in the National Type Collection during the year by Dr. C.H. Crickmay, and over 225 specimens were consigned on long loan by Laval University.

PALEONTOLOGY PREPARATION LABORATORY SERVICES, 1970-71

Names	Saw Cuts	Thin Sections	Peel Sections	Rubber Moulds	Plaster Casts	Rubber Casts	Mechanical Preparations
Bolton, T.E.	698	359		110	332		
Copeland M.J.	8	8					
Dean, W.T.	178						
Frebold, H.	151			30	59	192	148
Fritz, W.H.	30			26		26	
Jeletzky, J.A.	6	1		8	16	10	
Tozer, E.T.	3	3		11	14	18	
Uyeno, T.T.	22						
Divisional & Branch Services							
Brown, D.	3						
Taylor, F.C.	5						
Jackson, G.	26						
Steele, M.		105					
Univ. of Manitoba			250				
TOTAL	1130	476	250	185	421	246	148

Parcels Received 287
Parcels Shipped 145
Fossil Localities Catalogued
Invertebrate (GSC #85072 to 86880) 1,808
Plant (GSC #8838 to 8887) 49

The technical Curator, B.J. Botte, attended a Public Service Safety Seminar (one week) sponsored by the Canada Department of Labour, and spent three days at the Industrial Accident Prevention Association Conference in Toronto.

Four days were spent demonstrating the uses of Collodium Peels, as used in the Paleontological study of specimens, to students from the University of Manitoba.

Approximately one month was spent preparing Dr. T.T. Uyeno's conodont material for shipment to Calgary.

MICROPALEONTOLOGY LABORATORY SERVICES 1970-71

A total of 172 samples were prepared mechanically by crushing and washing, or were processed mechanically and chemically for the recovery of microfossils (conodonts, foraminifera, ostracods); 43 have been examined under the microscope and picked for forams and ostracods. Heavy liquid separations were carried out in the search for conodonts in 129 samples. Of the latter, 27 weighed 5½ kilos each, 11 were 8 kilos each and 9 were 4 kilos each. The remainder were regular samples.

	Anti-costi	Nfld.	N.S.	N.B.	P.Q.	Man.	B.C.	NWT	Y.T.	USA	Arctic	Total
Dev.					12			42				54
Sil.	24			1		7		1			20	53
Ord.	19	14	2	6			7		8	4	2	64
Camb.										1		1
TOTAL	43	14	2	7	12	7	7	43	8	5	22	172

PERSONNEL CHANGES

T.E. Bolton - transferred to Director's office, February 1st, 1971.

W.T. Dean - appointed Acting Head of Section, February 1st, 1971.

G.W. Sinclair - retired July, 1970.

ATTENDANCE AT MEETINGS

T.E. Bolton - Geological Association of Canada, Annual Meeting, Winnipeg, Manitoba.
American Association of Petroleum Geologists, Annual Meeting, Calgary, Alberta.
Biostratigraphy Seminar, Sudbury, Ontario.
Geological Society of America, Annual Meeting Milwaukee, Wisconsin.

M.J. Copeland – Geological Association of Canada, Annual Meeting, Winnipeg, Manitoba, Aug.-Sept. 1970.
Geological Association of Canada, Newfoundland Section meeting, Nov. 1970.

D.C. McGregor – Annual Meeting of American Assoc. of Stratigraphic Palynologists, Toronto, Oct. 14-17, 1970.
Discussion meeting, Commission Internationale de Microflore du Paléozoïque, London, England, Sept. 21-22, 1970.
International Symposium on Sporopollenin, Imperial College, London, England, Sept. 23-25, 1970.
Paleontology Discussion Group, University of Calgary, Calgary, Nov. 23, 1970.

STUDY OF COMPARATIVE MATERIAL

M.J. Copeland – USNM Washington, February, 1971.

W.T. Dean – USNM Washington, December 1970.
Harvard and Princeton Universities, March, 1971.

D.C. McGregor – I.S.P.G. and oil company palynology laboratories in Calgary, Nov. 23-27, 1970.
Type specimens of Devonian spores of Vestspitsbergen at Sedgwick Museum, Cambridge, Sept. 1970.

MEMBERSHIP ON COMMITTEES

T.E. Bolton – Chairman, GAC Programme and Publications Committee.
Member, GAC Editorial Committee.
Member, Exhibits Committee, IGC.
Program Coordinator, IGC Technical Program Committee.
Member, AAPG Committee on Stratigraphic Correlations.

M.J. Copeland – Geological Association of Canada - Councillor.
Geological Association of Canada - Member of Executive Committee.
Geological Association of Canada - Editor.
Geological Association of Canada - Chairman of Editorial Committee.

W.T. Dean – Adviser, Treatise on Invertebrate Paleontology.
Subcommittee on Ordovician Stratigraphy, Geological Society of London.

D.C. McGregor – Program Committee, American Assoc. of Stratigraphic Palynologists.
Nominating Committee, American Assoc. of Stratigraphic Palynologists.
North American Secretary, Commission Internationale de Microflore du Paléozoïque.

SPECIAL TALKS

D.C. McGregor - "Spores near the Lower/Middle Devonian boundary in Canada" - at Discussion Meeting, C.I.M.P., London, England.

"Devonian spores of the Queen Elizabeth Islands, Northwest Territories" - at the Annual Meeting of the Amer. Assoc. Stratig. Palynologists, Toronto.

OUTSIDE PUBLICATIONS

M.J. Copeland
1969: Ordovician Fossils from Lakefield Quarry: in Geology and Scenery - Peterborough, Bancroft and Madoc area, by D.H. Hewitt, Ontario Dept. Mines, Geol. Guidebook No. 3, pp. 24-29 (with G.W. Sinclair and T.E. Bolton).

W.T. Dean
1970: The Lower Paleozoic stratigraphy and faunas of the Taurus Mountains near Beyşehir, Turkey, Pt. 1. (with O. Monod). Bull. Brit. Mus. (Nat. Hist.), Geol., 19, pp. 411-426, 8 figs.

1971: The Lower Paleozoic stratigraphy and faunas of the Taurus Mountains near Beyşehir, Turkey. Pt. 11. Bull. Br. Mus. (Nat. Hist.), Geol., 20, pp. 1-24, 5 pls., 3 figs.

D.C. McGregor
1970: Hymenozenotriletes lepidophytus Kedo and associated spores from the Devonian of Canada. Colloque sur la Stratig. Carbonifere, Congres et Colloques Univ. Liege, Vol. 55, pp. 315-326, Liege, Belgique.

D.C. McGregor, B.V. Sanford, and A.W. Norris
1970: Palynology and correlation of Devonian formations in the Moose River Basin, northern Ontario. Geol. Assoc. Canada, Proc., Vol. 22, pp. 45-54, Toronto.

ACTIVE PROJECTS DURING REPORT YEAR

500029 - Staff: Identification of referred collections.

570015 - T.E. Bolton: Silurian-Ordovician macrobiostratigraphy of Anticosti Island.

580037 - T.E. Bolton: Maintenance of the paleontological type collection.

580153 - T.E. Bolton: Lexicon of stratigraphic names used in Canada.

600225 - D.C. McGregor: Microfossils from the Ordovician Red River Formation.

600227 - D.C. McGregor: Devonian plant microfossils of eastern Canada.

640040 - M.J. Copeland: Ordovician and Silurian microfauna, Anticosti Island.

670083 - D.C. McGregor: File of diagnoses of fossil spore and pollen genera.

680113 - D.C. McGregor: Biostratigraphic study of Paleozoic palynomorphs of the Arctic Islands.

680117 - M.J. Copeland: Ordovician and Silurian Ostracoda, Lakes Timiskaming and Nipissing, Ontario.

690006 - W.T. Dean: Lower and Middle Paleozoic biostratigraphy, Gaspé, Québec, Maritime region and Newfoundland.

690027 - T.E. Bolton - H.M. Steele: Ordovician of Ottawa Valley.

GEOCHRONOLOGY SECTION

ANNUAL REPORT, 1970-71

Introduction

The Geochronology 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.

During the report-year the Section has continued to determine geological ages by means of the K-Ar, Rb-Sr and U-Th-Pb methods, and to determine the isotopic composition of lead, sulphur and carbon in varied geological materials. Geochronological research initiated and conducted by the Section continued in the Noranada and Chibougamau districts and extended into the Fabre - Laniel area on the Quebec side of Lake Temiscaming. Field studies of short duration were carried out in each of these areas. Laboratory based research into the refinement of techniques for dating very young basaltic rocks has yielded encouraging results.

Activities

1. K-Ar Age Determination: A total of 182 K-Ar age determinations were made during the report-year. They were carried out on samples of biotite, muscovite, phlogopite, hornblende, sanidine, glauconite and whole-rocks from various Canadian surface and subsurface localities. In addition, several samples of glauconite from drilling sites on the eastern continental shelf as far off-shore as Sable Island have been dated, as also has one basic dyke of Precambrian age from Greenland. The great majority (90%) of these determinations were carried out for officers of the Crustal Geology Division.

2. Rb-Sr Age Determination: Rb-Sr geochronology is divided into two classes of determination:- isochron ages based on data from several (4 +) rock and mineral samples for each age, and mineral ages requiring analytical work on single mineral samples. In the report-year the Section has essentially completed five isochron age studies (Timber Lake granite, Kaminak Lake alkalic pluton, Penrhyn Group gneisses, Long Range gneisses and Michipicoten volcanics) for officers of the Crustal Geology Division, and fifteen mineral ages, all but one of which were also for Crustal Geology. The mineral ages were determined on concentrates from the Christmas Creek batholith, five samples from dykes cutting Precambrian Shield rocks, Kedahda Lake samples, Jacques Cartier granite, kimberlite from the Noranda district, four samples of gabbroic rocks from Labrador, the Wilson Island Group, and the Highland Valley copper district.

3. U-Th-Pb Age Determination: Mass spectrometric analyses were carried out on five uraninite/pitchblende samples for the Economic Geology and Geochemistry Division. This involved thirteen lead isotope determinations and five determinations each of uranium and thorium. Six complete mass spectrometric analyses on four size fractions of a zircon concentrate obtained from 700 lbs of Pontiac Schist have been carried out and involved nineteeen lead isotope determinations and six each of uranium and thorium. These studies of zircon geochronology relate to the Section's continuing research into the

Archean geological history of the Noranda -Val d'Or district. Preliminary work on several other zircon samples from this area commenced during the report-year and will be completed at a later time.

4. Lead Isotopic Analyses: Mass spectrometric determination of lead isotopic composition in minerals and rocks in relation to stable isotope studies (as distinct from geochronology described above) is designed to study the origin and nature of ore minerals, orebodies and their associated rocks. In this regard lead isotopic analyses have been carried out for officers of the Economic Geology and Geochemistry Division on eleven minerals from the Keno Hill - Galena Hill area and twenty seven samples from other unspecified localities.

5. Sulphur Isotopic Analyses: Isotopic analyses of sulphur from minerals and rocks were carried out primarily as a service operation during the report-year, though in previous years sulphur studies have been undertaken as co-operative research projects in order to elucidate the nature and origin of sulphide ore deposits and to investigate mineral paragenesis. This year a total of 152 samples were subjected to sulphur isotope analysis for the Economic Geology and Geochemistry Division.

6. Carbon Isotopic Analyses: A total of 123 samples were mass spectrometrically analyzed to determine their C^{13}/C^{12} isotopic ratios for the Radiocarbon Laboratory of the Quaternary Research Division. These data are employed in the computation of corrections to be applied to C^{14} age determinations carried out by that laboratory.

7. Laboratory Development: Final assembly of the new 15 inch solid source mass spectrometer was completed and the instrument was tested under high vacuum operating conditions. Certain design modifications to the internal parts and electronic components were found to be necessary. These changes were executed and final testing will establish the satisfactory performance of this instrument. It will be used primarily for high accuracy lead and uranium isotopic analysis.

Also during the past year the component parts of a second AEI MS-10 high sensitivity gas source mass spectrometer were acquired, suitably modified to our requirements and partly assembled to the stage of satisfactory vacuum testing. At a future time electronic assembly, testing and adjustment will be undertaken and the instrument will be used for argon isotopic analysis in the K-Ar age determination program. With its pre-existing sister instrument it will enable us to analyze both young and old samples concurrently without the risk of cross-contamination or memory effect inherent in the use of a single mass spectrometer for samples of all age ranges.

Associated with the secondment of the Section Head to Laval University to establish a K-Ar age determination laboratory within that institution, the Section has been active in the assembly, modification and testing of an additional AEI MS-10 mass spectrometer for that purpose. Work done on this instrument in Ottawa related mainly to physical modification, fabrication and vacuum technology. Electronic design and assembly was mainly accomplished at Laval and has resulted in an entirely new filament power supply and emission control system which was subsequently tested under operating conditions on the G.S.C. argon mass spectrometer. It has proved to be most satisfactory and a duplicate electronic system will be used to operate the G.S.C. MS-10. The design and construction of argon extraction, spike preparation and calibration systems at the Laval establishment were well in hand at year-end.

A useful development in technique has arisen out of the design and fabrication of a new style of high pressure "bomb" for the dissolution of highly refractory minerals in chemical preparation for isotopic analysis. In this vessel it is possible to dissolve such minerals as zircon in hydrofluoric acid at elevated temperature and pressure and the technique thus eliminates the use of copious quantities of flux and greatly reduces the time required to process a zircon sample. As a result the contamination level in zircon lead extractions has been reduced to about one half of its previous level and smaller mineral samples can be processed.

8. Research: Geochronological research has been pursued on three fronts by the Section during the report year. These are:-

A. A study of the occurrence of anomalous age phenomena associated with the Grenville Front. Most of our effort in this field has been directed to the Lac Dauversiere area in the Chibougamau district of Quebec where an anomalously old biotite age of 3800 m.y. has been recognized and verified in the Dauversiere Stock. This body intrudes metavolcanics of the Superior geological province and lies in close proximity to the Grenville Front. The general background to this phenomenon was described in the 1969-70 Annual Report (pp 45-46) and the results to that time were reported in a paper presented at the Geochronological Conference in Bern, Switzerland, in 1969. Field collecting and laboratory studies during 1970 were designed to determine the areal extent of the anomalous age phenomenon within the stock and its relation, if any, to variations in rock type. In addition, we have recently discovered a similar situation in the Fabre - Laniel district of Quebec where the Grenville Front crosses the lower part of Lake Temiscaming. Here biotite from gneissic rocks close to, but north of the Front yield an "age" of 3200 m.y. while associated hornblende has a more normal age of 2700 m.y. We now recognize anomalous age phenomena in four widely separated localities, the two indicated above, and others in Labrador at Churchill Falls and in the Groswater Bay area where the Front passes out to sea. Research in the Chibougamau and Groswater Bay areas is continuing.

B. The elucidation of Archean geological history in the Noranada - Val d'Or region of Quebec. This is an integrated age study where all three methods (K-Ar, Rb-Sr and U-Th-Pb) are being applied in an intensive way in an area where the geological framework is well established. Field collecting and laboratory studies have been designed to precisely order the temporal relationships of the various rock units and, hopefully, to establish the age of rocks pre-dating the Kenoran orogeny. Zircon geochronology offers the greatest potential to penetrate the orogenic events in the area and small zircon concentrates have been obtained from bulk samples (several hundred pounds) of Pontiac schist from the Arntfield and Granada areas, the Kewagama greywacke from areas near Destor and Mont-Brun, the Clericy syenite, the Kinojevis Lake granite, from boulders in the Temiscaming conglomerate, and from boulders in the Cobalt conglomerate. Age determinations have not yet been carried out on these concentrates, but K-Ar determinations on hornblendes from the Dufault and Flavrian granites near Noranda have yielded ages of 2700 m.y. and 2640 m.y. respectively. A Rb-Sr whole rock isochron age determination on the Dufault granite is in progress, but extensive sampling of the Flavrian granite has not yielded an adequate range for isochron work.

C. The development of K-Ar dating techniques for age determination of very young continental basalts from British Columbia. Whole rock samples from the geologically very young Mt. Edziza volcano contain large quantities of atmospheric argon which tend to swamp the radiogenic component. Methods of reducing the atmospheric argon content without expelling that of radiogenic

origin must be developed in order to precisely determine the age of such volcanic rocks. Considerable effort has been exerted in developing suitable argon extraction techniques to accomplish this and some success has been attained. However, we have discovered that some of the atmospheric argon component is held securely within the sample and we conclude that this part was probably incorporated (from the atmosphere) at the time of extrusion. Second generation modifications to the extraction techniques designed to help us identify and make allowance for this component have produced encouraging results. The techniques therefore are judged to hold considerable promise, but further refinements are necessary. In spite of the problems encountered, two important age results have been obtained. Determinations on samples of sanidine and volcanic glass indicate a younger limit of 1 m.y. for volcanic activity at Mt. Edziza, while the beginning of significant outpouring, originally believed to be about 4 m.y., now appears to be superseded by new indications of an age of about 6 m.y.

9. Limitations: Laboratory development and its capacity to meet an increasing demand for geochronological and isotopic investigations is handicapped by insufficient space and insufficient staff.

Owing to our tightly limited floor space it is not possible to operate all of our instrumental facilities to maximum advantage, and in fact it is physically impossible to operate some at all under present circumstances, as for example an older gas source mass spectrometer could be converted to solid source and/or rejuvenated for a productive second life, but there is simply no space to work on it. Not only do the space limitations cramp the laboratory operation, but they actually create a condition of dangerous over-crowding which has attracted critical comment from the Departmental Safety Officer.

Related largely to an economic "freeze" at an earlier time the demands on the laboratory staff have exceeded their capacity to do full justice to the increasing requirements. Thus the abilities of the personnel are being spread thinly over many projects, any one of which could expand to more fully meet the demand if more specialist time could be devoted to it. Consequently, backlogs are increasing and an Age Determination Committee has been re-constituted to establish priorities based on the merit and urgency of submissions, and in fact some submissions for geochronological and isotopic investigation have been rejected or postponed into the remote future.

It should be noted that both limiting conditions of room and personnel are closely interrelated and both would have to be improved substantially to effect a remedy, but if one must be considered more urgent than the other, the room problem must be solved first.

Personnel Changes

Dr. R.K. Wanless, Section Head, was seconded to Laval University, Quebec City in September of 1970 to organize and set up a K-Ar dating laboratory at that institution. The duration of this project is for one year and it is expected that Dr. Wanless will return to Ottawa early in September 1971. Meanwhile, he visits the Ottawa geochronology laboratory at approximately 2-monthly intervals to supervise operations and prepare papers and reports.

Mrs. M. Neidy resigned from her casual position in May 1970 and was replaced by Mr. Andrew Leeson, also in a casual capacity. Mr. Leeson transferred to another department in September 1970, and Mrs. Neidy was reinstated on staff in her original position but with increased duties.

Attendance at Meetings

No major meetings were attended by members of the Section during the report-year.

Membership on Committees

R.K. Wanless -- secretary, NRC Subcommittee on Isotope Studies and Geochronology.

R.K. Wanless -- member, GSC Age Determination Committee.

Special Talks

R.K. Wanless delivered an address to the Quebec Geological Society, Quebec City, on "The application of isotopic dating techniques to geological problems".

Outside Publications

Boyle, R.W., Wanless, R.K. and Stevens, R.D.
1970: 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.

Shibata, K., Nozawa, T. and Wanless, R.K.
1970: Rb-Sr geochronology of the Hida metamorphic belt, Japan; Canadian Jour. Earth Sciences, vol. 7, pp. 1383-1401.

Wanless, R.K. and Stevens, R.D.
1970: Note on the age of diabase dykes, Anticosti Island, Quebec; Proc. Geol. Assoc. Canada, vol. 23, pp. 77-78.

Active Projects during Report-Year

540028: Isotopic age determinations of rocks and minerals. R.K. Wanless.

580144: Lead and sulphur isotope geology of Keno and Galena Hills, Yukon R.W. Boyle.

650466: Isotopic study of mica-bearing rocks yielding anomalous K-Ar "ages". R.K. Wanless.

670553: Development on a new 15" radius solid source mass spectrometer. R.K. Wanless.

670558: National isotopic age data file. R.K. Wanless.

680148: Development of K-Ar dating techniques and their application to very young continental basalts from British Columbia. R.K. Wanless.

PETROLOGY SECTION

J.E. Reesor

ACTIVITIES

The Petrology Section conducts field and laboratory research into the theories and problems of petrology by carrying out systematic studies of specific rock types as well as detailed field studies of critical map-areas. These studies are expected to provide a means of elucidating petrologic problems of economic or regional significance. In addition, the section provides consultation on petrologic problems to scientists of the Branch, other 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 the anorthosites of Labrador to the high grade metamorphic rocks of the Kisseynew gneiss 'front', to experimental work on alkaline rocks and the role of water in the evolution of igneous rocks. Some high pressure work relating to the generation of anorthosites has been started, as well as a computerized index of experminetal work related to metamorphic mineral assemblages.

PERSONNEL CHANGES

Mr. Lawrence of the Petrology Laboratory resigned in April 1970, no suitable candidate for the position was available over the summer and he was replaced by Mrs. M.N. Turay at the end of October.

Dr. Currie spent the term from January to April at the University of Montreal, Dept. of Geology combining research and teaching on alkaline rocks with practice in operating in French.

During the year officers of the section presented for publication or published within the Geological Survey one memoir, 2 bulletins, and one paper as well as 13 outside papers.

ATTENDANCE AT MEETINGS

J.E. Reesor	-Second International Symposium on Arctic Geology San Francisco -Cordilleran Section, GAC
R.F. Emslie	-AGU, Washington -GSA, Milwaukee
E. Froese	-GAC-MAC Meeting, Winnipeg, Manitoba
T.N. IRvine	-Geodynamics Symp. on "Ultramafic rocks and the oceanic lithosphere", at Carleton U., Ottawa

MEMBERSHIP ON COMMITTEES

J.E. Reesor	Co-convener Section 11, Petrology, Intern. Geol, Congress, 1972
T.M. Gordon	Field Safety Standards Committee

SPECIAL TALKS

J.E. Reesor	The Shuswap metamorphic complex, SE B.C., GAC, Vancouver
K.L. Currie	-Garnet-cordierite equilibrium - at U. of Ottawa and Ecole Polytechnique -Role of water in genesis of alkaline rocks - at U. of Ottawa -3 lectures on alkaline rocks - at Ecole Polytechnique
R.F. Emslie	Anorthosite rocks and their genesis - University of Western Ontario, Ottawa University.
E. Froese	-The graphical representation of sulphide-silicate phase equilibria - at GAC-MAC Meeting, Winnipeg -Non-ideal solution models - Carleton University
T.M. Gordon	-The n-dimensional tie-line problem -Carleton U -Linear programming in Geology - Geochemical Discussion Group.
T.N. Irvine	Alpine-type peridotite - at Geodynamics Symp. in Oceanic Lithosphere, Ottawa

OUTSIDE PUBLICATIONS

Reesor, J.E. 1970: Some aspects of structural evolution and regional setting in part of the Shuswap Metamorphic Complex; in Symp., Structure of the Southern Canadian Cordillera; GAC special publ. no.6, pp.73-86.

Currie, K.L. 1970: An hypothesis on the origin of alkaline rocks suggested by the tectonic setting of the Monteregian Hills; Can. Min. 10 pt.3, pp.411-420.

1970: The anomalous structure at Lake St. Martin, Manitoba, a probable new cryptoexplosion structure, Nature, 226, pp.839-841.

1970: The mechanism of intrusion of lamprophyre dikes indicated by offsetting of dikes; (with J. Ferguson). Tectonophysics 9 pp.525-535.

Currie, K.L. 1971: A study of potash fenitization around the Brent Crater, Ontario - a Paleozoic alkaline complex; Can. J. Earth Sci.

Emslie, R.F. 1971 :Olivine-liquid equilibrium in basaltic melts; ms 40pp., 8 fig., 6 tables, accepted for publication, Contributions to Mineralogy & Petrology (with P.L. Roeder)

1971: Liquidus relations and subsolidus reactions in some plagioclase-bearing systems; Carnegie Inst. of Washington Yearbook 69, 14pp., 3 fig.

Froese, E. 1970: Calculated phase relations in the system $CaCO_3$-$SrCO_3$; Can. Min., v. 10, pp.665-676.

Gordon. T.M. Determination of internally consistent thermodynamic data from phase equilibrium studies; 1971: (abstract),Transactions of American Geophysical Union, v.52, p.379.

Irvine, T.N. 1970: Crystallization sequences in the Muskox intrusion and other layered intrusions, Olivine-pyroxene-plagioclase relations; Symp. on Bushveld igneous complex & other layered intrusions, Geol. Soc. S. Africa, Special Publ. No.1, pp.441-476.

1970: Heat transfer during solidification of layered intrusions 1 sheets and sills; Can. J. Earth Sci., v.7, pp.1031-1061.

1971: Emplacement of the Muskox intrusion; Geol. Surv. Can., Paper 71-1, pp.112-114.

ACTIVE PROJECTS DURING REPORT YEAR

530008	J.E. Reesor	Lardeau map-area, B.C.
590283	T.N. Irvine	Muskox Intrusion
620265	K.L. Currie	Diffusion studies in supercritical water
650288	T.N. Irvine	Aiken Lake B.C.
660014	R.F. Emslie	Michikamau anorthosite, Labrador
660547	K.L. Currie	Geochemistry of Canadian waters
670003	R.F. Emslie	Anorthosite study

670278	J.E. Reesor	Structural and petrological study of Pinnacle Peaks gneiss dome, B.C.
680071	K.L. Currie	Alkaline rocks in Canada
700048	T.M. Gordon	Petrology and structure of Daly Bay complex and environs
700065	E. Froese	Petrological studies in the vicinity of the Kisseynew Front

PETROLOGY LABORATORY

M.N. Turay

The Petrology Laboratory has been providing equipment and adivce for petrographic investigations.

The services available from the laboratory have remained as in previous years: specific gravity and mineral composition determinations, mineral staining, petrographic studies, optical properties of minerals, photomicrography and development of new petrographic techniques.

The laboratory has been unattended from April to October.

WORK PERFORMED DURING THE REPORT YEAR

Mineral staining (T.S.) slabs	47
Petrographic descriptions	69

One petrographic study has been concerned with samples of untramafic rocks from the Prince Albert Group of Melville Peninsula collected by Dr. W.W. Heywood.

The other study was a "rock classification" of samples sent to us from Italy by COGEODATA.

LAPIDARY SERVICES

A.E. Whitehead

The Lapidary Laboratory has a three-man staff consisting of A.E. Whitehead (Supervisor), Y. Demers and M. Beaulne.

Plaques of Jasper conglomerate for 25 years of service went to Mrs. Arscott, Dr. Henderson and Dr. Lang on retirement.

Book ends were presented to Mr. B. Orange and two other departing members at headquarters, Dr. Harrison, for an outstanding acheivement and Mrs. Barryman, secretary to The International Boundary Commission.

Paper weights went to Mr. E. Hall, Miss Gorley, Mrs. Hunt, Mrs. Suen (Nina) and Mrs. Lajoie on their departure.

A special paper weight of Jade was prepared for the Prime Minister for his trip to Russia.

Improvements over the year consisted in using the standard glass slide clear instead of frosted and also in purchasing 2 electrical hot plates.

Special Jobs:

(1) The slicing of 100 feet of core for petrographic examination

(2) Preparation of samples of jade for the Embassy, Economic & National Film Board Collections.

(3) Preparation of Lunar Samples.

(4) Preparation of thin sections from samples sent in by the Bedford Institute N.S. from the JOIDES Deep Sea Drilling project on Orphan Knoll and Rockall Bank.

(5) Cubes made for Dr. Katsube for Electrical Rock Property study.

(6) Four large samples were polished on the vibrators for Mr. Steacy's Systematic Reference Series, National Museum Collection.

Training and Advice were given to Dr. Nanius from Switzerland, Dr. Wicks - Royal Ontario Museum - Toronto, and Miss I Berta, University of Manitoba.

Work Report for 1969-70

(1) Standard thin sections with and without small or large cover slips.	5143
(2) Standard oriented thin sections with and without small or large cover slips,	132
(3) Standard oil thin sections; oriented, no cover slips, small cover slips.	45
(4) Standard thin sections stained for large cover slips.	25
(5) Grain thin sections with no cover slips.	1
(6) Large thin sections, oriented, with cover slips, standard cover slips, no cover slips.	254
(7) Polished thin sections.	323
Total thin sections	5923

Man-Hour Jobs

(1) Large and small polished surfaces for 70-71 were	430=	120¾ hrs.
(2) Trim saw cuts for 1970-71 were	2603=	71½ hrs.
(3) Drill cores made for 1970-71 were	7=	1 hr.
Total	3040=	193¼ hrs.

Slab Saw

Our slab saws production for 1970-71 was 429=221 hrs.

PRECAMBRIAN SUBDIVISION

M.J. Frarey

ACTIVITIES

The Precambrian Subdivision carries out geological research over the more than 1.7 million square miles of the Canadian Shield in the geological core of Canada. Objectives of this research 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 surveys of previously unmapped terrain and more detailed studies of areas and problems. In the report year, the amount of unmapped (and hence geologically unknown) territory was significantly reduced by the completion of the field component of Operation Penny Highlands, which completed the initial mapping of Baffin Island. Plans and preparation proceeded during the report year for similar operations in southern Labrador and in the northern part of Melville Peninsula; both were scheduled for the 1971 field season, but unfortunately the latter operation has had to be postponed due to lack of finances.

Much attention during the year has been directed to planning an expanded program of upgrading the level of geological knowledge of the Precambrian of more northern parts of Canada, particularly in the Slave, Bear and Churchill Provinces of the Districts of Mackenzie, Franklin and Keewatin. Here the level of geological knowledge and mapping is notably lower than elsewhere in the Shield and other parts of Canada, and it is hoped that efforts to achieve an intermediate grade of coverage through modern four-mile mapping can be accelerated. Such an expanded program is demanded by the increasingly evident need for determining the overall mineral potential of Canada's north, which cannot be realistically appraised on the basis of present information. It has become very clear, however, that any serious effort to upgrade the geology of even selected districts within these regions to the suggested standard in the medium term (one to two decades) will require sharply increased resources, both professional and support, in the Subdivision.

In 1970, thirteen staff members and one attached post-doctoral fellow were in the field, and as usual, most of the resources were directed to work north of the 60th parallel. The largest single activity was Operation Penny Highlands in Baffin

Island, led by G.D. Jackson, supported by W.L. Davison, W.C. Morgan, and I.F. Ermanovics of the Subdivision staff. 54,000 square miles were mapped using two helicopters, and the geological framework of the project-area was determined for the first time. Most other projects involved four-mile mapping, with special emphasis on disciplinary studies. Included were those of J.C. McGlynn south of Great Slave Lake, J.B. Henderson near Yellowknife, K.E. Eade in southern Keewatin District, and C.K. Bell in central Manitoba. P.F. Hoffman continued his sedimentological and basin analysis study of the Epworth Group in Bear Province, and R.H. Ridler commenced an investigation of the Archean volcanic-sedimentary sequence southwest of Rankin Inlet, Keewatin District. A.J. Baer concluded his field work on the Grenville portion of NTS 31, Ontario and Quebec. Under his post-doctoral fellowship, R.N. Annells completed field studies of Keweenawan volcanics of eastern Lake Superior. All these projects are of economic significance and are basic to assessing the mineral potential and future development of the respective areas.

Again this year a series of seminars highlighted the winter season, this time under the chairmanship of I.F. Ermanovics. The common theme was Archean geology, and the speakers included five of the Subdivision staff - C.K. Bell, A. Davidson, W.F. Fahrig, R.H. Ridler and F.C. Taylor as well as representatives from the Exploration Geophysics Division of the GSC, the Earth Physics Branch, Dept. of Energy, Mines and Resources, and of the Universities of Toronto and Western Ontario.

The usual numerous representatives of industry visited members of the Subdivision for advice and consultation during the year. The staff also provided information and advice to other federal government agencies and to provincial government agencies.

Members of the Subdivision published during the year 12 terminal maps and papers, and 9 preliminary maps and papers. Eleven papers were published in outside journals. In addition, 1 manuscript for bulletin, 2 for papers and preliminary maps, and 12 for outside papers were submitted.

PERSONNEL NOTES

There were no staff additions or resignations during the year. However, the establishment of the subdivision was reduced by one, because of the loss of a position. Effective strength was further reduced by the secondment of I.M. Stevenson to the 1972 International Geological Congress secretariat. In addition, L.P. Tremblay continued almost fulltime on the French version of Economic Geology Report No. 1 ("Geology of Canada") and work related to a C.I.D.A. project during the year. Thus, only 17 of the staff were actually engaged full-time in the work of the Subdivision.

ATTENDANCE AT MEETINGS

Annells, R.N. -Inst. on Lake Superior Geology, Thunder Bay, Ont.,

Bell, C.K. -GAC, Winnipeg, Manitoba
-CIMM, Toronto

Davidson, A. -Geological Society of Australia, Symposium on Archean Rocks, Perth, W.A.

Eade, K.E. -3rd International Geochemical Exploration Symposium, Toronto.

Ermanovics, I.F. -Inst. on Lake Superior Geology,Thunder Bay, Ont.

Fahrig, W.F. -3rd International Geochemical Exploration Symposium, Toronto.

Frarey, M.J. -Inst. on Lake Superior Geology, Thunder Bay, Ont.
-GSA Annual Meeting, Milwaukee, Wisconsin.
-Prospectors and Developers Assoc,, Toronto

Henderson, J.B. -GAC, Winnipeg, Manitoba

Heywood, W.W. -CIMM, Toronto

Hoffman, P.F. -Penrose Conference, Laramie, Wyoming
-Eastern Canada Biostratigraphy Seminar, Laurentian U., Sudbury, Ontario.

Jackson, G.D. -2nd Annual Symposium, Geology of the Arctic, San Francisco

McGlynn, J.C. -Penrose Conference, Laramie, Wyoming

Reinhardt, E.W. -Sub-Committee of Working Group on Geological Field Data, Vancouver

Ridler, R.H. -Inst. on Lake Superior Geology, Thunder Bay, Ont.
GAC, Winnipeg, Manitoba
-Prospectors and Developers Assoc., Toronto

MEMBERSHIP ON COMMITTEES

Baer, A.J. -Member, GSC age determination committee
-Member GSC Exhibits Committee

Baragar, W.R.A. -Member, Volcanology Subcommittee of Associate Committee on Geodesy and Geophysics of NRC

Bell, C.K. -Representative, Special Departmental Committee on Field working conditions
-Steward, PIPS Geological Survey of Canada

Davidson, A. -Member, GSC Age Determination Committee

Eade, K.E. -Member, Review Panel for Research Committee, Arctic Institute of North America

Fahrig, W.F. -Chairman, GSC Age Determination Committee

Frarey, M.J. -Member, American Commission on Stratigraphic Nomenclature
-Member, Federal-Provincial Committee on Huronian Stratigraphy.

Heywood, W.W. -Member, GSC Safety Committee for field survey operations

Jackson, G.D. -Alternate, Branch Computer Facilities Committee, GSC

McGlynn, J.C. -GSC Stratigraphic Committee

Morgan, W.C. -Member, Structural Geology Subcommittee of National Advisory Committee for Research in the Geological Sciences

Reinhardt, E.W. -Member, Subcommittee on Geological Field Data of the Standing Committee on Storage and Retrieval of Geological Data (NAC)
-Member, GSC Branch Computer Facilities Committee

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

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

TALKS

Bell, C.K. -"The Pikwitonei-Superior-Churchill Boundary" -at GAC Annual meeting, Winnipeg, Manitoba.
-"The Pikwitonei Province-an early Precambrian craton" - McGill University, Adams Club

Ermanovics, I.F. -"A model for tectonic variation of 'granitic terrain' in SE Manitoba" - at Annual Meeting, Institute on Lake Superior Geology, Thunder Bay, Ontario

Fahrig, W.F. -"Helikian Polar Wandering" - at Dept. of Geology, University of Bologna and University of Pisa, Italy

Henderson, J.B. -"Sedimentology of the Yellowknife Supergroup at Yellowknife" - at Conference on Precambrian sediments, Dept. of Geology, University of Western Ontario. and at Dept. of Geology. Queens University, Kingston.

Hoffman, P.F. -"Paleo-environment interpretation of Precambrian stromatolites" Eastern Biostratigraphy Seminar, Laurentian University, Sudbury, Ontario
-"Precambrian shallow to deep water carbonate facies transition in the Pethei Group, East Arm of Great Slave Lake, NWT" - at Conference on Precambrian Sediments, Dept. of Geology, University of Western Ont.
-"The Coronation Geosyncline" - at Penrose Conference, Laramie, Wyoming

Jackson, G.D. -"The development of the Precambrian Shield in West Greenland, Labrador and Baffin Island" - at 2nd International Symposium on Arctic Geology, San Francisco
-"A test of the nature and extent of continental drift as provided by the study of the Proterozoic dike swarms of the Canadian Shield" - at 2nd International Symposium on Arctic Geology, San Francisco

McGlynn, J.C. -"Geology of the Slave Province" - at Penrose Conference, Laramie, Wyoming

Reinhardt, E.W. -"Precambrian geology of the Ottawa area" - at Ontario Dept. of Mines and Northern Affairs, Mineral Exploration Course, Ottawa
-"The application of projections to metamorphism of pelites" - at Dept. of Geology, Carleton U., Ottawa

Ridler, R.H. -"Gold metallogeny and the geological cycle in the Archean" - at Universities of Toronto, Waterloo, Brock, Queens and Lakehead (CIMM Guest Lecture Series)
-"Archean volcanic stratigraphy of the Kirkland-Larder Lakes Area of NE Ontario" - at Annual Meeting of Inst. on Lake Superior Geology, Thunder Bay, Ont.
-"Metallogeny and iron formation, Kirkland Lake-Noranda-Cadillac" -at GAC Annual Meeting, Winnipeg, Manitoba

-"Relationship of mineralization to stratigraphy in the Archean Rankin Inlet-Ennadai Belt as compared with analogous 'Greenstone' belts of the Superior Province" -at Annual Meeting, Prospectors and Developers Association, Toronto.

Taylor, F.C. -"Geological relationships between western Greenland and adjacent Canada" -at Departments of Geology Universities of Bologna and Pisa, Italy

OUTSIDE PUBLICATIONS

Baragar, W.R.A.-1971: Distribution of ore elements in rocks for evaluating ore potential; frequency distribution of copper in the Coppermine River Group and Yellowknife Group Volcanic rocks, NWT, Canada; (with E.M. Cameron, senior author) Can. Inst. Min. Met., Proc. 3rd Int. Geochem. Prosp. Symp., Special Volume, in press.

1971: A guide to the chemical classification of the common volcanic rocks; (with T.N. Irvine, senior author), Can. J. Earth Sci., in press.

1971: Some physical and chemical aspects of Precambrian volcanic belts of the Canadian Shield; in The problem of identifying ancient oceanic lithosphere within the present-day continent., Publ. Earth Phys. Br., in press.

Bell, C.K. 1970: The Superior-Pikwitonei-Churchill Boundary, Regional Geological Setting; GAC-MAC Guidebook, 23rd Meeting, Field Trip #2, pp.3-9, 17-18, and parts of map.

1970: The Pikwitonei-Churchill Boundary; GAC-MAC Abstracts, 23rd Meeting, pp.3-4.

1971: AFMAG use in Geological Interpretation;with L.S. Collett, CIMM Bull., Vol. 64, No.706, Feb. 1971, pp.39-47.

Davidson, A. 1970: Nepheline-K-feldspar intergrowth from Kaminak Lake, NWT; Can. Min., Vol. 10, pp.191-206.

Fahrig. W.F. in press: A test of the nature and extent of continental drift as provided by the study of the Proterozoic dike swarms of the Canadian Shield; by W.F. Fahrig, E. Irving and G.D. Jackson, Symp. Vol., 2nd International Symp. on Arctic Geology, 10 ms pages.

Fraser, J.A. in press: The Bear Province; (with P.F. Hoffman) in Variations in Tectonic Style in Canada (ed. R.A. Price)

Henderson, J.B. 1970: Petrology and origin of the sediments of the Yellowknife Supergroup (Archean), Yellowknife, District of Mackenzie, Canada; Ph.D. thesis. The Johns Hopkins University, Baltimore, Md.

submitted: Tectonic history of the Slave Structural Province;with J.C. McGlynn for GAC symp. on Variation in Structural Styles in Canada.

Hoffman, P.F. in press: Stromatolites; in Sedimentology in the 20th Century, Progress in the Understanding of Sedimentary Rocks, a Conference Honouring Francis J. Pettijohn.

in press: The Bear Province; (with J.A. Fraser) in Variations in Tectonic Style in Canada (ed. R.A. Price)

Jackson, G.D. submitted: Use of a field-data collecting-form on Operation Bylot, 1968; by E.W. Reinhardt and G.D. Jackson, 31pp. typed ms pages, to be published in symp. volume by Can. Centre for Geoscience Data.

in press: Paleomagnetism of the Franklin Diabases; W.F. Fahrig, E. Irving and G.D. Jackson, 44pp. typed ms pages accepted for publication by Can. J. Earth Sci.

in press: The development of the Precambrian Shield in West Greenland, Labrador & Baffin Island; (with D. Bridgewater, A. Escher, G.D. Jackson, F.C. Taylor and B.F. Windley. Symp. volume AAPG 2nd Intern. Symp. on Arctic Geol., 44 ms pages.

in press: A test of the nature and extent of continental drift as provided by the study of the Proterozoic dike swarms of the Canadian Shield; by W.F. Fahrig, E. Irving, G.D. Jackson; Symp. vol., 2nd Intern. Symp. on Arctic Geology, 10 ms pages.

McGlynn, J.C. submitted: Tectonic history of the Slave Structural Province;with J.B. Henderson for GAC symp. on Variations on structural styles in Canada.

Reinhardt, E.W. 1970: Use of a field-data collecting-form on Operation Bylot, 1968; by E.W. Reinhardt and G.D. Jackson; (to be published in volume summarizing development of the Canadian System for Geoscience Data; includes number of case histories) approx. 30pp., 2 pl., 1 fig.

Ridler, R.H. 1970: Relation of mineralization to volcanic stratigraphy Kirkland Lake, Ontario. Geol. Assoc. Can. Proc. Vol. 21, pp.33-42.

1970: Archean volcanic stratigraphy of the Kirkland-Larder Lakes area of NE Ont. Inst. on Lake Superior Geology, Tech. Sessions, Abstracts and Field guide for 16th Convention, pp.37-39.

1970: Metamorphism of massive sulfides at Manitouwadge, Ontario. IMA-IAGOD '70 Collected abstracts, p.94 (with Suffel, G. & Hutchison, R.W.)

1970: Metallogeny and iron formation, Kirkland Lake-Noranda-Cadillac. GAC-MAC. Program and Abstracts, 1970. pp.44.

1971: Metallogenic relationships in Archean rocks. Bull. CIMM and Abstract in Bull CIMM, v.63, p.289. (with Hutchison, R.W. & Suffel, G.)

Taylor, F.C. submitted: Precambrian basic dikes metamorphosed to granulite facies in the vicinity of Four Peaks, Torngat Mountains, Labrador, Nfld. American Mineralogist.

submitted: A revision of Precambrian Structural Province in NE Quebec & N Labrador; Can. J. Earth Sci.

submitted: Tectonic style of the Nain Structural Province; GAC Symp. on Tectonic Style, Geophysics by J.G. Tanner (Earth Physics Branch)

submitted: The development of the Precambrian Shield in West Greenland, Labrador & Baffin Island; (with D. Bridgewater, A. Escher, G.D. Jackson and B.F. Windley) 2nd Intern. Symp. on Arctic Geology.

ACTIVE PROJECTS DURING REPORT YEAR.

490013	W.F. Fahrig	Labrador-Quebec iron belt, near Schefferville
540025	C.K. Bell	Milliken Lake area, Saskatchewan
590019	G.D. Jackson	Roads to Resources Project
600002	W.W. Heywood	Operation Back River
600004	J.C. McGlynn	Regional correlation - northwestern Can. Shield
610030	M.J. Frarey	Huronian rocks north of Lake Huron
610044	W.F. Fahrig	Diabase dykes of the Canadian Shield
620004	K.E. Eade	Kognak River area, NWT

620012	W.R.A.Baragar	Geochemical and petrologic study of Yellowknife volcanic rocks
620288	K.E. Eade & W.F. Fahrig	Element abundances of the Can. Shield
630009	J.A. Donaldson	Dubawnt Group sediments, NWT
630025	C.K. Bell	Geological investigations across the boundary between the Churchill and Superior tectonic provinces
640005	W.W. Heywood	Operation Wager
640010	L.P. Tremblay	Yellowknife and Goulburn rocks in the Contwoyto Lake area, NWT
640011	H.H. Bostock	Itchen Lake map-area
640036	M.J. Frarey	Lake Panache and Collins Inlet areas, Ont.
640423	L.P. Tremblay	Source rock for uranium in the Beaverlodge area
650008	J.C. McGlynn	Stratigraphy, sedimentology and correlation of the Nonacho Group, NWT
650009	E.W. Reinhardt	Petrologic and structural study of the MacDonald fault system south of Great Slave Lake
650044	W.R.A.Baragar	Volcanic studies in the Noranda region, Ont.-Que.
660005	W.W. Heywood	Tavani map-area, Keewatin
660006	A. Davidson	Granite studies in the Ennadai-Rankin Inlet region.
660007	W.R.A.Baragar	Studies of the Coppermine River volcanic rocks, NWT
660009	P.F. Hoffman	A sedimentological and stratigraphic study of the Great Slave and Et-Then Groups in the East Arm fold belt, Great Slave Lake
660011	R.H. Ridler	The interrelation of the Archean volcanic stratigraphy and mineral deposits of the Kirkland Lake area
660013	F.C. Taylor	Operation Torngat
660015	F.M.G.Williams	A structural metamorphic and petrological study of the Naskaupi and older fold belts of the Grenville and Nain provinces
670002	G.D. Jackson	Operation Bylot
670005	J.A. Fraser	Nature of the Thelon Front, NWT

670006	J.B.Henderson	Sedimentology of the Yellowknife Group,NWT
670057	W.R.A.Baragar	Volcanic study in the Kaladar area, Ontario
670569	J.A.Donaldson	Clay minerals in Proterozoic sediments
680012	J.C. McGlynn	Paleomagnetic study of Proterozoic red beds in the Western Canadian Shield
680030	A.J. Baer	Geology of the Precambrian Shield in the Rivière Gatineau map-area
680057	J.A.Donaldson	Sedimentological study of the Hornby Group
680074	W.L.Davison	Geology of the Seal River map-area, Man.
680076	W.L.Davison	Geology of Southern Indian Lake
680085	K.E. Eade	Structural and stratigraphic study of the Precambrian rocks of southwestern Keewatin, NWT
680092	W.W.Heywood	Geology of Southampton Island
680096	W.R.A.Baragar	Studies in the Seal Lake volcanic province
680115	R.N. Annells	Keweenawan volcanic succession, Sault Ste, Marie
680135	W.E. Fahrig	Basin analysis of the Athabasca sedimentary basin
690010	I.F.Ermanovics	Berens River-Deer Lake map-area, Man. & Ont.
690024	P.F. Hoffman	A stratigraphy, sedimentological and paleontological study of the Epworth Group, north central District of Mackenzie
690025	J.A.Donaldson	Sedimentary geology of the Coppermine area
690028	J.A. Fraser	Operations Coppermine and Bathurst Inlet
690034	E.W.Reinhardt	Petrochemical study of selected Grenville granulites
690058	D. Hogarth	Geology of part of Gatineau Park, Quebec
690061	G.D. Jackson	Operation Penny Highlands
700010	A.J. Baer	Gatineau River (NTS 31) map-area 1:1,000,000 Geological Atlas Program
700015	J.B. Henderson	Yellowknife and Hearne Lake

700052	R.H. Ridler	Volcanic study in the Ennadai Belt, Keewatin
700095	C.K. Bell	Mineral potential of Manitoba

ECONOMIC GEOLOGY AND GEOCHEMISTRY DIVISION

S.C. ROBINSON, Chief

J.A. Maxwell, Assistant Chief

INTRODUCTION

Activities of the Division are wholly devoted to attainment of objectives of the Mineral and Energy Resources Program; primarily to ascertaining the potential mineral resources of Canada and secondarily to improving the means of their discovery. Inevitably results of these activities are of major value to the mining industry, particularly as guides to exploration for new mineral deposits. These activities comprise four main components:

1. Mineral resource geology, (by commodity and regionally).

2. Geochemical aspects of the geological framework of Canada (including development of methods for this purpose).

3. Statistical and metallogenic analysis of the mineral resource potential of Canada, nationally and regionally.

4. Provision of laboratory services and advice of specialists in mineralogy, chemistry and geomathematics to the Branch and limited services in mineralogy to the Public.

Inevitably, the results of these activities also contribute to information required by the Earth Science Program, for Regional Economic Expansion, Northern Development, Transportation and for Pollution and other aspects of Man's Environment. In the past year, officers of the division have been increasingly consulted in these fields.

Activities of the Division are now carried out by the following six groups:

Analytical Chemistry	Geomathematics,
Geochemistry	Mineralogy
Geology of Mineral Deposits	Special Projects

The extensive laboratory facilities of Analytical Chemistry and Mineralogy supply services to the Branch as a whole.

Staff of the Division published 2 bulletins, 11 papers and 1 'A' series map during the year together with 40 papers in professional journals. At the end of the year staff comprised - 42 scientists, 33 support personnel and 18 man years of casual assistants. Budget for the year was $1,489,000.

Divisional contributions to ascertaining the potential mineral resources of Canada comprised major progress in the studies of the geology of eleven commodites; near completion of the metallogenic map of Canada; the first quantitative estimates of mineral potential (in the Abitibi area) and important extensions to factors included as a basis for these estimates; successful prototype surveys of economic element concentrations in streams, lakes and their sediments north of 60°N, and excellent progress in methods and equipment to facilitate such surveys and to prospect for base metal deposits; and successful application of mineralogical techniques to understanding of processes leading to mineral deposition.

Much of the above work contributes also in improving the means of discovery of mineral deposits in Canada. Results specifically applicable to this objective formed an important group of papers contributed to the Third International Geochemical Exploration Conference and to the Prospector's and Developer's Annual Meeting.

One indication of the important contribution geochemical inventory studies may make to a data base for pollution and the environment generally was the fundamental paper by Boyle and Jonasson before the Royal Society of Canada's Symposium on Pollution. Unquestionably, geochemical inventories undertaken for M.E.R.P. could, by adding analysis for a few toxic elements, provide a sound background for evaluation of natural and artifical pollution in Canada.

DIVISION ADMINISTRATION

Personnel Notes

S.C. Robinson: major duties, additional to those of Division administration, included work on classification of G.S.C. projects under the Mineral and Energy Resources Program with J.O. Wheeler; compilation of statements in rebuttal of criticisms that could potentially be made of G.S.C. functions; served as a member of a Departmental Committee on classification and administration of Research Scientists - this duty was later turned over to R.W. Boyle; and visited the British Columbia Department of Mines in June 1970.

J.A. Maxwell: returned to full-time administrative duties as Assistant Chief on April 1, 1970. He continues analytical work at night and on weekends, on 3 Apollo lunar samples, the results of which have been published in a joint paper with Dr. H.B. Wiik, Geological Survey of Finland. He has also been appointed as Principal Investigator for the remaining Apollo lunar mission 14 - 17. He was Acting Chief during the period February 1 - April 16, 1971.

At the invitation of The Chemical Institute of Canada he made a short tour of local Sections in the Maritimes in October, speaking on the chemistry of lunar material.

J.H. Lapp: During the year the Division financial accounting was taken over from D.S.S. (Treasury Office) in order to maintain adequate financial control and along with this a limited signing authority was assigned to the Administrative Officer. In connection with this added responsibility and work load, a casual administrative clerk was hired to assist. Three clerk-typists provide a 'pool' type service to facilitate the work of the Division.

Also during the year, the facilities available to the Administrative Officer were added to in order to provide more efficient service, this included the addition of a suitable stationery cabinet, and an approved type vault for safeguarding cheques, cash, documents, etc. During the report period a major revision of the Divisional filing system was completed. The Division's photo-copy work continued to be processed by the Branch Xerox machine facility on the fifth floor of the building and work done has reached an average of approximately 11,000 copies per month.

F.W. Jones: The laboratory equipment maintenance and development operation has been entirely re-oriented this year in accord with electronic industry trends towards use of small control computers and computer type logic in all new instrumentation and systems. This has been done by adding a small stock of logic type integrated circuit modules and the purchase and construction of new test equipment and circuit mock-up devices. A small computer, Nova 1200, is to be used for system development. Contact with manufacturers and updating of technical files has been continued from contacts made at the I.E.E.E. exposition in New York.

The computer controlled systems installed in March 1970 in the Electron Probe laboratory under Dr. A.G. Plant and the 40 channel Spectrometer System in use by Mr. R. Horton are both giving excellent results and extended uses are planned and under way.

In the spectrographic analysis laboratory under Mr. W.H. Champ, the multi-channel spectrometer is now updated and ready for more automatic read out when required, the Wadsworth Spectrograph has

been brought into line with new timer and control panel and will shortly be fitted with a new logic controlled plate racking mechanism.

The multi-channel X-ray Quantometer in use by Mrs. S. Courville, has had the time base and scanning control re-designed and plans will be proposed for replacing the console by a more compact system.

A new scanning densitometer for tree ring dating method was completed and has been set up in the Forest Products laboratory in B.C. by Mr. M.L. Parker.

Service and maintenance of equipment in general has been satisfactory and where possible, firms with local service facilities have been employed. There has been no resort to parent company technicians from U.S.A.

Attendance at Meetings

S.C. Robinson: Third International Geochemistry Symposium, Toronto, April 1970.

Ninth International Symposium on Decision Making in the Mineral Industry, Montreal, June 1970.

Codata Meeting, St. Andrews, Scotland, September, 1970.

Cogeodata Meeting, Fontainebleau, France, September, 1970.

J.A. Maxwell: Joint Meeting of Mineralogical Association of Canada - Geological Association of Canada, Winnipeg, Man., September, 1970. Presented two papers, was Co-Chairman of Special Session on Lunar Studies, and arranged for display of G.S.C. lunar samples at the Conference.

Symposium on Lunar Material, University of Western Ontario, London, March 31, 1971.

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

Papers, Lectures and Talks Given

S.C. Robinson: "The Role of the Geological Survey of Canada in Storage and Retrieval of Geological Data";Annales Instituti Geologici Publici Hungarici, Vol. LIV, Fasc 1, pp. 131-139.

"A Review of Data Processing in the Earth Sciences in Canada", Mathematical Geology, Vol. 2, No. 4. pp. 377-397.

J.A. Maxwell: "The Lunar Sample Program at the G.S.C". Can. Inst. Min. Met., Ottawa Branch, April 1970.

"Apollo lunar sample investigation at the Geological Survey of Canada". Engineering Institute of Canada, Kingston Branch, October 1970.

"Apollo Lunar Sample Studies in Canada's Department of Energy, Mines & Resources".

"The Chemical Composition of some Apollo Lunar Samples". Special Lunar Session, Joint Meeting of the Geological Association of Canada - Mineralogical Association of Canada, Winnipeg, Man., September, 1970.

"The Chemical composition of some Apollo 11 and 12 lunar samples". The Chemical Institute of Canada Local Section Meetings in Deep River, Ont., Fredericton, N.B., Halifax and Antigonish, N.S., and St. John's, N'fld., in October, 1970.

"Chemistry of Lunar Material". Symposium on Lunar Material University of Western Ontario, London, March 31, 1971.

Membership on Committees

S.C. Robinson:

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

Member, Organizing Committee of XXIV International Geological Congress.

Departmental Committee on Research Scientists.

Council member, International Committee for Mathematical Geology.

J.A. Maxwell:

Chairman, Branch Classification Evaluation Committee, Technical Category.

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. 1970:

The role of the Geological Survey of Canada in Storage and retrieval of geological data, Annales Instituti Geologici Publici Hugarici, Vol. LIV, Fasc 1, pp. 131-139.

Robinson, S.C. 1970: A Review of Data Processing in the Earth Sciences in Canada, Mathematical Geology, Vol. 2, No. 4. pp. 377-397.

Maxwell, J.A., Peck, L.C., and Wiik, H.B. 1970: Chemical composition of Apollo 11 Lunar samples 10017, 10020, 10072 and 10084. Geochim. Cosmochim. Acta. Suppl. 1, vol. 2, 1369-1374.

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

Maxwell, J.A. and Wiik, H.B. 1970: Chemical composition of Apollo 12 lunar samples 12004, 12033, 12051, 12052 and 12065. Earth and Plan. Sci. Letters, vol. 10, 285-288.

Jones, F.W., and Parker, M.L. 1970: G.S.C. tree Ring Scanning Densometer and Data Acquisition System. Univ. of Arizona Tree Ring Bull., vol. 30 1970.

Jones, F.W. and Horton, R. (In Press) A data acquisition system with computer control for an optical emission spectrometer. Can. Spectroscopy.

Active Projects

Lunar Crust investigation	670561
BCRA of the accuracy of ceramic analyses	690085

REPORTS ON SECTIONS

SPECIAL PROJECTS

R.W. Boyle K.R. Dawson 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 at Bralorne, B.C. and in Newfoundland.

K.R. Dawson — commenced a study of the Canadian Deposits and Occurrences of niobium (columbium) and tantalum. An exhaustive literature search is being made and the resulting data base is being compiled as a magnetic tape file with maintenance and retrieval

by computer. Contacts have been made with companies developing or mining niobium deposits in the carbonatites of Ontario and Quebec as well as the Geological Surveys of the two provinces. Plans were made to visit Canada's only tantalum producer at Bernic Lake in the Winnipeg River Area of Manitoba. A visit was also made to the Ontario Geological Survey in November to obtain information on carbonatite occurrences.

A.H. Lang completed arrangements for the final editing and publication of the 4th edition of E.G. 7, Prospecting in Canada. He continued his compilation of data on case histories of contributions of the G.S.C. to economic development. Although he resigned from the committee on history of the G.S.C. he has continued to contribute to that project, and has continued these and other projects after his date of retirement.

H.W. Little (Uranium Programme) continued his field and laboratory investigations of Canadian deposits of uranium and thorium. Visits were made to deposits in Quebec, Ontario, Saskatchewan, British Columbia, and District of Keewatin. He prepared jointly, a pilot paper on energy policy and prepared a program for the Branch to implement related studies of uranium in Canada. With Dr. E.E.N. Smith he began the organization of an excursion to Canadian uranium deposits for the I.G.C.

Dr. V. Ruzicka , N.R.C, Postdoctorate Fellow, completed a manuscript on comparison of Canadian and East European uranium deposits. This paper will be published by G.S.C. in 1971.

T.J. Bottrill devoted a large part of the field season to ground support of airborne gamma-ray spectrometer surveys. Some time was spent in examining uranium deposits in Elliot Lake area, Ontario and on Simpson Islands, District of Mackenzie and Padlei area, District of Keewatin.

Personnel Notes

Dr. A.H. Lang: retired from the G.S.C. in July 1970 after more than 40 years of activity.

Dr. V. Ruzicka, resigned his postdoctorate fellowship in April.

T. J. Bottrill resigned his position as support scientist in December 1970

Attendance at Meetings

R.W. Boyle: Annual meeting, Prospectors and Developers Association, Toronto, March, 1971.

K.R. Dawson: Annual Conference, Data Processing Institute of the Federal Institute of Management, Ottawa, February 1971.

Annual Meeting, Prospectors and Developers Association, Toronto, February 1971.

H.W. Little: Joint Meetings of European Nuclear Energy Agency and International Atomic Energy Agency, on uranium resources and demand and uranium exploration geology, Vienna, April, 1970.

T.J. Bottrill: Annual meeting, Canadian Institute of Mining and Metallurgy, April, 1970.

Papers, Lectures and Talks Given

R.W. Boyle: Lecture on origin of mineral deposits, Mount Allison University, October 1970.

Talks on geochemistry of mercury, International Symposium on Mercury in Man's Environment, Royal Society of Canada, February 1971.

Talk on chelates and organic concentration of metals, Ottawa University, March, 1971.

Talk on the source of metals in ore deposits, Carleton University, March, 1971.

H.W. Little: Talk on distribution of types of uranium deposits and favourable environments for uranium exploration, at joint IAEA-ENEA Meeting, Vienna, April 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).

H.W. Little: Branch Uranium Committee (Chairman)

Outside Publications

Boyle, R.W. 1970: Geochemistry in Canada; Chemistry in Canada, vol. 22, No. 11, pp. 20-24, 34

1971: Thomas Sterry Hunt (1826-1892) - Canada's first geochemist, Proc. Geol. Assoc. Can., vol 23, pp. 15-18.

Boyle, R.W. In Press: Theoretical geochemistry, in McGraw Hill Encyl. Sci. and Technol.

Boyle, R.W. and Jonasson, I.R. In Press: Geochemistry of mercury; Roy. Soc. Can., Symposium on Mercury in Man's Environment, Ottawa, February, 1971.

Lang, A.H. 1970: Historical sidelights of Brenda mine and region; Can. Min. Jour. vol. 91, No. 5, pp. 45048 and No. 7, pp. 54-58

1970: Discovery and benefits of Marmora iron deposit; Can. Min. Jour. vol. 91, No. 8, pp. 47-49.

1971: Contributions of W. E. Logan and G.M. Dawson to the Canadian Mineral Industry; Proc. Geol. Assoc. Can., vol. 23, pp.19-23.

In Press: G.M. Dawson and the economic development of Canada; Canadian Public. Administration.

Little, H.W. 1970: Distribution of types of uranium deposits and favourable environments for uranium exploration, in Uranium Exploration Geology, I.A.E.A., Vienna, 1970.

Little, H.W., and Williams R.M. 1970 Canada, in Uranium resources production and demand, Joint E.N.E.A - I.A.E.A. report, Paris, 1970.

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
Geology of uranium and thorium deposits of Canada	670014
Study of conglomeratic uranium deposits in Canada (until DEC. 1970)	690014
A comprehensive economic Geology series report on the geology of niobium and tantalum in Canada	700069

ANALYTICAL CHEMISTRY SECTION

Sydney Abbey

During 1970-71, the Section continued to provide compositional data on geological materials as a contribution to geological studies; to collaborate in world-wide analytical studies on international reference samples; to adapt, develop and publish methods for such analyses; and to provide consultation service on chemical and analytical matters for the benefit of Branch officers, of other government agencies and of other geological groups in Canada and abroad.

Activities

A. General

Studies regarding relative costs of analytical services confirmed the slight financial advantage of our laboratories over outside services, and also emphasized the distinct advantage in quality. Using relative costs as a yardstick, it appeared that two officers of this division received more service than all of the officers of the Crustal Division combined. The latter group tends to request straightforward general silicate analyses, while the former is more likely to be concerned with unusual sample types, less familiar constituents or lower-than-normal concentrations.

Analyses of international reference samples, compilation of data on them and assignment of usable values (particularly for trace elements) were continued in both laboratories. Some analytical work was also done on the Apollo XII lunar rocks.

During the year, the Section was consulted regarding equipment, techniques and standard samples by representatives of three federal and two provincial agencies and crown corporations, six universities and colleges, five private companies, one Canadian geologist involved in an international development program, and various groups in the U.S.A., Nicaragua, Switzerland, Ireland and India.

B. Chemical and X-Ray Fluorescence Laboratories

Production Analysis

As indicated in the statistics below, there was an increase in both the number of samples received and the number completed, resulting in a small net decrease in the backlog awaiting analysis. The decrease in the number of x-ray fluorescence and chemical determinations reflected a slight trend away from the "run-of-the-mill" rock analysis, toward more specialized analyses for relatively few components of an unusual nature.

The x-ray fluorescence spectrometer suffered the usual series of breakdowns, none of which were sufficiently serious to impede production to any significant extent. However, the instrument is nearly 10 years old and such problems may very well become more serious within the next few years. Consideration might well be given to replacement with a newer model.

The atomic absorption spectrophotometer has seen increasing use, particularly with some of the newer component modules. The modular construction of the instrument has facilitated up-dating and adaptation of the system to new applications. The same is true of the induction furnace and its ancillary component.

The staff was given a sense of "involvement" by holding "critique" sessions on several established methods, and by circulating reprints of geologists' publications that contain some of our data.

Analytical Method Development

Several refinements were introduced in the combustion methods for sulfur and carbon by means of induction heating. In both cases, the methods required absorption of the volatile product in an absorption solution, followed by back-titration of the excess. The sulfur method was first simplified by the introduction of an automatic sulfur titrator, which automatically draws iodate titrant as sulfur dioxide is absorbed from a flow-through system, thus eliminating the back-titration. By merely changing the absorption solution, titrant and indicator, it is possible to apply the same apparatus to the determination of carbon, although a few difficulties remain to be ironed out in that case. Further, it appears that the same titrator can be used to determine ferrous iron in a variety of samples by titrating the sulfur dioxide evolved on digestion with a phosphoric-sulfuric acid mixture at a relatively high temperature. The digestion scheme, originally designed for use with resistant oxide minerals such as chromite, has been found applicable to silicates.

A composite scheme, mainly involving atomic absorption with few chemical separations, has been evolved for determining traces of silver, gold and the six metals of the platinum group in materials where one or two of those elements are present as major constituents. Effective sample decomposition was a major problem in this work.

Using the atomic absorption spectrophotometer in the emission mode, a composite scheme has been devised for determining lithium, rubidium and cesium down to the 1 ppm level in rocks, using no chemical separations. Aliquots of the same solution may be used as well for determining at least five major components by atomic absorption. Further work is proposed, permitting use of another aliquot of the same sample solution for the determination of barium and strontium in the usual concentration ranges found in rocks.

C. Spectrographic Laboratories

General

With a reasonably stable personnel situation once again existing in the laboratory, we were able to resume our methods development program, and with temporary laboratory assistants the considerable backlog of samples for analysis has been reduced to manageable levels.

Analytical operations

Increased experience of the staff with interpretation of complex spectra made it possible to do a greater number of varied mineral and ore samples than in previous years, by the improved semi-quantitative system established in 1969-70. Some 39 elements are determinable in miscellaneous sample types.

Quantitative determinations on rock samples were somewhat reduced because it became necessary to retire two of our methods late in the previous year for technical reasons, and it took many months before all the necessary working curves were re-established.

Trace element determinations were made on three lunar samples from Apollo 12, to complement the chemical analyses by Dr. J.A. Maxwell.

Complete trace element analyses were made on four special glass samples made up for use as standards for the U.S. Geological Survey. Similarly analyses were completed on a set of six varied rock reference materials prepared by the South African Bureau of Standards for use as international standard samples for geochemical work.

Methods development

The revised and improved method for silicate rocks put in use in March 1970 has been further extended and now includes 56 working curves, which give coverage of 37 elements between the ranges of approximately .001 to 5% with better precision than before. In addition most of these curves have been corrected to the available international reference standards, so that accuracy also is now at a much improved level for the trace elements.

Numerous operating difficulties had forced us to stop using an established procedure for trace volatile elements in silicates, and since August of 1969 a large backlog of these analyses had built up. After considerable investigation we succeeded in resolving the worst of these analytical problems and in October 1970 established a new method which enables us to determine 15 elements quantitatively at the 0.1 to 1000 ppm concentration ranges in most common silicate rocks and minerals, exclusive of the ultrabasics. The method is based on fractional distillation of volatile elements (Zn, Pb, Ca, Ag, etc.) from the sample, which is mixed with a refractory and alkali salt buffer, in a globule type DC arc. Arc stability, and therefore, also precision, are much improved.

Considerable progress was made also towards setting up two similar complementary methods for these volatile elements in ultrabasic rock matrices and in iron mineral matrices. At these low concentration levels however, it is exceedingly difficult to synthesize adequate standard samples required to set up analytical working curves, and much more work is needed before these methods can be put into regular use.

D. Statistics

1. Samples Received and Completed

			Chemical and XRF		Spectrographic
Carried from 1969-70			829		1,382
Received 1970-71			2,377		1,839
			3,206		3,221
Completed, 1970-71			2,449		2.027
	Crustal	1,171		698	
	E.G. & G.	1,264		1,045	
	All others*	14		284	
			757		1,194
Withdrawn			6		31
Carried to 1971-72			751		1,163
	Crustal	719		315	
	E.G. & G.	28		564	
	All others*	4		284	

* Mainly from Q.R. & G. Division, with minor contributions from E.G. Division and outside sources.

2. Comparison with Preceding Year

	1969-70	1970-71
Samples Received		
Chem. and XRF	1,828	2,377
Spectrographic	2,407	1,839
Samples Completed		
Chem. and XRF	2,012	2,472
Spectrographic	1,386	2,027
Individual Spectrographic Analyses		
Qualitative	17	42
Semi-quantitative	122	267
Quantitative	2,575	1,818

Backlog at Year End

	1969-70	1970-71
Chemical and XRF	829	751
Spectrographic	1,382	1,163

Determinations	1969-70	1970-71
Chemical	12,483	11,644
X-ray fluorescence		
Production	12,080	10,872
Controls	4,272	3,960
Rechecks	1,592	4,432
Spectrographic		
Semi-quantitative	2,279	4,263
Quantitative	18,698	17,249
Spectrographic exposures		
Analytical	2,428	3,027
Development	2,043	3,339

Personnel Notes

Professional Staff

There were no changes

Trainees

M.A. Qaiser, an International Development trainee from Pakistan, left early in the fiscal year, after spending some months learning methods in our spectrographic laboratory.

Norman Lyttle, a graduate student in geology at Dalhousie University spent several weeks in our chemical laboratories, using our methods to analyse some of his own samples, under supervision of our staff.

Technical Staff

Mrs. Gisèle Bélanger returned from maternity leave in September.

Richard Charbonneau, of the Mineralogy Section, and Subhas Tella, of the Crustal Geology Division, spent some time working in the spectrographic laboratories.

Jean Gravel, of the Mineralogy Section, similarly provided temporary assistance in the chemical laboratories.

Gerald Richardson, of Gallaudet College for the Deaf, and Miss Gisèle Proulx, of CEGEP de Hull, worked as summer assistants in the chemical laboratories. D.J. Dobson, of Algonquin College, and Miss Ruth Cross, of Queen's University, did similar work in the Spectrographic laboratories.

Miss Ruth Robertson, of Carleton University, worked for part of the summer in both laboratories.

Attendance at Meetings

Joint Conference, Chemical Institute of Canada and American Chemical Society
(Toronto, May 24 - 29)

J.G. Sen Gupta

Sydney Abbey

Analytical Chemistry Division, Chemical Institute of Canada
(Annual Business Meeting and Executive Meeting, Toronto, May 26)

Sydney Abbey

Editorial Board, Chemistry in Canada
(Toronto, May 24, 1970: Ottawa, January 11, 1971)

Sydney Abbey

Spectroscopy Symposium of Canada
(Ottawa, October 26 - 28)

G.P. Bender

J.L. Bouvier

W.H. Champ

K.A. Church

Serge Courville

J.G. Sen Gupta

Sydney Abbey

Development Course for Managers of Support Services
(Ottawa, February 1 - 12)

Serge Courville

Special Talks

J.G. Sen Gupta:	"Determination of carbonate and total carbon by non-aqueous titration - Application to rocks, stony meteorites and metallurgical samples". Joint ACS-CIC Conference, Toronto, May 27.
W.H. Champ:	"Spectrochemical methods of analysis at the Geological Survey of Canada". Spectroscopy Symposium of Canada, Ottawa, October 26.
Sydney Abbey:	"Some applications of atomic absorption spectroscopy in the analysis of geological materials". Sepctroscopy Symposium of Canada, Ottawa, October 26.

Sydney Abbey (with J.J. Lynch and A.G. Plant):
"New horizons in analytical geochemistry",
Geochemistry Discussion Group, Ottawa, March 25.

Membership on Committee, etc.

Serge Courville:	Branch Coordinator, Informal French Language Study Groups.
	Safety Officer, Economic Geology and Geochemistry Division.
Sydney Abbey	Editorial Board, Chemistry in Canada
	Executive of Analytical Chemistry Division, Chemical Institute of Canada.

Outside Publications

Abbey, S. 1971:	Variation in the composition of muscovite and albite in pegmatite dike near Yellowknife: Discussion: Can. J. Earth Sci., vol. 8, pp. 394-395
Sen Gupta, J.G. 1970:	Determination of carbon by non-aqueous titration after combustion in a high-frequency furnace. Anal. Chim. Acta. vol. 51, pp. 437-447.

Active Projects

Analysis of Rocks and Minerals	380077
Analysis of International Reference Samples	690089
Development of Analytical Methods	690090

GEOCHEMISTRY SECTION

E. M. Cameron

Some highlights of the year included:

1. Sampling lake sediments by helicopter at the economical density of one sample per 10 square miles clearly outlined the Coppermine copper belt and the known deposits. This technique may now be applied to outline unknown mineral belts throughout the Shield. (R.J.A.)

2. Rapid reconnaissance sampling of granitic rocks over large parts of the Yukon allowed the mineral potential of a number of mineral commodities to be cheaply and positively identified, including tungsten, tin, gold, and copper-molybdenum. On the basis of this, areas of ground were staked by companies during the winter. (R.G.G.)

3. Mercury, copper, zinc and lead have been detected in snow overlying a sulphide deposit in eastern Ontario. These elements were enriched 20x over background. This gives encouragement to our studies of vapour detection of metallic compounds in mineral exploration. (I.R.J.)

4. Chemical methods have been developed to distinguish ultramafic rocks that are associated with nickel-copper ores from those that are barren. These methods have been rapidly adopted by industry. (E.M.C.)

5. A very light field vapour detector has been designed and built that is based on the shift in frequency of a quartz crystal coated with a selective adsorbent. Coated with gold as little as one nanogram (10^{-9} gm) of mercury can be detected. Coated with other adsorbents other vapours, such as I and SO_2, may be measured to help locate ore deposits. (Q.B.)

6. A anticoincidence ionization chamber maga detector which measures the radon content of the atmosphere from ground vehicles and aircraft and is designed to sniff out uranium deposits was tested. (W.D.)

7. High levels of mercury have been detected within sulphide ores in parts of the Shield draining into the Great Lakes. In parts of the Shield where increased contents of mercury have been noted in fish, the background level of mercury in rocks has been found to be several times the average elsewhere. (I.R.J., E.M.C.)

8. Water sampling at a density of one sample per 10 square miles near Kaminak Lake, N.W.T. outlined a previously unknown belt with anomalous ore element values which lies within high grade metamorphic terrain. (E.H.W.H.)

9. Newly developed computer interpretation techniques have been used to outline areas of high mineral potential from the Arctic to the tropics (Guatemala). (D.H.)

10. Members of the Section took an active role in the organisation of the Third International Geochemical Exploration Conference and the Royal Society Special Symposium, "Mercury in Man's Environment". They played an important part in the organisation of the Association of Exploration Geochemists and in the founding of a new international journal of Geochemical Exploration.

These items primarily reflect the efforts of the Section to develop and apply new methods of mineral evaluation. Sufficient progress has been made during the last two years in developing mineral evaluation techniques for the Shield that a large scale geochemical survey operation has been planned for 1972 over the 36,000 square miles of the Bear province. If this operation is successful, it is hoped to contract out further routine surveys to industry.

Members of the Section continued to have many enquiries from other scientists in government, industry and the universities on problems of the environment. One of the reasons for this is that most studies of environmental problems are detailed investigations of specific topics; for instance, mercury contamination of fish. The classical geochemist is concerned with the bigger picture--the migration of elements through all natural media. Thus he is able to tie together and place in perspective the observations of others. The biologist cannot know that high mercury contents in fish within certain areas of the Shield may be related to Archean plate tectonics! The Section continued to suggest during the year that it has an important role to play in the study of the environment. Although no projects of this nature were initiated some of our mineral evaluation studies were able to produce data of interest to those working on the environment and Drs. Jonasson and Boyle presented a paper on mercury at the Royal Society Special Symposium.

The geochemists in the Section continued to enjoy a great many visits from geologists from mining companies who came to get advice of exploration methods and analytical techniques. A number of visitors spent time in the Section learning our techniques. Those here for the longest periods were Dr. Peter van den Boom of the Bundesanstalt fuer Bodenforschung in Hanover, West Germany who spent two months learning our computer based interpretation techniques and Mr. M. Persaud of the Geological Survey of Guyana who spent three months learning geochemical exploration methods.

Contrary to what the title may imply, the Section has a multidisciplinary approach to its projects. At the close of the year only two professionals trained as geochemists were on staff, compared to three chemists, one chemical engineer, one mathematician, one soil scientist and a physicist. This character was enhanced by Dr. I. R. Jonasson, a chemist from Adelaide, joining the Section at the close of the fiscal year and the presence during the year on an N.R.C. Fellowship of Dr. Jiri Soukup, a mathematician from Czechoslovakia. Also at the close of the year, Dr. A. Nigrini left the Section to join the exploration staff of Kennecott Copper in Boston.

Attendance at Meetings

R. J. Allan, E. M. Cameron, W. Dyck, R. G. Garrett, D. Hobbs, E.H.W. Hornbrook, I. R. Jonasson, J. J. Lynch, and A. Nigrini: The Third International Geochemical Exploration Symposium, Toronto, April, 1970.

R. J. Allan, R. G. Garrett, and E.H.W. Hornbrook: The Prospectors and Developers meeting, Toronto, March, 1971.

I. R. Jonasson: The Royal Society Special Symposium, "Mercury in the Environment", Ottawa, February, 1971.

Lectures, Talks Given

R. J. Allan and E.H.W. Hornbrook: gave a paper at The Third International Geochemical Exploration Symposium, "Exploration Geochemistry Evaluation Study in a Region of Continuous Permafrost; the Coppermine Basalt Belt, N.W.T., Canada".

E. M. Cameron, G. Siddeley and C. C. Durham: gave a paper at The Third International Geochemical Exploration Symposium, "Distribution Functions of Ore Elements in Rocks for Evaluating Ore Potential".

E. M. Cameron gave a talk at Carleton University, "The Geochemistry of Precambrian Sediments".

E. M. Cameron presented a paper to Logan Club on, "Recent Approaches to Exploration Geochemistry in the Shield".

W. Dyck et al presented a paper to the Third International Geochemical Exploration Symposium, "Comparison of Regional Geochemical Uranium Exploration Methods in the Beaverlodge Area, Saskatchewan".

R. G. Garrett gave a paper to the Third International Geochemical Exploration Symposium on "The Dispersion of Copper and Zinc in Glacial Overburden at the Louvem Deposit, Val D'Or, Quebec".

R. G. Garrett presented a paper at the Prospectors and Developers meeting on, "Molybdenum, Tungsten, and Uranium in Acid Plutonic Rocks as a Guide to Regional Exploration, Southeast Yukon".

R. G. Garrett gave talks at Ottawa and Queen's University on statistical methods in geochemistry.

E.H.W. Hornbrook gave a talk at the Third International Geochemical Exploration Symposium on, "Effectiveness of Geochemical and Biogeochemical Exploration Methods in the Cobalt Area, Ontario".

I. R. Jonasson and R. W. Boyle presented a paper to the Royal Society Special Symposium on "Geochemistry of Mercury".

I. R. Jonasson gave a talk at Carleton University on "Mercury in Geochemical Exploration".

Membership on Committees

Q. Bristow - Member Algonquin College Advisory Council on Electronics.

E. M. Cameron - Member of Council of the Association of Exploration Geochemists; Chairman, Publication Committee, Association of Exploration Geochemists.

R. G. Garrett - Member Subcommittee on Computer Applications of National Advisory Committee.
Member Computer Application Committee of Association of Exploration Geochemists.

I. R. Jonasson - Member Organising Committee: "Mercury in Man's Environment".

Outside Publications

R. J. Allan and E.H.W. Hornbrook
Exploration Geochemistry Evaluation Study in a Region of Continuous Permafrost, Northwest Territories, Canada; C.I.M. Special Volume 11, "Geochemical Exploration", 1971.

R. W. Boyle and R. G. Garrett
Geochemical Prospecting a Review of its Status and Future; Earth-Sci. Rev. 6 (1970) 51-75.

Q. Bristow
Contribution to a technical book, "Geoscience Instrumentation" (John Wiley & Sons). Contribution entitled, "Gamma Ray Sensors".

E. M. Cameron and W.R.A. Baragar
Distribution of Ore Elements in Rocks for Evaluating Ore Potential: Frequency Distribution of Copper in the Coppermine River Group and Yellowknife Group Volcanic Rocks, N.W.T., Canada; C.I.M. Special Volume #11, "Geochemical Exploration", 1971.

E. M. Cameron and D. Hobbs
Computerized Methods for Interpreting Reconnaissance Geochemical Surveys (Abstract); C.I.M. Special Volume #11, "Geochemical Exploration", 1971.

E. M. Cameron, G. Siddeley and C. C. Durham
Distribution of Ore Elements in Rocks for Evaluating Ore Potential: Nickel, Copper, Cobalt, and Sulphur in Ultramafic Rocks of the Canadian Shield; C.I.M. Special Volume #11, "Geochemical Exploration", 1971.

W. Dyck, A. S. Dass, C. C. Durham, J. D. Hobbs, J. C. Pelchat, and J. H. Galbraith
Comparison of Regional Geochemical Uranium Exploration Methods in the Beaverlodge Area, Saskatchewan; C.I.M. Special Volume #11, "Geochemical Exploration", 1971.

R.G. Garrett
The Dispersion of Copper and Zinc in Glacial Overburden at the Louvem Deposit, Val d'Or, Quebec; C.I.M. Special Volume #11, "Geochemical Exploration", 1971.

E.H.W. Hornbrook
Effectiveness of Geochemical and Biogeochemical Exploration Methods in the Cobalt Area, Ontario; C.I.M. Special Volume #11, "Geochemical Exploration", 1971.

A. Nigrini
Investigations into the Transport and Deposition of Copper, Lead and Zinc in the Surficial Environment (Abstract); C.I.M. Special Volume #11, "Geochemical Exploration", 1971.

Analytical Services and Development

John J. Lynch

Tables 1, 2, 3, 4 and 5 summarize the productivity of the Sample Preparation, Trace Element, Direct Reading, and two field laboratories. A more detailed record of the output of the first three laboratories may be obtained from the monthly or bi-monthly reports submitted for this project. Most of the time during the 1970-71 fiscal year was devoted to routine analyses and hence little development work was carried out.

In the Trace Element Laboratory a colorimetric method for the determination of As in water was devised with a detection limit of 1 ppb. A rpaid method for the determination of Na, K and Fe was set up for the analysis of R. Garrett's granite samples. A new atomic absorption spectrophotometer was installed for the determination of Hg in geochemical samples. Experiments on the feasibility of long absorption cells were performed. At present methods are available which permit the determination of Hg in rocks, soils and sediments down to 2 ppb and in water samples down to 0.01 ppb.

In the Direct Reading Laboratory tests were performed on the new spectrometer and computer. The fusion method for major constituents was refined and some preliminary work on direct-running of untreated samples was commenced.

TABLE 1

Sample Preparation Laboratory

	1969-70	1970-71
Samples carried over	0	0
Samples received	3286	3757
Samples completed	3286	3757
Samples carried forward	0	0
Sizing	796	225
Crushing	2280	4149
Grinding	2166	4086
Ball Milling	1649	3141
Superpanner	58	48
Frantz	23	12
Heavy Liquid	286	0
Hand Picking	35	8

TABLE 2

Trace Element Laboratory

	1969-70	1970-71
Samples carried over	570	120
Samples received	9808	8073
Samples completed	10258	7512
Determinations	32662	52560
Samples carried forward	120	681

TABLE 3

Direct Reading Laboratory

	1969-70	1970-71
Samples carried over	1349	0
Samples received	2178	3709
Samples completed	3527	3704
Determinations	19580	30261
Samples carried forward	0	5

TABLE 4

Colorimetric Field Laboratory - Kaminac Lake

Officer in Charge - E. Hornbrook

	1970-71
Samples completed	1434
Determinations	3150

TABLE 5

Colorimetric Field Laboratory - Coppermine

Officer in Charge: R. Allan

	1970-71
Samples completed	1700
Determinations	1850

GEOLOGY OF MINERAL DEPOSITS SECTION

G. A. Gross

Economic geologists and staff of this Section, work throughout Canada determining the kinds and characteristics of mineral deposits and the geological settings and regions favourable for the occurrence of mineral resources. Geological concepts and information necessary for recognizing and evaluating mineral resources are developed and applied in the estimation and forecast of resources and in defining new areas with mineral potential.

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

Metallogenic studies establish the geological relationship of various kinds of mineral occurrences to broader regional geological features and determine factors which control the distribution and kind of mineral resources in a region or geological province. The preparation of a metallogenic map for Canada on a scale of 1:5 million is being emphasized in work at present. This map, on a National scale provides orientation and general definition of regions with mineral resources and contributes an essential part of the geological knowledge and framework required for appraisal and estimation of mineral resource potential.

Special effort continues in the Section to accelerate work on the systematic collection, recording, compilation and presentation of geological information on mineral deposits for reference use and documentation of Section project work and for other Geological Survey reports and maps. Field data, previous records on mineral deposits from various sources and systematized project data files are being amalgamated and coordinated in centralized files to provide a data base for the mineral commodity and metallogeny projects.

The principal scientific contributions from 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 mineral resources and regional mineral potential. 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

A concerted effort was made in the study of major metallic mineral deposits during the year to develop the necessary geological framework based on modern scientific concepts for assessment and evaluation of mineral resource potential in a National context. In spite of depletions in scientific support staff and further restraints in the geology of mineral deposits program extensive field studies were continued by the commodity staff in a number of critical mineral exploration and development areas.

Very influential work on the occurrence of nickel in mafic and ultramafic rocks by Dr. O. R. Eckstrand was continued in various parts of the Precambrian shield. Extensive field work by Dr. R. V. Kirkham on copper deposits, and by Dr. R. I. Thorpe on silver and gold deposits provided important new information on genetic types and distribution of these mineral commodities throughout Canada. Study of lead and zinc deposits by Dr. D. F. Sangster was advanced to a stage where preparation of a comprehensive Economic Geology Series report is feasible. Preparation of a report on the Geology of Chromium deposits in Canada by Dr. D. R. E. Whitmore based on available sources of information proceeded on schedule. Dr. R. Mulligan studied pegmatite deposits in Brazil under sponsorship of the National Research Council exchange agreement with this country and continued with preparation of an Economic Geology report on tin deposits. Dr. E. R. Rose completed an Economic Geology Series report on vanadium deposits, and resumed study of rare earth element deposits. The study of iron and manganese deposits received a limited amount of time by Dr. G. A. Gross and included field work in the Labrador and Quebec iron mining areas, in the Melville Peninsula of the Eastern Arctic and in Central Canada, as well as participation in an International Symposium on the genesis of Precambrian iron and manganese deposits at Kiev and Krivoy Rog in the Ukraine.

Section and Branch project leaders continued to make extensive use of the Section laboratory facilities to provide basic scientific data pertaining to their areas of study. Three technicians from industry and university visited to receive training in the operation of Durener polishers. The preparation of polished sections for project studies and research is summarized below:

For Economic Geology and Geochemistry Division	Number of Sections
Mineral Deposits Section	582
Mineralogy Section	24
Geochemistry Section	4
Special Projects	18
For Crustal Geology Division	111
For training	20
Total	747

Metallogeny

Dr. G. B. Leech continued work on the general metallogeny of Canada and enlarged the scope and level of detail on mineral occurrences on the Metallogenic Map of Canada. Preparation of manuscript for the Canada part of the metallogenic map of North America is nearly complete and this map is 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.

Records of Mineral Deposit Geology

A project headed by Mr. A. G. Johnston for the development and maintenance of documentary records of the geology of mineral deposits was approved and started in late August. This project coordinates and centralizes a large amount of the geological record presently distributed with mineral commodity and metallogenic projects and in various reference files, maps and publications prepared in the Section program.

At the end of March 1971 the project geological records consisted of:

I Documentary files

1. Mineral property files arranged by mineral commodity and location by National Topographic System - 15,000 files

2. Subject files, selected clippings, reprints, reports, 3 cabinets of 4 drawers each.

3. Producing Mine file - 350 files

4. University theses - Abstracts - 200 files
   Theses copy incorporated in files - 50 files

II Index Files

(a) Card Index - to data bank Property Files arranged by Commodity, Property Name and Province

(b) Card Index by Subject - index cards and files developed by project leaders for special geological subject matter

(c) Mineral Occurrence Index,
Index Cards from the Mineral Resources Branch incorporated in the Geology of Mineral Deposits Data Bank for the Yukon, N.W.T. and Copper commodity files - 3,500 files

III Machine Processable Files

A. M-file for Mineral occurrences

1. IBM Cards

(a)	Records on IBM Punch Cards	6,786 files
(b)	Records on Input Documents (Being key-punched and checked)	435
	Total	7,221

2. Magnetic Tapes (Data from M-File IBM cards)
   (a) 6786 Records on tapes by Accession Number
   (b) 6264 Records on tapes arranged by National Topographical System (N.T.S.)

3. Print-Outs - M-File
   (a) The file (1 - 6786) printed in six volumes arranged by Accession Number
   (b) The file (1 - 6264) printed in five volumes arranged by N.T.S.
   (c) A print-out of the mineral occurrences in Northwest Territories (1 volume)
   (d) A print-out of the mineral occurrences in British Columbia (1 volume)
   (e) A print-out of nickel occurrences
   (f) A print-out of niobium-tantalum occurrences
   (g) A print-out of chromite occurrences
   (h) Mineral distribution maps (1:1,000,000) plotted by computer for several projects (3 for A.G.Johnston). A number of these maps have also been plotted for the chromite and the niobium-tantalum projects.

B. Other IBM Punch Cards
   1. Hudson Bay Mountain Area, British Columbia Assay data on Punch Cards for 70 properties

IV Data input during the period September, 1970 to March, 1971 by Data Bank Staff, Mr. Johnston, Miss Burns, 1 casual for 6 weeks is as follows:

1.	M-File print-outs of mineral deposits (a) by N.T.S. (b) British Columbia (c) Northwest Territories	
2.	Mineral distribution maps. Maps (1:1,000,000)	3
3.	Updated tape files. Records added	500
4.	Systematically checked mineral occurrences in N.W.T. and completed new M-file entries in N.W.T.	1,200 400
5.	Obtained copies of University Theses Abstracts(xeroxed)	200
6.	Inorporated copies of some of these theses into Data Bank	50
7.	Current information about Producing Mines, Major mineral deposits and exploration activity. Records processed	60
8.	Answered individual requests for geological information about mineral deposits both within the Survey and from other agencies	24
9.	Mineral Resources Branch Occurrence Index. Incorporated copies of occurrence cards into Mineral Deposits Data Bank.	3,500

General Activities

More than 150 representatives from mining and exploration companies consulted the Section Staff concerning the appraisal and evaluation of mineral deposits and on scientific and technical matters related to mineral development. The kind of information and consultation provided are summarized as follows:

1. Canada-wide distribution patterns of metals and main types of deposits.
2. The relationship of a particular metal to certain geological environments.
3. Information on the mineral potential of specific areas.
4. Localities where specific geological conditions can be found for the occurrence of different mineral commodities.
5. Trace elements as an aid to exploration for major elements.
6. On subjects such as isotopic studies, data storage, laboratory procedures for the study of ores, advice on research work and university theses, and critical reading of scientific manuscripts and reports.

Consultation and advice on mineral potential and possible future mineral developments were provided for a number of Department and Government agencies including Mineral Resources Branch, Department of Regional and Economic Expansion, Department of Indian Affairs and Northern Development and Provincial Government Agencies.

Personnel Notes

Dr. R. I. Thorpe began full time study of the geology of silver and gold deposits as a Section project in May, 1970.

Professor J. Kutina of Charles University in Prague, Czechoslavakia spent April and May with the Section studying mineral deposit distribution in relation to major structural features in the Abitibi Region of Quebec and Ontario.

Attendance at Meetings

Canadian Institute of Mining and Metallurgy, Toronto, April 1970.
E.D.Kindle, G.B.Leech.

Prospectors and Developers Association Annual Meeting, Toronto, March 8-10, 1971.
O. R. Eckstrand, R. V. Kirkham, D. F. Sangster, E. D. Kindle, G.A.Gross.

Geological Association of Canada, Annual Meeting, Winnipeg, Aug.31-Sept.2, 1970
O. R. Eckstrand, G. B. Leech

Society of Economic Geologists, Annual Meeting, Milwaukee, Wisconsin, Nov. 1970.
G. A. Gross

4th International Geochemical Symposium, Toronto, April 16-18, 1970
O. R. Eckstrand, D. F. Sangster

British Columbia Section of the Canadian Institute of Mining and Metallurgy, Kamloops, British Columbia, October, 1970.
R. Mulligan

Experimental Petrology and Sulphides Symposium, Kingston, 19 February, 1971.
O. R. Eckstrand

International Symposium on the genesis of Precambrian iron/manganese deposits; Kiev, Ukrainian S.S.R., August, 1970.
G. A. Gross

International Association on the Genesis of Ore Deposits, Meeting in Japan, August-September, 1970.
D. F. Sangster

Papers, Lectures and Talks Presented

O. R. Eckstrand
- Presented paper "The nickel potential of serpentinized ultramafic rocks" at Prospectors and Developers Association Meeting, Toronto, March,1971.
- Talk "Geology and alteration of a porphyry copper deposit, Geochemical Discussion Group, Ottawa, October, 1970.

R. V. Kirkham
- Presented paper "Geological exploration guies for stratiform copper deposits in sedimentary sequences" at Prospectors and Developers Association Meeting, Toronto, March, 1971.
- Talk "Some general aspects of copper deposits" at Queen's University, Kingston, March 31, 1971.

G. A. Gross
- Talk "Development Trends in the World Iron Ore Industry" at Schefferville, Quebec and Wabush, Labrador, Newfoundland, Branches of the Canadian Institute of Mining and Metallurgy, June, 1970.

G. A. Gross
- C.I.M.M. sponsored lecturer to six universities in the Maritime Provinces in January, 1971 - lectures on:
  1. The Origin of Iron Formation and Volcanogenic Mineral Deposits
  2. Iron Deposits of the Labrador Geosyncline
  3. Geological Methods of Appraisal and Evaluation of Mineral Resources
- Lecture "Iron-formation and Volcanogenic Mineral Deposits", Carleton University, October 23, 1970
- Presented Paper on "The Depositional Environments of Principal Types of Precambrian Iron-formation", at Int. Symposium on Genesis of Iron and Managese Deposits, Kiev, Ukraine, August, 1970.

R. Mulligan
- Talk "Lithophile metals and the Cordilleran Tin Belt" at meeting of B.C. Section of C.I.M.M. at Kamloops, B.C., October, 1970.

D. F. Sangster
- Presented paper "Sulphur Isotopes, Stratabound Sulphide Deposits, and Ancient Seas" at Int. Assoc. Genesis of Ore Deposits Meeting in Japan in September, 1970.
- Lecture "Stratiform types of lead-zinc deposits, Carleton University, October, 1970.

Drs. Eckstrand, Kirkham, Rose and Mulligan of the Section presented talks on Mineral Deposit Geology to the graduating class in geology from Carleton University in November, 1970.

R. Mulligan
- In the course of a National Research Council sponsored exchange visit to Brazil in May and June lectures were presented at a number of Institutions on the Geology and Mineral Deposits of Canada.

Membership on Committee

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, Int. Assoc. on the Genesis of Ore Deposits

D. F. Sangster
- Ottawa Branch, C.I.M.M. Committee
- Assistant Treasurer - Int. Assoc. Genesis Ore Deposits

E. R. Rose
- Chairman of Logan Club, Geological Survey of Canada

Papers Published in Outside Journals

G. A. Gross
- Geological concepts leading to mineral discovery; Can. Min. Jour. April, 1970.

G. B. Leech
- Estimating regional mineral potential. Metallogeny and Math. combine to aid appraisal, the Northern Miner, Nov. 26, 1970.

D. F. Sangster
- Geological exploration guides for Canadian lead-zinc deposits in carbonate rocks; Can. Min. Jour. April, 1970.
- Metallogenesis of some Canadian lead-zinc deposits in carbonate rocks; Proc. Geol. Assoc. Canada, Vol. 22, pp. 27-36, 1970.
- Discussion of papers on "Geological habitat of Mississippi Valley type Ore Bodies; I.M.M., Bull. No. 771, p. B65, Feb. 1971.

Geological Survey Publications

D. F. Sangster
- The contact metasomatic magnetite deposits of southwestern British Columbia; Geol. Surv., Canada, Bulletin 172, 1970.

R. I. Thorpe
- Geological exploration in the Coppermine River area, Northwest Territories, 1966-68; Geol. Surv., Canada, Paper 70-47

C.R. McLeod
- Some Canadian occurrences of maghemite; Geol. Surv., Canada, Paper 70-7

J. A. Chamberlain and A. G. Johnston
- Nickel in Canada; Geol. Surv., Canada, Map 1258A, 1970.

E. D. Kindle - Preliminary report on the copper deposits, Coppermine River Area, District of Mackenzie; Geol. Surv., Canada, Paper 70-49.

E. R. Rose - The ferride element content of titaniferous magnetite in Canada; Geol. Surv., Canada, Paper 69-54, 1970.

- Geology and Economic Minerals of Canada, Econ. Geol. Report No. 1, 5th Edition, 1970.

- Chapter V - Economic Minerals of the Canadian Shield;
by A. H. Lang, A. M. Goodwin, R. Mulligan, D. R. E. Whitmore, G. A. Gross, R. W. Boyle, A. G. Johnston, J. A. Chamberlain and E. R. Rose

- Chapter VII - Economic Minerals of Southeastern Canada;
by E. R. Rose, B. V. Sanford, and P. A. Hacquebard

Active Projects

Project No.	Leader	Approved Title	Field Component
		A. Mineral Deposits Section	
630037	O.R.Eckstrand	Geology of Canadian nickel and platinum group desposits	X
690084	J.M.Franklin	Study of copper, silver and uranium deposits of the Shield immediately northwest of Lake Superior.	
570029	G. A. Gross	Geology of iron and mananese deposits in Canada	X
600009	E. D. Kindle	Geology of copper deposits in Canada	
700059	R.V.Kirkham	Geology of copper and molybdenum deposits	X
690093	J. Kutina	Relationship of structural lineaments and mineral occurrences in the Abitibi area of the Canadian Shield (to 31 May 1970)	

640125	G. B. Leech	General metallogy of Canada	X
680149	G. B. Leech	Committee on the history of the G.S.C.	
700072	G. B. Leech	Preparation for I.G.C. Field Trip A03-C03	X
530014	R. Mulligan	Geology of Canadian lithophile metals (Li, Be, Sn, W, Mo)	X
650012	R. Mulligan	Metallogenic study of beryllium - tin province of Cassiar batholith	
630039	E. R. Rose	Geology of vanadium deposits in Canada	
650056	D. F. Sangster	Geology of lead and zinc deposits in Canada	X
630028	D. F. Sangster	Nakina geologic-magnetic study	
540027	R. I. Thorpe (J. C. McGlyn)	Mineral industry of the mainland Northwest Territories	
650050	R. I. Thorpe	Metallogenic maps and reports, District of MacKenzie	
680060	R. I. Thorpe	Geology of Silver and Gold deposits in Canada	X
640058	D.R.E.Whitmore	Whalesback comprehensive mine study	
640402	D.R.E.Whitmore	Certification of bedded and non-bedded mineral deposits	X
700055	D.R.E.Whitmore	A report on the geology of chromium deposits in Canada	
690077	H.P.Wilton	Iron formations in the Timagami area, Ontario	
690076	I. S. Zajac	Iron formation facies in Superior-type iron formations in the Knob Lake area	
700084	A.G.Johnston	Development and maintenance of mineral deposits geology records	

GEOMATHEMATICS PROGRAM

F.P. Agterberg

The primary objective of the program is to develop methods for the quantification of geological data from maps and other sources of information and, by the application of multivariate statistical methods, to relate the occurrence of various types of mineral deposit to geological, geophysical and geochemical parameters. This involves the identification of those parameters which are relatively strongly correlated to mineralization in an area. Relationships derived for explored areas are projected to unexplored areas in order to estimate the potential abundance of mineral resources. The favourable environments for a commodity or type of deposit are shown by contours on potential maps which permit the estimation of expected number of undiscovered mines and their size per unit of area. The uncertainty of these numbers is expressed by using confidence intervals. Current areas of study are parts of the Canadian Shield in Quebec, Ontario, Manitoba and the District of Mackenzie.

The staff of the program also is involved in the construction of geomathematical models for geological processes ranging in scope from the deposition of lava flows in an Archean basin to the sedimentation of varved clay in a Pleistocene glacial lake.

Personnel Notes

F.P. Agterberg returned in June from leave of absence as a visiting research scientist with the University of Kansas.

C.F.Chung began work as a casual employee in computer programming in July after obtaining his Master's Degree in mathematics at Carleton University.

A.M. Kelly joined the program in August, as a casual employee, to undertake a statistical appraisal of the mineral potential of the Slave-Bear Province.

J. Kutina, Visiting Research Scientist, left the Survey in May after participating in the program as a consultant for the quantification of structural parameters.

Y.J. Lepinis has been transferred to the program in April as a staff support member.

J.S. Springer moved from Ottawa to Toronto in August but continued her work on the program as a consultant.

Attendance at Meetings

A.G. Fabbri: Ninth International Symposium on Decision-making in Mineral Industries, C.I.M.M., Montreal, June, 1970.

Papers, Lectures, Talks Presented

F.P. Agterberg: Geomathematics, Course GEO 4503, University of Ottawa, January - April, 1971.

- A probability index for detecting favourable geological environments: Ninth Int. Symp. Decision-making in Min. Industries, C.I.M.M. Montreal, June, 1970.

F.P. Agterberg and A.M. Kelly:

- Geomathematical methods for use in prospecting: Prospectors and Developers Association Meeting, Toronto, March, 1971.

A.M. Kelly: Some uses of Geomathematics in Exploration, Lecture, Carleton University, February, 1971.

A.G. Fabbri: Lectures on Geomathematics at Laboratoria di Geologia Marina, Bologna and Instituto di Geologia, Ferrara, Italy, March, 1971.

Membership on Committees

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

Associate Editor, Canadian Journal of Earth Sciences

Associate Editor, Computer Contribution Series, Kansas Geological Survey and A.A.P.G.

Technical Program Committee, Ninth International Symposium on Decision-Making in Min. Industries, C.I.M.M., Montreal, June, 1970.

A.M. Kelly: Mineral Deposits Working Group of Sub-committee on Computer Applications of the National Advisory Committee on Research in the Geological Sciences.

Technical Program Committee, Ninth International Symposium on Decision-Making in Min. Industries, C.I.M.M., Montreal, June, 1970.

Outside Publications

F.P. Agterberg: Multivariate prediction equations in geology; Jour. Mathematical Geology, Vol. 2, pp. 319-324, 1970.

F.P. Agterberg: Autocorrelation functions in geology: Geostatistics, D.F. Merriam, Editor, Penum Press Corp., New York, pp. 113-141, 1970.

F.P. Agterberg and A.M. Kelly: Geomathematical methods for use in Prospecting; Can. Min. Jour. May Issue, 1971.

MINERALOGY SECTION

R.J. Traill

The scientists and support staff of the Mineralogy Section produce data and concepts that contribute to the National inventory of potential mineral and energy resources, to the search for mineral deposits and to the basic knowledge of the geology of Canada. Research is directed towards an understanding of the mineralogical setting and mineral guides to ore deposits. Specialist scientists provide Branch scientific services through development and application of techniques in the fields of x-ray diffraction, x-ray fluorescence, electron and laser beam excitation, and through the operation of sample preparation and mineral-separating laboratories. Section staff are responsible for cataloguing and extending the Systematic Reference Series of Canada's National Mineral Collection, the National Meteorite Collection, and reference collections of the minerals of Canadian ore deposits; and for the dissemination of geological information to the public by sale of sets of minerals and rocks, by identification of geological specimens, and by answering requests for information.

Activities

A comprehensive study of the non-ore mineralogy of the Cobalt-Gowganda silver deposits was completed by J.L. Jambor and will be published in 1971 in a special issue of The Canadian Mineralogist, together with the results of a study of the ore mineralogy by W. Petruk of the Mines Branch. Dr. Jambor also made preliminary field studies in British Columbia in connection with a new project on the mineralogical environment of porphyry deposits of copper and molybdenum.

J.Y.H. Rimsaite transferred the emphasis on her research studies of micas to a new project on the mica minerals associated with mineral deposits. She began field and laboratory studies of micas associated with nickel deposits by collecting and studying specimens from the Thompson - Lynn Lake area.

R.J. Traill continued to compile data on Canadian minerals. A Catalogue of Canadian Minerals (Paper 69-45) was published during the year, and a first supplement is under preparation. Following the resignation of J.A.V. Douglas, R.J. Traill assumed responsibility for projects 570119 (Meteorite studies) and 680124 (Mineralogy and petrology of lunar material). A. G. Plant and R.J. Traill completed a study of lunar rocks and fragments from the Apollo 12 mission. Four scientific papers on the mineralogy and petrology of lunar samples were published during the year and a fifth was presented at the Apollo 12 Lunar Science Conference in Houston, Texas.

A.G. Plant, G.R. Lachance and R.N. Delabio filled requests for electron probe microanalyses of minerals in support of 24 different Branch projects. Problems ranged from the analysis of isolated mineral grains to the examination of complex mineral assemblages requiring in excess of 1000 element determinations. The application of digital computer techniques to various aspects of data processing was continued and G.R. Lachance completed a two-week computer programming course given by the Hewlett-Packard Company to aid in this work.

Ann P. Stenson continued her investigation of mineral-collecting areas by visiting about 100 localities in the Precambrian of northern Manitoba and Saskatchewan between Thompson and La Ronge.

H.R. Steacy reports extension of the Reference Series of the National Mineral Collection through the addition of 326 specimens on groups of similar specimens. The ore collection received considerable attention with the introduction of an index card for reference and computer use and the cataloguing of about 1,200 specimens. Three ore displays were placed in Logan Hall. Mr. Steacy was instrumental in arranging transfer of the Logan Boulder from the grounds of the Victoria Museum to the front of the Geological Survey Building, and in establishing the attractive and educational Geology Court in front of the Surveys and Mapping Building.

M. Bonard, R.N. Delabio and D. Fong provided the following x-ray diffraction and mineralogical services in support of 33 Branch projects including the age determination program which serves many other projects: 2,680 mineral identifications, 47 determinations of unit cell constants and 17 olivine composition determinations by x-ray powder diffraction; x-ray diffractometer analyses of 127 clays, 83 micas, 31 amphiboles, 31 feldspars, 14 serpentines, 12 glauconites, 21 other minerals and 61 rocks; examinations and reports on 121 samples forwarded to the Geochronology Section for age determination. The laboratory reference files of standard x-ray patterns and specimen mounts were updated and 39 new standards were added. A digital microdensitometer for reading x-ray films was installed in the laboratory and interfaced with the Hewlett-Packard computer in the electron probe laboratory.

R.J. Gravel completed 2,086 quantitative and 863 qualitative x-ray fluorescence analyses on 914 rock and mineral samples in direct support of 20 Branch projects, and indirectly in support of others through provision of analyses for the age determination program. Analyses were made for 35 different elements; the three most often requested were strontium (634), rubidium (574) and potassium (324).

J.C. Paris, B. Machin, R. Charbonneau, A. Brown and Mr. Huot processed 4,146 samples in the sample preparation and mineral-separating unit, and prepared 372 concentrates of minerals. This work required the following numbers of operations: crushed, ground and sized 3,126; heavy liquids 2,156; Frantz separations 1,497; Carpco separations 799; superpanner separations 534; Wilfley table 51; and electrostatic separations 13.

J.M. Larose, J. Turpin and T.R. Racine prepared and shipped 8,106 Prospector's Sets of Minerals and Rocks. The distribution of these throughout Canada was as follows:

Alberta	1.472
British Columbia	1,569
Manitoba	114
New Brunswick	239
Newfoundland	30
Nova Scotia	117
Northwest Territories	383
Ontario	1,883
Prince Edward Island	13
Quebec	489
Saskatchewan	524
Yukon	303
Ottawa Office	768
Minister's Office	82
Other	120

Sales of the 120-specimen collection of minerals, rocks and ores representing the raw materials of the Canadian mining industry amounted to 179. Two special sets of these collections in wooden cabinets were presented to the Deputy Minister. At the request of the National Film Board, 200 special collections were supplied to accompany Earth Science film-strip kits. A collection of 40 specimens size 4" x 4" x 3" was prepared for the Inland Waters Branch at Burlington, Ontario; and 25 large size (2" x 2" x 1") Prospector's Sets of Rocks were supplied to the Research Council of Alberta.

C.H.R. Gauthier examined and reported on the identity of 1,014 specimens submitted by the Public. Mrs. Ann P. Stenson replied to 19 requests from the public for mineral-collecting information.

Attendance at Meetings

J.L. Jambor — Mineralogical Association of Canada, Annual Meeting, Winnipeg, September 1970.

G.R. Lachance — Canadian Electron Probe Users Group, Annual Meeting, Pinawa, Manitoba, September 1970.

A.G. Plant	Mineralogical Association of Canada, Annual Meeting, Winnipeg, September 1970.
	Apollo 12 Lunar Science Conference, Houston, Texas, January 1971.
J. Rimsaite	Mineralogical Association of Canada, Annual Meeting Winnipeg, September 1970.
	Clay Minerals Society, Miami Beach, October 1970.
Ann P. Stenson	Mineralogical Association of Canada, Annual Meeting, Winnipeg, September 1970.
R.J. Traill	Meteoritical Society, Annual Meeting, Skyland, Virginia, October, 1970.
	Apollo 12 Lunar Science Conference, Houston, Texas, January, 1971.

Membership on Committees

J.L. Jambor	Executive Committee, Mineralogical Association of Canada
H.R. Steacy	Ottawa Branch Committee, Canadian Institute of Mining and Metallurgy.
	Branch Uranium Committee
	Branch Exhibits Committee
Ann P. Stenson	Treasurer, Mineralogical Association of Canada
R.J. Traill	Branch Classification Evaluation Committee, Operational Category.

Special Talks

A.G. Plant	"Electron microprobe analysis and its use in lunar sample studies". Toronto-Hamilton Section of the Spectroscopy Society of Canada, and Geology Department, Dalhousie University. "Mineralogy and petrology of Apollo 11 samples" Mineralogical Association of Canada, Annual Meeting, Winnipeg. "Petrology of Apollo 12 crystalline rocks" Second Lunar Science Conference, Houston, Texas. "Horizons in analytical chemistry" Ottawa Geochemical Discussion Group.

J. Rimsaite "Absorption and retentivity of adsorbed and radiogenic argon in heated micas" Mineralogical Association of Canada, Annual Meeting, Winnipeg.
"Effect of dehydration and oxidation on optical and x-ray properties of dehydrated micas" Clay Mineral Society, Annual Meeting, Miami Beach.

Outside Publications

Agrell, S.O., Peckett, A., Boyd, F.R., Haggerty, S.E., Bunch, T.E., Cameron, E.N., Dence, M.R., Douglas, J.A.V., Plant, A.G., Traill, R.J., James, O.B., Keil, K., and Prinz, M.

1970: Titanian chromite, aluminian chromite and chromian ulvospinel from Apollo 11 rocks. Proc. Apollo 11 Lunar Sci. Conf., Geochim. Cosmochim. Acta, Suppl. 1, Vol. 1, pp. 81-86.

Chao, E.C.T., Minkin, Jean A., Frondel, C., Klein Jr., C., Drake, J.C., Fuchs, L., Tani, B., Smith, J.V., Anderson, A.T., Moore, P.B., Zechman Jr., G.R., Traill, R.J., Plant, A.G., Douglas, J.A.V., and Dence, M.R.

1970: Pyroxferroite, a new calcium-bearing iron silicate from Tranquillity Base. Proc. Apollo 11 Lunar Sci. Conf., Geochim. Cosmochim. Acta., Suppl. 1, Vol.1, pp. 65-79.

Dence, M.R., Douglas, J.A.V., Plant, A.G., and Traill, R.J.

1970: Petrology, mineralogy and deformation of Apollo 11 samples. Proc. Apollo 11 Lunar Sci. Conf., Geochim Cosmochim. Acta., Suppl. 1, Vol. 1, pp. 315-340.

Lachance, G.R.

1970: Fundamental coefficients for X-ray spectrochemical analysis. Can. Spect., Vol. 15, pp.3-11.

Rimsaite, J.

1970: Anionic and cationic variations in zoned phlogopite. Contr. Mineral. Petrol., Col. 29, pp. 186-194

Traill, R.J., Plant, A.G., and Douglas, J.A.V.,

1970: Garnet: first occurrence in the lunar rocks. Science, Vol. 169, pp. 981-982.

Active Projects

Preparation of collections of Canadian rocks and minerals for distribution to the public. 400006

Examination and report on geological specimens received from the public 400007

Reference collection of standard X-ray powder patterns of minerals	490015
Systematic reference series of the National Mineral Collection and G.S.C. collections of minerals and ore suites	550101
Meteorite studies	570119
Catalogue of Canadian Minerals	580160
Study of mica group minerals and associated host rocks.	590309
X-ray emission analysis	600307
Electron probe microanalysis	620308
Study of mineral collecting areas of interest to rockhounds and tourists	640048
Study of non-metallic vein minerals and wall-rock alteration, Cobalt camp	660040
Testing field and office collections for radioactive and fluorescent minerals	660479
X-ray diffraction analyses and mineralogical studies	680023
Mineralogy and petrology of lunar material	680124
Mineralogy of porphyry deposits of Cu and Mo in Canada	700041
Mica group minerals and related silicates in Canadian mineral deposits	700067

EXPLORATION GEOPHYSICS DIVISION

A. G. Darnley, 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.

In the light of these functions the work of the division can be considered to comprise three stages: research into new methods, and development of the most promising; experimental use and appraisal of the latter under carefully controlled conditions; formulation of specifications for routine use and application of the best of the new methods by industrial contractors, and the monitoring of contractors' performance. The results of both the second and third stages must be continuously fed back into the first so that ideas on new and old methods can be continuously revised.

During 1970 methods in the first stage of development included ARES, a potentially very versatile variable frequency airborne resistivity mapping system; the Overhauser magnetometer; and ATGAS, an airborne trace gas analyser system being developed under a research contract by the Institute of Aerospace Studies, University of Toronto. Methods in the second stage include the high sensitivity gamma-ray spectrometer, and the Rb-vapour magnetometer, which are now both being used on systematic experimental surveys. The third stage of development is represented by the aeromagnetic surveys carried out under contract for the Federal-Provincial governments, and the mixed aeromagnetic, radiometric, EM, and seismic surveys being carried out under contract through DREE and CIDA sponsorship, for which GSC acts as technical adviser and supervisor.

For a complete description of the Division's activities in 1970-71, see relevant pages of CG 85 forms (approximately 300 pages) and Report of Activities, Paper 71-1A (pp. 39-60 incl.)

Personnel Notes

A. G. Darnley - appointed Division Chief, February 1, 1971.

REPORT OF SECTIONS

SPECIAL PROJECTS

Personnel

Dr. A. S. MacLaren died on February 23, 1971, following several months of illness. He had served GSC for 30 years having undertaken field mapping in Northern Ontario, Eastern Townships and Nova Scotia before joining the Geophysics Division in 1953.

Activities

This section has been responsible for the supervision and inspection of the Federal Provincial Aeromagnetic surveys which are flown and compiled by contractors.

Statistics for 1970-71 are as follows:

1 mile map sheets flown	357
1 mile map sheets published	186
4 mile map sheets published	11

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 & Baffin Island
690073	Fed/Prov. - Quebec
700020	Fed/Prov. - Newfoundland
700023	Fed/Prov. - British Columbia
680083	Recompilation - Timmins Area

ELECTRICAL METHODS SECTION

L. S. Collett

The Electrical Methods 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, improvement on present systems and development of new techniques to meet the objectives. Efficient means of handling large amounts of data and presentation in map form are part of the functions. Theoretical interpretation of electromagnetic data and scale modelling are part of the work of the section. To assist in the interpretation and development of new techniques, an electrical rock properties program has been initiated to determine the electrical characteristics of rocks, sulphides, permafrost, coal and overburden. The section cooperates with the provinces, especially in the area of regional economic expansion programs, and with universities and industry by aiding and stimulating activity in application of electrical methods to exploration.

Activities and Research Highlights

Evaluation of various airborne electromagnetic systems continued during the year. Data from previous surveys of INPUT and AFMAG resulted in commencement of a new Geophysical Series (Electromagnetic) starting with Map 25,001 G. Four AFMAG maps were published for the St. Mary's River area, Nova Scotia; 26 maps for the Upper Nelson area, Manitoba; and four maps for the Uranium City area, Saskatchewan. AFMAG data acquired from AMAX covering the Thompson belt, Manitoba, will soon be available for publication. Excellent progress has been made on reducing the INPUT data for publication covering the Ottawa and Hawkesbury areas, Ontario; the Winkler and Pioneer areas, Manitoba; and Drumheller area, Alberta. Theoretical and scale model work have aided greatly in the interpretation of the INPUT data.

Barringer Research Ltd. flew a VLF survey in the discontinuous permafrost region of Manitoba using the station NAA Cutler, Maine (17.8 KHz) as the energy source. The Quaternary Research and Geomorphology Division cooperated with the Exploration Geophysics Division in this test survey and Dr. R. J. E. Brown, Building Research Division, NRC acted as an advisor for selection of the areas in this project. Four areas were flown at an elevation of 200 feet in this test survey, Thompson (49 line miles), Kelsey Dam area (110 line miles), Ilford (792 line miles) and Long Spruce Rapids (161 line miles), making a total of 1112 line miles. Preliminary assessment of the data is not too encouraging for the detection of permafrost in the discontinuous zone because the frequency used may be too low. However, this is very useful information for any further consideration of work to be done in mapping permafrost in the discontinuous zone.

The AFMAG surveys have emphasized the need for a systematic investigation of the nature of natural electromagnetic fields. For the next two years, a study which has already commenced will be directed toward the frequencies in the 8-40 Hz b and and for developing a 3-component airborne measuring system. Cooperation with the University of Toronto and the Defence Research Establishment Pacific (DREP) has been inaugurated.

An airborne resistivity electromagnetic system (ARES) has been conceived by the section and scale model work using a laboratory prototype system shows that the idea is feasible. It will be a new concept in airborne electromagnetics in that the frequency in the transmitter, instead of being fixed, will be variable. This will be the first time that any EM system will be able to sound at constant depth over areas of varying conductivity. This feasibility will have a decided advantage over the present EM systems and it may be possible to use the system for mapping in areas of permafrost. This project will likely be the next large project undertaken by the Exploration Geophysics Division.

Good progress has been made in the electrical rock property laboratory which is now capable of systematically measuring rock samples over a frequency range from 10^{-2} Hz to 10^{7} Hz on a routine basis. At present, the capabilities are being extended to 150 MHz. At the low frequency end of the spectrum, research to date indicates that copper-rich sulphides may be distinguishable from iron-rich sulphides and graphite. If this is true, this will be a very real contribution to the sulphide mineral exploration industry. At the upper end of the frequency spectrum, results from these investigations will aid in the design of new techniques for mapping stratigraphy in Pleistocene and Quaternary sediments and permafrost. During the year, measurements were made on three samples each from Apollo 11 and 12 flights. The results were reported on at the 1971 Lunar Science Conference in Houston in January. The work of this laboratory is being increasingly recognized by NASA and the Principal Investigators asked to advise in connection with lunar electromagnetic sounding experiments to take place on Apollo 17 flight. We have been asked to continue to extend our investigations on rocks returned by Apollo 14 and those from future flights. During the year, Dr. G. Finzi-Contini, University of Siena, Italy, was awarded a Canada Council Fellowship to work in this laboratory for four months on membrane polarization and complex mobility in moist rocks.

The ground work on phase measurements at .01 Hz to 10 Hz over sulphide zones has proven that phase shifts do exist. Detailed analyses of the results have shown that phase shifts of up to 15° are detectable over sulphide ore bodies. There is some evidence that the variation of phase shift with frequency may be characteristic of the type of mineralization. Results of this work is being incorporated into a Ph.D. thesis by W. J. Scott, McGill University.

During the year, L. S. Collett acted as the EMR's technical advisor to the New Brunswick Department of Natural Resources and the Department of Regional Economic Expansion for airborne geophysical surveys. A request for quotation and a contract were drafted for a multi-sensor airborne survey (magnetic, radioactivity and VLF-EM) over the

Caledonian Mountain area. The survey was let to Barringer Research Ltd., Toronto, and will commence on or about May 15, 1971. Consideration is now being given to an airborne geophysical survey for two regions in the Bathurst area.

Personnel Notes

Dr. A. Becker - granted a second year leave of absence on September 1, 1970, to teach exploration geophysics courses at the Department de Genie Geologique, Ecole Polytechnique, Montreal. Dr. Becker was on staff from April 15 to August 15, 1970.

Dr. G. Finzi-Contini - University of Siena, Siena, Italy, was awarded a Canada Council Fellowship to work in the section for four months commencing July, 1970, on a theoretical study on membrane polarization and complex ionic mobility in moist rocks.

Dr. T. J. Katsube - second year tenure of a Postdoctorate Fellowship from Waseda University, Tokyo, Japan, from March 17, 1970 to April 30, 1971.

Mr. W. J. Scott - joined the section on March 29, 1971. He is completing his Ph.D. requirements at McGill University.

Attendance at Meetings

L. S. Collett - Attended Canadian Institute of Mining and Metallurgy Annual Meeting, Toronto, April 20-23, 1970. Presented a paper with Dr. C. K. Bell entitled "AFMAG Use in Geological Interpretation".

- Attended GAC/MAC Annual Meeting, Winnipeg, Aug. 30 - Sept. 2, 1970. Presented paper with co-authors T. J. Katsube, A. Becker and R. Ahrens on "Electrical conductivity of lunar rocks".

- Attended 40th Annual International Meeting of Society of Exploration Geophysicists, New Orleans, November 8-12, 1970. Acted as member on mining committee and committee for cooperation with Government Agencies.

- Attended the third meeting, SOQUEM's Research Project 17-120, Quebec City, December 1, 1970.

- Attended two week course on Public Management, Kemptville, Ontario, December 6-18, 1970.

- Attended 1971 Lunar Science Conference, Houston, Texas, January 11-14, 1971. Presented a paper with T. J. Katsube on "Electrical properties of Apollo 11 and 12 rock samples".

- Attended the Prospectors and Developers Association meeting, Toronto, Ontario, March 8-10, 1971.
- Addressed the breakfast meeting of KEGS, March 9, 1971, on "The need for a Canadian Exploration Geophysicists Association".
- Chairman of two meetings of Subcommittee on Exploration Geophysics held in Ottawa on October 28, 1970 and February 25, 1971.
- Attended two meetings of the Associate Committee on Geodesy and Geophysics held in Ottawa on October 29, 1970 and February 26, 1971.

Special Projects

L. S. Collett
- Critically reviewed one paper for the Associate Editor (Dr. S. H. Ward) of Geophysics.
- Compiled the Annual Report, Exploration Geophysics Division, for 1969-70.

Membership on Committees

L. S. Collett
- Member, Classification Evaluation Committee (Technical Category)
- Member, Associate Committee on Geodesy and Geophysics, National Research Council.
- Chairman, Subcommittee on Exploration Geophysics, ACGG, NRC.
- Member, Mining Committee, Society of Exploration Geophysics.
- Member, Committee for Cooperation with Government Agencies, Society of Exploration Geophysicists.

Outside Papers

Collett, L. S. and Bell, C. K.
AFMAG use in geological interpretation: CIM Bull. v. 64, no. 706, pp. 39-47, Feb. 1971; CIM Trans., v. LXXIV, pp. 33-41, 1971.

Collett, L. S. Exploration geophysics: Can. Geophys. Bull., v. 23, December 1970.

Active Projects During 1970-71

620056	Audio frequency studies
630049	Electrical rock properties
660043	Airborne INPUT surveys
660494	Magnetotelluric investigations
670040	Geophysical investigations
670041	VLF mapping
670062	DC resistivity - Ontario
670564	Time domain EM theory
680005	Electrical conductivity lunar samples
680089	Airborne resistivity electromagnetic system (ARES)
680123	AFMAG surveys
700091	Regional economic expansion program - airborne geophysics - New Brunswick.

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 continued the cooperative ocean aeromagnetic project with the National Aeronautical Establishment of the National Research Council. No field work was actually carried out during 1970 although this was planned due to non-availability of aircraft time. The office work carried out during the year centered on the compilation of the Labrador Sea and Baffin Bay results for a paper presented at the Earth Science Symposium on Offshore Eastern Canada held in Ottawa during February 1971.

Geological models for profiles in the Labrador Sea and Baffin Bay have been computed in which the dimensions and magnetizations of the various causative bodies have been calculated. Depth determinations carried out on the aeromagnetic profiles on the Canadian side of Baffin Bay show that a considerable sedimentary section exists on the Baffin Shelf. Moreover the presence of high-frequency anomalies on the outer part of the shelf would also strongly suggest that a basement ridge runs along the outer part of the shelf which is probably similar to that

found along the eastern seaboard of North America. Depth determinations carried out on the profiles indicate that the thicknesses of sedimentary rock exceed 10,000 feet on the Baffin Shelf. However, sedimentary cover in the central deep-ocean part of Baffin Bay appears to exceed 20,000 feet over large areas. Considerable work was also carried out by Margaret Bower in programming an Interdata computer in order to convert Omega navigation co-ordinates to latitudes and longitudes during survey flights. Navigation is usually the greatest problem in offshore geophysical surveys and perfection of such a long-range navigation system is of great interest to the commercial survey companies as well as ourselves.

During the report year various modifications to the electronic circuitry of the high resolution aeromagnetic survey system installed in the GSC Beechcraft B80 aircraft were carried out by P. Sawatzky. A much better gyro compass for the Doppler was installed in the aircraft together with a Crash Position Indicator and a new HF radio, both of which are essential for operations in the far north. The system was used in aeromagnetic surveys of the sheets south of Ottawa (not yet completed) and in the St. Mary's River Graben area of Nova Scotia, which amounted to some 5000 line miles. An agreement was also reached with Aero Services of Philadelphia with regard to the paying of a line mileage royalty for the use of optical absorption magnetometers which was negotiated by P. J. Hood and the legal adviser to DEMR, Mr. C. Mullane.

During the survey in Nova Scotia it became apparent that the efficiency of the survey operation would be increased if there were a small computer facility in the field with which to check the digital survey data and an automatic film processor to develop the survey film and both these items were subsequently purchased. Some of the digital logic circuitry has been redesigned by P. Sawatzky and a second control unit is being constructed. Various modifications to the layout of the survey equipment and power supplies in the Queenair aircraft will be carried out during the next report-year including the installation of an instrument rack for electronic navigation equipment, such as a Decca hyperbolic receiver, which would permit surveys of near-shore areas on the east coast to be carried out. A Honeywell radar altimeter will also be installed to replace the Bonzer instrument which has proved unreliable in survey use.

The field operations will provide high resolution aeromagnetic survey data which will enable the data to be evaluated in terms of its usefulness in geological mapping. The cost of these surveys will be very much less per line mile than would be available from contract surveys. Many of the features of the Queenair system are being copied by Canadian airborne geophysical survey companies and the project is therefore helping to improve the current state of the aeromagnetic survey art in Canada.

P. J. Hood was the Program Chairman for the Earth Science Symposium on Offshore Eastern Canada which was held in Camsell Hall from February 22-24, 1971. A total of 39 papers were presented in the 2 1/2 day symposium, which was opened by the Deputy Minister of Energy, Mines and Resources, Mr. J. Austin. The meeting was closed by Mr. Arne Nielsen,

President of Mobil Oil (Canada) Ltd. whose company was the first to obtain permits on the east coast. A total of 373 persons attended the Symposium, of these 215 were from industry, 130 from Alberta, 63 from the U.S.A. and 14 from overseas. The main objective of the Symposium was to summarize our present knowledge of the continental shelves and slopes of eastern Canada. The areas discussed were the Bay of Fundy, Scotian Shelf, Gulf of St. Lawrence, Grand Banks, Flemish Cap, Labrador Sea, Baffin Bay and the west Greenland shelf. The topics included Surficial Geology, Geochemistry, Repetitive-source Seismic, Bedrock Geology and Tectonics, Seismic Reflection and Refraction, Gravity, Magnetics, Magnetotellurics, Paleomagnetism, Offshore Drilling and Icebergs. Each of the sessions was a multi-disciplinary study of one or more areas, and the papers were arranged so that those bearing on surficial geology were first and the papers which followed were arranged in order of increasing depth penetration. Thus in a given session the geological edifice for a specific area was studied from the top downward. As there is only one geological edifice in a given area, the results presented in the papers should have been mutually compatible. To this end the authors were given until June 1st, 1971, to revise their papers for the proceedings volume to take account of other people's results if necessary.

On behalf of CIDA, P. J. Hood (with G. D. Hobson) visited Guyana during July/August 1970 in order to gather the background information necessary to plan a 70,000 line-mile aeromagnetic survey of the country. The invitation to tender was drawn up by P. J. Hood with the help of E. Ready and issued by the Geological Survey of Guyana. The aeromagnetic survey will commence in September 1971, with P. J. Hood acting as the Technical Inspector for the contract.

The annual mineral exploration review was prepared by P. J. Hood and published in the February 1971 issue of the Canadian Mining Journal. Tabulations of commercially-available ground IP and radiometric equipment and airborne scintillation spectrometers were compiled. These articles are essentially a service to industry and summarize for them what new equipment, techniques, etc. are available for mineral exploration, and the extent to which the various methods are being utilized throughout the world. Reprints of these articles are much sought after by industry and such agencies as CIDA and the UN to keep their personnel up-to-date. These articles help to maintain Canada's prestige and leadership in the mineral exploration field throughout the world.

L. J. Kornik continued his regional compilation and interpretation of aeromagnetic data of central Canada. During the report year a field program was carried out in northern Saskatchewan and the southern district of Mackenzie. New aeromagnetic and other data were integrated into the program and prepared for study as it became available. Aeromagnetic composites have been prepared for the portion of the Churchill province between the Superior and Slave provinces. An oral paper on the Magnetic subdivisions of Manitoba was presented at the GAC-MAC meeting in Winnipeg, August-September 1970 and an oral presentation of work of this project was also presented to the "Superior Round" discussion group.

P. McGrath carried out field investigations in New Brunswick, Newfoundland and central Nova Scotia during 1970. Magnetic property investigations were carried out at 305 sites in order to ascertain the contributions of the remanent and induced magnetization components. P. H. McGrath continued the development of an automated multi-model computer technique for the interpretation of magnetic anomalies, and the method was described at a paper presented at the Society of Exploration Geophysicists meeting in New Orleans in November 1970. A paper summarizing the magnetic properties of rocks in the Appalachian region and interpreting the magnetic anomalies in the Gulf of St. Lawrence was presented at the Earth Science Symposium on Offshore Eastern Canada in Ottawa in February 1971.

S. Washkurak has successfully developed a continuous reading high sensitivity Overhauser magnetometer with a laboratory sensitivity of 0.01 gamma. A patent held by the government will provide the GSC with a royalty free high sensitivity magnetometer for federal provincial surveys. Scintrex of Canada Ltd. has been licensed by Canadian Patents and Development to manufacture this magnetometer. During the report year Scintrex have completed two production models. On evaluation at the GSC quiet magnetic site at Blackburn it was found that magnetic inclusions in the detector head caused abnormal gradients limiting the sensitivity to slightly better than one gamma. The radio-frequency coaxial cavity is being redesigned to avoid a patent as well as improving the signal to noise ratio. Further tests will have to be made on the magnetometer when these modifications have been completed.

Measurements have been made on various stable free radicals and solvents at different concentrations and temperature to determine suitability for the high sensitivity magnetometer. It is important for the solvent to have a long relaxation time for high sensitivity measurements.

S. Washkurak has been investigating the application of holographic methods to geophysical data enhancement and pattern recognition. A high-resolution digital cathode-ray display has been purchased which used in conjunction with a mini-computer will convert aeromagnetic data to a form amenable to optical data processing techniques. With this equipment photographic quality images of magnetic data will be produced for evaluation of coherent optic processing systems. The proposed study would be to perform instant Fourier transforms, auto and cross correlation, filtering and convolution optically and compare the results at every stage with the same process done by standard computer methods.

Personnel Changes

M. A. Lajoie resigned February 26, 1971.

Attendance at Meetings

P. J. Hood
- American Geophysical Union, Washington, D.C., April 19-24, 1970.
- Mines Ministers Conference, Winnipeg, September 8-10, 1970.
- Management Development Course, Carleton Place, October 18-30, 1970.
- Society of Exploration Geophysicists, New Orleans, November 8-13, 1970.
- Earth Science Symposium on Offshore Eastern Canada, Ottawa, February 22-24, 1971.

L. J. Kornik
- Geological Association of Canada, Winnipeg, August 30 - September 2, 1970.

P. H. McGrath
- Society of Exploration Geophysicists, New Orleans, November 8-13, 1970.
- Earth Science Symposium on Offshore Eastern Canada, February 22-24, 1971.

S. Washkurak
- Course on Fundamentals and Applications of Optical Data Processing and Holography, Ann Arbor, Michigan July 20-31, 1970.

Special Talks and Projects

P. J. Hood
- The high resolution aeromagnetic survey system of the Geological Survey of Canada, Mines Ministers Conference, Winnipeg, September 10, 1970.
- An automatic least squares multimodel computer method for magnetic interpretation, Society of Exploration Geophysicists, Annual Meeting, New Orleans, November 12, 1970 (with P. H. McGrath).
- Magnetic surveys of the Gulf of St. Lawrence and the Scotian Shelf, Earth Science Symposium on Offshore Eastern Canada, February 23, 1971 (with P. H. McGrath).
- Low-level aeromagnetic surveys of the continental shelves bordering Baffin Bay and the Labrador Sea, Earth Science Symposium on Offshore Eastern Canada, February 24, 1971 (with M. E. Bower).
- Critically reviewed a paper for the CIM Bulletin.

L. J. Kornik
- Magnetic subdivisions of Manitoba, GAC-MAC Annual Meeting, Winnipeg, August 30-September 2, 1970.

Membership on Committees

P. J. Hood

- Program Chairman Earth Science Symposium on Offshore Eastern Canada.
- Member, Subcommittee on Geomagnetism, NRC Associate Committee on Geodesy and Geophysics (to October 1971).
- Member, Subcommittee on Exploration Geophysics, NRC Associate Committee on Geodesy and Geophysics (appointed April 1, 1970).
- Member, National Organizing Committee, 24th International Geological Congress, Montreal 1972.
- Co-convenor, Section 9 (Exploration Geophysics) 24th International Geological Congress, Montreal 1972.

Outside Publications

Hood, Peter: Position-finding methods in airborne geophysical surveys: in The Position Finder, Geospace Engineering Co., Ottawa, pp. 2-3.1 to 2-3.10, 1970.

Hood, Peter; Geophysical developments to aid ore quest: Northern Miner, pp. 33, 36, 37, November 26, 1970.

Hood, Peter: Mineral exploration: trends and developments in 1970: Can. Min. J., Vol. 92, no. 2, pp. 185-214, 1971.

Kornik, L. J.; Aeromagnetic survey of the Athabasca formation; a quantitative interpretation: Can. Min. J., Vol. 91, no. 8, pp. 50-53, 1970.

McGrath, P. H. and Hood, P. J.:
The dipping dy ke case: a computer curve-matching method of magnetic interpretation: Geophysics, Vol. 35, pp. 831-848, 1970.

Active Projects

590258	Sea magnetometer survey compilation
630404	Magnetic gradient techniques
650007	Ocean aeromagnetics
660042	Regional aeromagnetic-geologic correlation
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
700089	Portable weather satellite receiving unit
700090	Holographic enhancement of geophysical data.

REMOTE SENSING METHODS

A. G. Darnley

This section is responsible for the development and assessment of techniques for the remote measurement and delineation of surface outcrop and overburden composition and structure. Remote sensing methods are normally confined for practical purposes to that portion of the EM spectrum which extends from γ rays to radar. Methods currently being actively evaluated are gamma-ray spectrometry, visual imagery (multispectral photography and TV systems) and infra-red imagery, with subordinate effort going into radioisotope induced X-ray fluorescence analysis as a field technique to complement ground gamma-ray spectrometry.

Remote sensing measurements provide the means of extrapolating from known to unknown areas across the Continent, but they are of negligible or limited value without complementary ground and laboratory control, the intensity of which must be adjusted according to particular circumstances. Therefore laboratory, ground and airborne methods are being developed in step with one another.

Activities

A detailed gamma-ray spectrometer survey with 0.5 km line spacing was flown in June over 550 square miles, west of Elliot Lake.

A survey with a wide line spacing (5 km spacing) was flown in July and August over 15,000 square miles between Fort Smith and Great Slave Lake. The limits of a major radiometric high were delineated. On the margin of this high, Cominco reported a pitchblende occurrence following the Open File release of the 1969 flights in this area.

Reconnaissance profiles were again flown from Ottawa to Fort Smith by a more southerly route than in 1969, and also some reconnaissance profiles were flown in New Brunswick.

Experimental photography and IR imagery was obtained by V. R. Slaney on three sections across the Fort Smith gamma-spectrometer survey area and also around Yellowknife.

Ground gamma-ray spectrometer measurements were taken by B. W. Charbonneau on three areas of unusual radioactivity in the Fort Smith survey area (the same areas were over-flown with photography, I.R. and gamma spectrometry).

Sixty one profiles and seven maps from the 1969 Bancroft survey representing about 2,000 line miles of data were prepared for Open File release (and some for eventual publication) by computer reduction procedures co-ordinated and devised by R. L. Grasty. Data from approximately 4,700 line miles from the 1969 Ottawa to Yellowknife reconnaissance were re-reduced in preparation for publication.

Approximately 300 samples were analysed using the laboratory gamma-ray spectrometer.

L. Ostrihansky completed data collection using the laboratory solid state detector for an investigation into the disequilibrium of surface samples of Elliot Lake ore-bearing quartzites and conglomerates.

T. R. Flint continued his development for the Skyvan of aircraft TV track recovery, the adaptation of Doppler navigation for low-level survey use, and the improvement (by reducing weight and increasing reliability) of aircraft power supplies.

Personnel Changes

A. G. Darnley - was appointed Chief of Division 1st February 1971 but continued to have responsibility for Section activities.

L. Ostrihansky - completed his two year term as a P.D.F. at the end of October 1970, and returned to his home in Czechoslovakia.

Miss E. Barber - joined the Section (in a casual position) in May 1970.

Attendance at Meetings

A. G. Darnley - (a) Third International Geochemical Exploration Symposium, Toronto, April 1970: presented paper "Mapping from the air by gamma-ray spectrometry".

(b) Prospectors and Developers Association Convention, Toronto, March 1971.

(c) Mines Ministers Conference, Winnipeg, September 1970, presented paper on "Applications of gamma-ray spectrometry".

(d) Canadian Aeronautics and Space Institute, Toronto, March 1971. Symposium on Remote Sensing.

R. L. Grasty - attended (b) and (d)

B. W. Charbonneau - attended (a) and (b)

Special Talks

A. G. Darnley - Two talks were delivered in January 1971 at the University of Alberta, Edmonton and University of British Columbia, Vancouver, on behalf of the Bio Physical Sciences Seminar Series of the Public Service Commission. Titles were "Remote Sensing Methods and their relevance to Canadian Geology" and "Gamma-ray spectrometry - development of a method".

Membership on Committees

A. G. Darnley - Member, Working group on airborne sensing: Inter-departmental Committee on Resource Satellites and Remote Airborne Sensing (I.C.R.S. R.A.S.)

V. R. Slaney - Member, Technical subcommittee of I.C.A.S.

- Member, Data handling working group I.C.R.S.R.A.S.

Outside Papers

Darnley, A.G., Grasty, R.L., Charbonneau, B.W. 1970: Highlights of GSC airborne gamma spectrometry in 1969. Can. Min. J. 91 No. 4, pp. 98-101.

Active Projects

630031	Multispectral Photography
670050	Airborne gamma spectrometry
670052	Gamma-ray support
670053	Radioisotope methods
670054	Infrared scanning
680095	A Grenville front Magnetic Anomaly
700057	Airborne geochemistry

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 paleomagnetic measurements were carried out on dated intrusive and dyke rocks from the Cordillera and from Labrador as an attempt to solve geotectonic and geochronologic problems and in order to provide basic data for future studies; paleointensity studies were continued as a test to the dipolar nature of the geomagnetic field throughout the Pre-Cambrian; research was continued on the fundamental properties of sulphide minerals and techniques developed in this laboratory were applied to the practical application of using magnetic susceptibility in assessing the quality of asbestos; the development of a vibrator-magnetometer was temporarily delayed due to major breakdown of manufactured component.

Personnel Changes

D. T. A. Symons resigned in September 1970 to accept a teaching post at the University of Windsor.

Attendance at Meetings

E. J. Schwarz and D.T.A. Symons attended the AGU meeting in Washington in April 1970.

A. Larochelle attended the Prospectors and Developers meeting in Toronto in March 1971.

A. Larochelle participated in two feasibility studies for aeromagnetic surveys sponsored by CIDA. This assignment required a month long trip in Ethiopia in November and a 3-week long trip in Upper Volta.

A. Larochelle attended a 2-week Public Management course in Kemptville in September.

Outside Papers

Larochelle, A.: Notes on the paleomagnetism of two diabase dykes, Anticosti Island, Quebec; Proc. Geol. Assoc. Canada, vol. 23, pp. 73-77.

Schwarz, E. J. and D.T.A. Symons, 1970:
Paleomagnetic field intensity during cooling of the Sudbury irruptive 1700 m.y. ago. J. Geophys. Res., 75, 32, 6631-6640.

Schwarz, E. J., 1970:
Thermomagnetics of lunar dust sample 10084-88. Proc. Apollo 11 Lunar Sci. Conf. v.3, 2389-2397.

Larochelle, A. and E. J. Schwarz, 1970:
The Mid-Atlantic Ridge near 45° N, IX. Thermomagnetics of dredged samples of igneous rocks. Cdn. J. Earth Sci. 7, 2, 268-273.

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

Schwarz, E.J. and D.C. Harris, 1970:
Phases in natural pyrrhotite and the effect of heating on their chemical composition. J. Geomag. Geoelect, 22, 4.

Winer, A.A., Karpoff, D., and Symons, D.T.A. 1970:
Low-field magnetic susceptibility of asbestos; Res. Rept. R 232, Mines Branch, Dept. Energy, Mines and Resources, Ottawa, 17 pp.

Active Projects

680059 - Magnetic properties of moon samples

690042 - Paleomagnetic studies of radiometrically dated igneous rocks in the Cordillera

700017 - Paleomagnetism - Appalachian Province

700018 - Paleomagnetism and Rock magnetism instrumentation and technological development

700054 - Thermomagnetics of single minerals and rocks.

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

The activities of the section are partially reported in GSC Paper 71-1, Part A. A major conventional refraction seismic program was undertaken over the Dubawnt Sandstone Formation revealing a considerable thickness of sandstone and the presence of intruded sills in some areas which reduced the effectiveness of the seismic method to determine the total thickness of the sandstone. In the vicinity of Baker Lake, the presence of these volcanics indicates a thickness of 4200 feet of sandstone while on the Thelon Plain the greatest thickness calculated is about 6300 feet.

The results of several field seasons of marine seismic work in the Gulf of St. Lawrence were presented at the Earth Science Symposium on Offshore Eastern Canada. The section will be further involved in critically reading papers submitted for publication in the GSC paper resulting from this symposium.

A rather extensive hammer seismic survey was conducted in the general Ottawa area in conjunction with an urban geology project of Q.R.G. Division. Over 2000 locations were occupied giving wide scope to the investigation of new data reduction and interpretation techniques. A computer velocity-depth function technique has been developed to assist in the recognition of the drift bedrock interface. Also, shallow reflection techniques have been developed in the Quyon, Quebec sector of the study area.

Personnel Changes

J. A. Hunter - joined the Section July 1970

G. D. Hobson - returned full time as section head in February, 1971.

Attendance at Meetings

G. D. Hobson
- Association of Professional Engineers of Alberta, Jasper, Alberta, May 21-23, 1970: presented paper "Arctic Geophysical Work".
- Cold Region Research Labs (CRREL), Hanover, New Hampshire, July 15-17, 1970.
- Geological Association of Canada, Winnipeg, August 31 - September 2, 1970.
- Society of Exploration Geophysicists, New Orleans, November 9-13, 1970.
- Second Arctic Symposium, San Francisco, January 31 - February 4, 1970.

A. Overton
- Society of Exploration Geophysicists, New Orleans, November 9-13, 1970.

- Earth Science Symposium on Offshore Eastern Canada, Ottawa, February 22-24, 1971; presented paper "Sedimentary seismic surveys, Gulf of St. Lawrence" by George D. Hobson and A. Overton.

Special Talks and Projects

G. D. Hobson
- Special representative and lecturer for C.I.D.A. to Geological Survey of India, February 24 to May 3, 1970 and again February 5 to March 17, 1971.
- Special representative for C.I.D.A. to Geological Survey of Guyana, July 27 to August 10, 1970 re seismic project.

Membership on Committees

G. D. Hobson
- Program Committee, Earth Science Symposium on Offshore Eastern Canada.
- Distinguished Lecturer Committee and Planning Advisory Committee of Society of Exploration Geophysicists.

A. Overton
- Subcommittee Seismology and Physics of the Earth's Interior of the Associate Committee Geodesy and Geophysics.

Outside Papers

Overton, A.: Seismic refraction surveys, western Queen Elizabeth Islands & Polar Continental Margins; Can. Jour. Earth Sciences, vol. 7, no. 2, pp. 346-365.

Active Projects

620038	- Seismic - Oak Ridge Moraine
630434	- Seismic - Beauceville
640049	- Marine Seismic - Gulf of St. Lawrence
660050	- Seismic - Rocky Mountain Trench
660051	- Seismic - Interior Plateau, B.C.
660052	- Seismic - Winkler, Manitoba & 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
700061	- Seismic - Precambrian Shield

Theoretical Geophysics and Data Processing Section

B. K. Bhattacharyya

This Section is primarily involved in the development and application of automatic methods for the treatment and analysis of various kinds of geophysical data, particularly aeromagnetic.

Activities

During 1970-71, automatic methods for editing, compilation and mapping of aeromagnetic data developed by the Section were applied to the high resolution survey in the Timmins area and similar work was started on data from the Tathlina Lake region, Hay River, N.W.T. Digitization of a large area of existing aeromagnetic maps from the Polar Continental Shelf west of Prince Patrick Island, and from Grenville region was completed and edited and interpretation work on these regions is commencing. A new method for the reduction of irregularly spaced data to a regular grid was developed due to the special nature of this Arctic data.

Personnel Notes

Since September 1970 Dr. Bhattacharyya has been on Sabbatical leave, initially as a visiting professor at the school of engineering geosciences, University of California, Berkeley, California, and later during the spring of 1971 taking up a similar position at the Instituto de Fisica, Universidade Federal da Bahia, Brazil.

Whilst in Berkeley, Dr. Bhattacharyya held a two-day symposium on aeromagnetic methods.

Dr. A. K. Sinha joined the Section in August 1970.

Attendance at Meetings

B. K. Bhattacharyya - C.I.M.M. Symposium on decision making in the mineral industry June 1970, Montreal. Presented a paper by Bhattacharyya and Holroyd "Numerical Treatment and Automatic mapping of Two-dimensional data in Digital Form"

B. K. Bhattacharyya - SEG Congress in New Orleans, November 1970. Presented paper "An Automatic Method of Compilation and Mapping of High-resolution Aeromagnetic Data".

M. T. Holroyd - C.I.M.M. Symposium on Decision Making in the Mineral Industry, Montreal, June 1970.

M. T. Holroyd - A.G.U. Congress in Washington, D.C.

Outside Publications

Bhattacharyya, B. K.: Some important considerations in the acquisition and treatment of high-resolution aeromagnetic data; Bollettino di Geofisica teorica ed applicata, 1970, v. 12, nos. 45-45, pp. 21-44.

Bhattacharyya, B. K. and Holroyd, M. T.: Numerical Treatment and Automatic Mapping of Two-dimensional data in Digital Form. CIM Bull. (In press).

Bhattacharyya, B. K.: An Automatic Method of Compilation and Mapping of High Resolution Aeromagnetic Data. Geophysics (In press)

Active Projects

680139 - Quantitative Aeromagnetic Analysis

680140 - High resolution aeromagnetic data

680141 - Pattern recognition

660478 - Airborne EM Analysis

GEOLOGICAL INFORMATION PROCESSING DIVISION

Peter Harker

This new division was formed on 1 April 1970 to incorporate a number of related activities of the Branch into a single area of management. The former Manuscripts and Cartography Section provided the nucleus, to which was added the Library, Data Processing and the Photographic Section. In addition to overall management duties, the Division Chief has acted as a senior scientific adviser in various capacities and as a member of the branch management team. A major activity of the Division is the processing for publication of all scientific manuscripts; in addition to the work carried on with the Division, The Chief Scientific Editor R. G. Blackadar has a functional responsibility for the scientific editing carried out by E. J. W. Irish in Calgary and by Miss Tamara DeVreeze for the Division of Quaternary Research & Geomorphology. Complementary to conventional publication methods, the open file system of releasing information to the public was further developed, it serves as an alternative to publication, for the release of information ahead of normal publication, and as a means of access to detailed supporting data. Thirty items were placed on open file for examination in one or more of the offices of the Survey; in some instances copies are available at the users expense. The system is administered through the Library. The year saw the publication of the English version of the new editions of 'Geology and Economic Minerals of Canada' and 'Prospecting in Canada'. French versions are in preparation but translation and scientific editing of so large a volume of French text presents serious problems with present resources. A ten year index of Geological Survey publications was completed and published. Officers of the Division continue to provide information on a variety of topics to the general public in response to letters and in-coming telephone calls to the technical enquiries number manned by the Division and listed in the government telephone directory. From the wide range of enquiries, the Division appears to be providing a departmental service. The appointment of Mr. L. P. St. Pierre as Division Administrative Officer has done much to offset the considerable increase in paper work resulting from divisional status. His ability to conduct business in both official languages has been an asset to the Division.

Membership on Committees, Courses, etc.

P. Harker	- Geological Survey of Canada History Committee - Senior Advisor, Treasury Board, Collective Bargaining Team, (Physical Sciences) - P. P. B. Seminar
L. P. St. Pierre	- Grid Management Course, Phase 1, Cornwall, Ontario

CHIEF SCIENTIFIC EDITOR

R. G. Blackadar

During the report period the manuscripts for 68 papers, 14 memoirs, 33 bulletins, 18 (final) coloured maps and one economic geology report were received. Many of these reports were accompanied by additional coloured maps, preliminary maps and complex cartographic illustrations. A listing of these is included in the report of the Superintendant of Cartography. Of the 68 papers received, 23 were published during the same period; the average elapsed time from receipt of a manuscript by the Chief Scientific Editor to publication was 5½ months for a paper without accompanying maps or large graphics and 11 months for those with such material.

At the close of the report period, 64 papers, 14 memoirs, 33 bulletins, 18 coloured maps and one economic geology report were recorded in the office of the Chief Scientific Editor and were in various stages of production.

Mr. Louis-Errol Vincent joined the staff as a scientific editor to work in French and is also able to provide valuable service in dealing with scientific and general enquires in French. Miss W. Havard left and was replaced by Mrs. L. Parsons as editorial assistant.

Membership on Committees

R. G. Blackadar
- Geological Survey of Canada History Committee
- Public Service Commission Data Stream Advisory Group

STATUS OF GEOLOGICAL MANUSCRIPTS ON MARCH 31, 1971

WITH COMPARABLE FIGURES FOR 1968-69 AND 1969-70

Type of Report	In Process						Published During Year		
	Scientific Editing			Cartography and EM&R Ed. Div. & Q.P.					
	70-71	69-70	68-69	70-71	69-70	68-69	70-71	69-70	68-69
Memoirs	0	1	1	14	8	9	1	3	6
Bulletins	3	4	4	30	18	36	7	13	10
Econ. Geol. Reports	0	0	0	1	2	4	3	2	2
Misc. Repts. etc.	0	0	0	0	0	0	0	0	2
Multicolour maps	0	0	0	31	10	20	24	18	9
P. S. Papers	6	4	8	58	37	34	60	75	67
P. S. Maps	0	0	6	9	2	6	1	7	9
Catalogues	0	0	0	0	1	2	1	1	1
Open File Reports	0	0	0	0	0	0	30	11	6

PHOTOGRAPHIC SERVICES

J. B. Emslie

The activities and operation of the Photographic Section ran smoothly during the year, with the total overall production and output up by 5% over the previous year. More work was handled by the Canadian Government Photo Centre than in the past, and this removed the pressure from the Section at critical periods and also enabled the Section to increase its own true production by 10%.

As well as handling a fair quantity of black and white field photo prints, the Canadian Government Photo Centre is also handling all of our colour print work. This is proving to be the most economical arrangement at present, since the demand for colour prints or display transparencies is not high, and even if it was, it is most unlikely that the Geological Survey Photographic Services could handle colour printing in any great quantity without additional staff and equipment. However, we do still retain the capability of performing this type of work when requirements of a special nature arise.

The Section again provided assistance in the field program of the Exploration Geophysics Division; J. B. Emslie was in the field during August and September for a total of six weeks. This time operating out of both Fort Smith and then Yellowknife N.W.T. and again for the purpose of Experimental Multi-Spectral Aerial Photography and involving the installation and operation of various camera systems in the G.S.C. Skyvan aircraft.

Photographic Section Production Totals

Production

Section Work	Black & White Negatives	6187	
	Colour Negatives	167	
	Colour Transparencies	1289	
	Black & White Prints & Transparencies	43420	
	Black & White Slides	1046	
	Colour Slides	1348	
	Total -	53457	53457
	(Total for previous year 1969-1970	48682)	
Field Work	Black & White Negatives Processed	9458	
	Colour Negatives Processed	48	
	Colour Transparencies Processed	506	
	Total -	10012	10012

Photo-Finishing	Negatives Opaqued		1513	
	Negatives Retouched		727	
	Slides Coloured		83	
	Slides Mounted		3489	
	Prints Mounted		442	
	Prints Spotted		410	
		Total -	6664	6664
Production by the Canadian Government Photo Centre				
	Black & White Prints		7964	
	Colour Prints		91	
	Colour Slides		52	
	Colour Negatives		9	
		Total -	8116	8116
		Grant Total -		78249
	(Grant Total for previous year 1969-1970			74314)

GEOLOGICAL CARTOGRAPHY SECTION

C. E. McNeil

With the reorganization into the new Division of Geological Information Processing, the Cartography Unit was given the status of a Section with the responsibility of producing all maps and illustrations required for Geological Survey publications.

On the recommendation of the Report by the Bureau of Management Consultants (The Needham Report) a totally new production control system was started at the beginning of the fiscal year and has proved very effective in controlling the output of the Section. Also recommended was a return to the principle of using the cartographic staff as compiler-draftsmen and a retraining program was initiated. Unfortunately lack of office space at 601 Booth Street has made it necessary to keep our staff divided although it was possible to move about 15 staff members back to Booth Street, and the full implementation of the reorganization and retraining program was hampered. In spite of this handicap production was maintained on maps and illustrations for the Survey Reports, publications in outside journals and slides for illustrating lectures. The work load in the Photomechanical Unit has increased to the point where difficulty was found in meeting priorities.

Personnel

Relatively few changes occured in staff during the past year. M. T. Auger, a cartographic draftsman, transferred to another government department, W. M. Snyder, a camera operator resigned and was replaced by R. W. Wilkinson.

Membership on Committees

C. E. McNeil	- Member, Classification Evaluation Committee - Member, E. M. & R. Advisory Board on Draftsmen and Compilers
E. P. Nunn	- Board of Directors, Ontario Institute of Chartered Cartographers
N. E. Buck	- Secretary, Cartography Suggestions Award Sub Committee
J. G. E. Gagnon	- Member, Cartography Suggestions Award Sub Committee

Production Data

Maps and illustrations completed by the Cartography Section during the period from April 1, 1970 to March 31, 1971 comprise the following:

Multicoloured geological maps	23
Preliminary geological maps	21
Figure illustrations (pocket)	47
Figure illustrations (page)	222
Multicoloured maps reprinted	8
Preliminary maps reprinted	11
Aeromagnetic maps reprinted	246
Indexes to Publications revised	21

Miscellaneous drafting totalled 56 illustrations and 102 slides. Miscellaneous jobs such as plotting projections, assembling base maps, preparing open file items, preparing displays etc. along with the miscellaneous drafting accounted for approximately 22% of our total man years.

Maps and Illustrations In Progress March 31, 1971

Multicoloured geological maps	31
Preliminary geological maps	9
Figure illustrations	217

Manuscripts Received

Multicoloured geological maps	19
Preliminary geological maps	13
Figure illustrations	275

Work Completed In Photomechanical Unit

Mapping Camera

Film negatives and positives	5,958

Contact Processes

Film negatives and positives	11,117
Colour keys on film	853
Peelcoats	289
Scribe-etch	22
Colour proofs	77
Vandyke prints	1,873
Blueline map prints	791
Whiteprints	729
Xerox prints	479,678

LIBRARY SERVICES

Mrs. D. M. Sutherland

Introduction

In April, 1970, the Library was re-organized under the new Geological Information Processing Division and is now responsible for the operation of the Library, the Central Technical Files, the Open Files and the Data Processing Unit.

Activities

1. Library

Owing to a need for space by Cartography, the map library was moved from Room 390 to G67 to share the same quarters as the Departmental Map Library. The two units are administratively separate and the Geological Survey Library staff service our maps and users as before. This seems to be working out well for users at present.

The CAN/SDI program operated by the National Science Library continues to be used by GSC scientists; one result is the increase in the amount of material borrowed from other libraries - as is evidenced by the statistics.

Miss Swirsky compiled a list of the translations which were prepared for the GSC by the Secretary of State between 1967 and 1970 and it was published as GSC Paper 70-62 in February, 1971. Requests for purchase are starting to be received and they are expected to increase. Two lists of Russian material recently received were compiled by Miss Christensen and have been circulated to GSC staff with the result that a considerable amount is now is use.

2. Central Technical Files and Open Files Unit

The operation of both these files is the responsibility of one clerk but the principle of allowing commercial services to do the reproduction made the operation much more manageable.

The Open file method of announcement of completed research is being used for various types of data such as maps, photographs, computer tapes.

3. Data Processing Unit

This unit now consists of one clerk and two key punch operators and has the responsibility for maintenance of the Geodat project, the Photo Negative Index and the Library Periodical Finding List. It provides key-punch services and card storage to the Branch when required and maintains the Branch files of source and object computer decks. It also serves as a Branch delivery point between the Geological Survey and the Computer Science Centre.

The unit provides services to the production of the Mineral Deposits File such as key punching, corrections to cards and an update program.

Personnel

Two library clerks resigned from the Geological Survey in January and their loss has been keenly felt, as Mrs. Maheral, the Purchasing clerk, and Mrs. Wistaff, the Kardex clerk, had been with the library for some years. Permanent replacements have not yet been made.

Miss Swirsky, the Cataloguing Librarian resigned in August, 1970 and Mrs. Irene Yee was appointed in October. Mrs. Marjorie Wickens joined the staff as a temporary, part-time replacement for the cataloguer and has remained with us, assisting the Reference and Acquisition units.

Attendance at Meetings, Cources, etc.

D. M. Sutherland
- Geological Information Society in Milwaukee, November 1970
- Computer concepts for Management; Course, August 25-27

Membership on Committees

D. M. Sutherland
- Secretary, Geological Information Society, 1971
- Member (rotating), Canadian Government Library Committee
- Departmental Coordinator for the United Appeal, 1970
- Member, Standing Committee of Chief Librarians of Energy, Mines and Resources

Statistics

I Acquisitions (received by purchase, exchange or gift)

Periodicals and serials	15,142
Books	594
Maps	1,990
CTF reports	240
Open Files	30

II Circulation

a. Loans	
Books, periodicals, etc. to GSC staff	26,926
To individuals other than GSC staff	3,925
To other libraries	1,363
Articles xeroxed in lieu of loan	5,878
Maps	533
CTF reports	1,120
Borrowed or obtained xerox from other libraries	803 703
b. Open files examined	35

c.	Registration (GSC staff are not registered)	368	Total
	Government officials	110	
	Industry	67	
	University - Carleton	102	
	- Ottawa	68	
	- Other	21	

III Cataloguing

Books, periodicals, serials	607	
Analytics prepared	895	
Maps	822	

IV Clerical

Letters and memoranda	500	
Catalogue cards printed	22,581	
Pages xeroxed	126,783	
Requisitions	623	
Subscriptions	624	

V Reference and Interlibrary Loans

Enquiries (estimate)	8,000	
CTF enquires	125	
Interlibrary loan requests received		
by form	3,175	
by telex or letter	750	
by telephone	950	(est.)

VI Translations

Prepared by Secretary of State	118	
Photocopies sold (from October 1970-April 1971)	67	

VII Data Processing Unit

Cards punched by DPU staff	200,000	
Geodat retrievals	54	
Cards punched by GSC users	15,000	

PUBLICATIONS DISTRIBUTION OFFICE

L. Touchette

During the year the following publications were received and made available for distribution.

Economic Geology Series	3
Economic Geology Series (reprinted)	1
Memoirs	1
Memoirs (reprinted)	1
Bulletins	7
Bulletins (reprinted)	1
Preliminary Papers	60
Preliminary Papers (reprinted)	23
Misc. Report Series (reprinted)	2
Misc. Geol.	19
Dept. Annual Report	2
Preliminary Maps	1
Preliminary Maps (reprinted)	4
Maps 'A' Series	24
Maps 'A' Series (reprinted)	5
Derived Series	1
Aeromagnetic Maps	354
Aeromagnetic Maps (reprinted)	205
Indices to G.S.C. Maps (revised)	23
Indices to Aeromagnetic Maps (revised)	15

Distribution Data

Maps	158,089
Reports	81,541
Indices, Listings, Brochures, etc.	68,639
Total Distribution	308,269

Other Data

Requests for publications, information, R & M	23,331
Visitors (cash sales 2,276) (others 2,584)	4,860
Notification Lists (including O.F. Lists)	77
Total publications advertised	487

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 National Air Photographic Library of the Surveys and Mapping Branch, the Mining Research Center of the Mines Branch, and the field office of the National Energy Board. In addition, offices and laboratories are occupied by the Western Research Section of the Groundwater Subdivision of the Hydrologic Sciences Division of the new Department of Environment.

During the year, scientists of the Institute published 1 bulletin, 8 papers, 3 preliminary maps, 4 "A series" maps, 1 topical report, and 14 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, 1969. 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, 1969, and has undertaken a research program involving Devonian carbonate deposits in the northern Alberta subsurface.

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

Committee on Curation of Rocks and Fossils:
B.S. Norford (Chairman)

Attendance at Meetings

D.J. McLaren

Field Conference of Silurian-Devonian Boundary Committee, Nevada, May, 1970.

Field Conference Silurian-Devonian Boundary Committee, Prague, September, 1970.

Arctic Symposium, San Francisco, February, 1971.

Special Talks

D.J. McLaren

"Correlation and Catastrophism": Edmonton Geological Society, June, 1970.

"Energy versus Environment - The Arctic Dilemma": Royal Canadian Institute, Toronto, February, 1971; and Canadian Association Marine Equipment Industries, Ottawa, February, 1971.

Membership on Committees

D.J. McLaren

Paleontological Society, past President.

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.

Alberta Society of Petroleum Geologists, President.

REPORT ON SECTIONS

STAFF GEOLOGIST

B.A. Latour

Activities

The Staff Geologist is responsible for studies of Canada's coal deposits and for developing and maintaining an inventory of the coal reserves of Canada. In addition, he is responsible for the administration of the core and sample repositories; the functional and administrative control of the Lapidary, Photography and Sedimentary Petrology Laboratories and the technicians in them; the administrative control of all the remaining laboratory areas and the technicians in them; and the administrative control of the library.

B.A. Latour completed a study leading to a preliminary estimate of the measured coal reserves of Western Canada and started work on a complete review of all categories of coal resources in Western Canada.

Active Projects

500038 - Coal reserves of Canada and studies of coal deposits in Canada.

Core and Sample Repositories

The main activities of this unit are summarized as follows:

Visitors utilizing core and sample examination facilities	2,175
Number of wells from which samples were examined	1,260
Boxes of core that were examined	22,269
Drill samples received from Manitoba	14,921
Drill samples received from Saskatchewan	50,898
Drill samples received from Alberta	284,583
Drill samples received from British Columbia	98,362
Drill samples received from Yukon Territory, Northwest Territories and Arctic Islands	36,007
Drill samples received from offshore drilling	10,000
Total drill samples received from all sources	494,871
Boxes of core received from Yukon Territory, Northwest Territories and Arctic Islands	2,225
Boxes of core received from offshore drilling	55
Mechanical logs received	7,366
Drill samples transferred from envelopes to vials	51,000

Lapidary Laboratory

Production figures from this unit are:

Standard thin sections completed	1,918
Polished slabs	31
Polished sections	18
Stained sections	28

The technician from this laboratory was given several weeks of training in the techniques used in the Sedimentary Petrology Laboratory.

Photography Laboratory

Production figures for this unit are:

Enlargements, black and white	1,818
Contact prints, black and white	1,460
Slides prepared, 35 mm, black and white	114
Slides prepared, 35 mm, colour	135
Colour transparencies, 4" x 5"	127
Glass slides, black and white, 3 1/4" x 4"	27
Negatives produced, black and white, 4" x 5"	549
Rolls of film processed, black and white	30
Work orders processed	155

The photographer spent two weeks in the photographic unit in Ottawa observing and learning their techniques.

Sedimentary Petrology Laboratory

Production figures for this unit are:

Standard thin sections (103 stained)	601
Large size thin sections (8 stained)	149
Thin sections of grains and well cuttings	30
Impregnated thin sections	49
Stained sections	115
Polished specimens	93
Acetate peels (stained)	35
Heavy mineral separations	66
Sieve analyses	36
Acid-insoluble residue determinations	393

Considerable time was spent by the technician in instructing students and personnel from other units of the Institute in the techniques used in this laboratory.

Library

Some space adjoining the library was made available to the library to provide a much needed storage and reference area for the map collection.

A new system was put into practise to accommodate the increasing demand for interlibrary loans. These requests are now met by an arrangement with Riley's DataShare International whereby they provide xerox copies of the material directly to the borrower at a nominal cost. This system avoids having to loan out original material for extended periods of time, tends to act as a deterrent on some requests that may not be necessary and allows the staff to direct more of their efforts to other duties.

Mrs. M. Jones visited the libraries of the Geological Society of London, the British Museum and the Institute of Geological Sciences during a visit to England in the spring of 1970.

Statistics for the year are:

Acquisitions

Books, etc. acquired by purchase (excluding periodicals)	1,192
Books, etc. acquired by gift or exchange	2,088

Circulation

Books, periodicals (to staff only)	8,466
Interlibrary loans	
Borrowed from GSC Ottawa library	317
Borrowed from other libraries	250
Loaned	219
Xerox copies provided (through Riley's DataShare)	60

Reference

Books, periodicals, etc. consulted in library (other than staff)	840
Inquiries (less than 5 minutes)	7,125
Information searches (more than 5 minutes)	1,873
Visitors	3,677

Serials

Serial publications received (titles)	542

Personnel Notes

Mr. M. Rice joined the staff as custodian of the rock and fossil collections and has been temporarily assigned to the paleontological section for training in paleontological curation.

Mr. A. Murison continued as a temporary assistant in the library until September.

Miss Tina Matiisen joined the staff as assistant librarian in March.

Miss Nita Penley was transferred from the Well Files to Central Registry and was replaced by Mr. F. Maiden who was transferred from the Stationery and Supply unit.

Attendance at Meetings

B.A. Latour

22nd Canadian Conference on Coal, Vancouver, September, 1970.

Attendance at Courses

A first aid course sponsored by the Workmen's Compensation Board and conducted by the St. John Ambulance Corps, October 19 - 23, was attended by the following: Miss A.C. Renn, Mrs. S.L. O'Keefe and Messrs. A.G. Heinrich, G.D. Karg, W.O. McEwan and R.D. Michie.

Special Talks

B.A. Latour

"Coal Deposits of Western and Northern Canada"; 22nd Canadian Conference on Coal, Vancouver, September, 1970.

"Coal Deposits of Western Canada"; Mineral Exploration Group, Vancouver, March, 1971.

"Coal Deposits of Canada"; presented as two lectures to geology class, University of Calgary, March 17 and 19, 1971

Membership on Committees

B.A. Latour

Departmental Advisory Committee on Coal.

MANUSCRIPTS AND CARTOGRAPHY SECTION

E.J.W. Irish

Activities

The Scientific Editor is responsible for the overall organization and co-ordination of the Section, for the processing of all manuscripts submitted for publication by officers of the Institute, and for the distribution of geological information. 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 and provide information required by other organizations and the general public.

Throughout the year, the Geological Cartography unit remained two short of its full complement of draftsmen. Positions for a Draftsman (DD1) and a Platemaker (OFE6) have been established, however, and these should be filled very soon. The addition of a Platemaker to operate all photo-reproduction equipment will allow a senior draftsman to return to his drafting duties and, thereby, increase the efficiency of the unit.

A very large percentage of the total volume of GSC publications (all types) and, also, publications of both the Surveys and Mapping Branch and the Mines Branch are being distributed through the Institute office in Calgary. The total number of items distributed has increased steadily each year since the opening of this office in 1967. Whereas the companies, consultants and public obtaining maps and reports from this office originally were concerned mainly with information pertaining to potential hydrocarbon areas, there is now an ever increasing demand for information on all types of mineralization in all parts of Canada. Thus, the distribution unit is required to keep an ever increasing stock of maps and reports dealing with areas of Canada other than the sedimentary basins.

The unit has, for some time, had more work than it can handle efficiently with the present staff (two clerks), and the continuing increase in volume of items handled will not only aggravate this staff situation but will soon create storage problems.

Total number of publications by the Institute (1970-1971):

Bulletin	1
Paper	8
Map (preliminary)	3
Map (A series)	4
Topical report	1
Total GSC	17
Outside journals	14

The following table shows the status of reports and maps received from Institute officers for processing and publication between April 1, 1970 and March 31, 1971.

Type of Report or Map	Number Received	Prelim. Editing Completed	Editing and drafting completed	To Ottawa for printing	Number published of those received
Memoir	1	-	-	-	-
Bulletin	4	2	2	2	-
Paper	13	9	7	7	3
Map A Series	19	19	5	5	3
Topical Report	1	1	1	1	1
Outside Paper	10	10	10	-	8

Note: Preliminary series maps have not been listed separately as these now accompany Papers.

Personnel Notes

During the year Miss R.G. Pulleyblank joined the staff as Editorial Assistant.

Attendance at Meetings

E.J.W. Irish

Geological Society of America, Annual Meeting, Milwaukee, Wis., November 11 - 13, 1970.
American Association of Petroleum Geologists, Annual Meeting, Calgary, Alberta, June 22 - 24, 1970.

Membership on Committees

E.J.W. Irish

Commissioner, American Commission on Stratigraphic Nomenclature.

Outside Publications

E.J.W. Irish

"The Edmonton Group of south-central Alberta"; Bull. Can. Petrol. Geol., vol. 18, No. 2, pp. 125-155, June, 1970.
"A brief history of the Geological Survey in the sedimentary basins of Western Interior and Arctic Canada"; Oilweek, vol. 21, No. 17, June 15, 1970.

Geological Cartography Unit

L. MacLachlan

The unit continues to produce all the cartographic work for internal and external publications and the miscellaneous drafting required by the professional staff of the Institute. This includes the final drafting, and since mid-1970, the colour separation and duplicate negatives necessary to print maps in full colour.

Slide drawings continue to form a large part of the miscellaneous drafting, and in addition this year the unit produced all the artwork for a large display depicting the work of the Institute which was used at the A.A.P.G. convention in Calgary.

All photomechanical work, photostating, and white printing is done by draftsmen. The unit also supplies a projectionist for all lectures given in the Institute.

Unit strength at the end of March 1971 was 8 with 2 positions still vacant, a draftsman and a platemaker. Both positions have been advertised and hiring should take place in the very near future.

Production Data

Maps and figures prepared by the Cartography Unit and returned to Ottawa for printing during the period April 1, 1970 to March 31, 1971.

Multicoloured geological maps	5
Preliminary geological maps	2
Figure illustrations (page)	126
Figure illustrations (pocket)	19

Miscellaneous drafting totalled 281 items including 115 figures for outside publications and 117 slides.

Manuscripts Received

Multicoloured geological maps	17
Preliminary geological maps	3
Figure illustrations (page)	142
Figure illustrations (pocket)	29

Maps and illustrations in progress at March 31, 1971

Multicoloured geological maps	5
Preliminary geological maps	0
Figure illustrations (page)	41
Figure illustrations (pocket)	10

Backlog of maps and illustrations in the Unit

Multicoloured geological maps	7
Preliminary geological maps	1
Figure illustrations (page)	4
Figure illustrations (pocket)	0

Reproduction services

Photostat prints	643
Diazo prints (blueline, blackline, sepia)	2,068

Photomechanical services

Film, negative and positive	944
Vandyke prints	162
Drafting keys on scribe	29
Blueline on Cronaflex	254
Colour proofs	21
Peel coats	68

Sixty-seven orders were placed with commercial firms for camera work; a total of 221 negatives or positives.

Publications Distribution Office

Mrs. M.H. Brooks

During 1970-1971 the volume of business handled by this office continued to increase, although the increase was slightly less than that of the previous year. The number of visitors to the office and the number of requests for information by mail and by telephone were considerably larger than in the previous year.

Publications of all types continue to be distributed to the public so quickly that larger initial shipments from Ottawa have been requested. Ever larger quantities of reports and maps on areas in Eastern Canada, the Shield and the Cordilleran regions must be stocked to meet an increasing demand by industry and the public for information dealing with minerals other than oil and gas.

Attendance at Courses

Mrs. M.H. Brooks

Evening course, Shorthand 130 at the Southern Alberta Institute of Technology; winter 1970-1971. Certificate of achievement received.

Distribution Data

Distribution

Year	Items received	Value (items sold)
1969-1970	-	$46,301.33
1970-1971	123,554	47,156.80

Accounts

	1969-1970	1970-1971
Credit sales	$29,545.77	$26,731.95
Cash sales	16,755.56	20,424.85
Rec'd on account	27,108.62	24,985.16

Breakdown of deposits (to Chief Treasury Officer, Ottawa)

Item	Per cent of total	1969-1970	1970-1971
Surveys and Mapping	20	$ 8,956.12	$ 9,082.00
Mineral Resources	1	455.04	454.13
Rock and Mineral Sets	1	416.54	454.13
GSC publications	50	22,083.97	22,705.03
GSC maps	28	12,156.82	12,714.72
Total receipts		$44,067.82	$45,410.01

	1968-1969	1969-1970	1970-1971
Visitors to the office	2,686	3,700	3,900
Requests by letter etc.		2,797	3,415
Telephone calls		6,672	8,640

Average number of telephone calls per day - 36

SENIOR RESEARCH SCIENTIST

H.R. Belyea

Activities

Dr. Belyea continued to work on the subsurface Devonian stratigraphy of Alberta, British Columbia and District of Mackenzie. Also, from well examination, data have been accumulated for: (a) a study of the stratigraphy and origin of rock types of the lower Elk Point Group between 57° and 62°30' north latitude; and (b) a study of the facies distribution and diagenesis of the Sulphur Point Formation.

Acted in an advisory capacity to the group under R.G. McCrossan who were compiling formation tops for wells in the Northwest Territories.

Active projects

500336 - Devonian of Alberta, British Columbia and District of Mackenzie.
610394 - Schedule of wells, Northwest Territories.

SENIOR RESEARCH SCIENTIST

R. Thorsteinsson

Activities

Dr. Thorsteinsson completed the preparation of geological maps of Axel Heiberg and Ellesmere Islands, and continued work on a monograph on the Carboniferous and Permian stratigraphy of the area.

Active projects

610002 - Axel Heiberg and Ellesmere Islands.
650003 - Cornwallis and adjacent smaller Islands.

Attendance at Meetings

R. Thorsteinsson

Second International Symposium on Arctic Geology; San Francisco, February, 1971.

ARCTIC ISLANDS SECTION

R.L. Christie

Activities

Both field and office research were carried out by the Arctic Islands Section. R.L. Christie, R. Thorsteinsson and J. Wm. Kerr took part in a major, air-supported project designed to improve our knowledge of the stratigraphy of Prince of Wales Island and surrounding small islands in response to interest in this region shown by petroleum exploration companies. During the year, J.Wm. Kerr completed a memoir on Bathurst Island.

H.P. Trettin studied the stratigraphy and sedimentology of selected lower Paleozoic formations in the Tanquary and Canyon Fiord regions of northern and central Ellesmere Island. In the office he completed a summary account of the early Paleozoic mobile belt of northern Axel Heiberg and Ellesmere Islands. W.W. Nassichuk was engaged in a biostratigraphic study of selected Carboniferous and Permian formations in northern British Columbia and Yukon Territory. During the winter he completed a preliminary account of upper Paleozoic stratigraphy on western Ellesmere Island.

H.R. Balkwill completed manuscripts based on field work in the northern Interior Plains (Operation Norman). K.J. Roy commenced work on a Basin Analysis program in the Arctic Islands and prepared a paper on the Triassic Boundary Lake oil field in northeastern British Columbia.

Active projects

630002 - Bathurst Island (Operation Bathurst Island); J.Wm. Kerr.
630003 - Operation Grant Land (NE Ellesmere Island and NW Greenland); R.L. Christie, H.P. Trettin, T. Frisch, and P. Dawes (GGU).
680039 - Study of Continental Drift; J. Wm. Kerr
680063 - Permian biostratigraphy, northern British Columbia and northern Yukon; W.W. Nassichuk.
680064 - Stratigraphy and paleontology of upper Paleozoic rocks in the Sverdrup Basin; W.W. Nassichuk.
690002 - Sedimentology and stratigraphy of clastic formations in the Arctic; H.P. Trettin.
700029 - Operation Peel Sound - Stratigraphy and structure of Prince of Wales Island and adjacent small islands; R.L. Christie, J.Wm. Kerr, and R. Thorsteinsson.

Personnel Notes

H.R. Balkwill rejoined the Geological Survey of Canada for work in the Arctic Islands.

K.J. Roy joined the staff of the Geological Survey for subsurface studies in northern Canada.

Attendance at Meetings

H.R. Balkwill

Conference on applications of structural geology to rock mechanics problems; Edmonton, Alberta, March, 1971.

J.Wm. Kerr

American Association of Petroleum Geologists Annual Meeting; Calgary, Alberta, June, 1970.

Second International Symposium on Arctic Geology; San Francisco, February, 1971.

W.W. Nassichuk

American Association of Petroleum Geologists Annual Meeting; Calgary, Alberta, June, 1970.

H.P. Trettin

National conference on Earth Science: the evolution of deformed belts; Banff, Alberta, May 4 - 8, 1970.

Second International Symposium on Arctic Geology; San Francisco, February, 1971.

R.L. Christie

Fifth National Northern Development Conference; Edmonton, Alberta, November, 1970.

Second International Symposium on Arctic Geology; San Francisco, February, 1971.

Special Talks

J.Wm. Kerr

"Importance of Continental Drift to Petroleum Exploration"; American Association of Petroleum Geologists Annual Meeting, Calgary, June, 1970.

"Wildlife and Environment in the Canadian High Arctic"; Western Inter University Geological Conference, Edmonton, 1970, McConnell Club, I.S.P.G., Calgary, 1970, Several High School Assemblies.

"Strip Mining and Environment in Alberta"; McConnell Club, I.S.P.G., Calgary, 1970.

"Canadian Arctic Rift System"; International Symposium on Arctic Geology, San Francisco, February, 1971.

"Geology of the Canadian Arctic Archipelago"; seminar at the University of Alberta, Edmonton.

H.P. Trettin

"Early Paleozoic evolution of northern parts of Canadian Arctic Islands"; Second International Symposium on Arctic Geology, San Francisco, February, 1971.

"Canada Basin and Lomonosov Ridge: inferences based on Precambrian and lower Paleozoic geology of Canadian Arctic Islands"; Second International Symposium on Arctic Geology, San Francisco, February, 1971.

Membership on Committees

J.Wm. Kerr

Canadian Coordinator of Second International Symposium on Arctic Geology, San Francisco, 1971.

Director, Alberta Society of Petroleum Geologists.

Member, Technical Program Committee, American Association of Petroleum Geologists, Annual Meeting, Calgary, 1970.

W.W. Nassichuk

Member, Program Committee, International Conference on the Permian and Triassic Systems, Calgary, August, 1971.

H.P. Trettin

Member, Sub-committee for Geodynamics, National Advisory Committee on Research in the Geological Sciences.

Vice-chairman, Arctic Symposium of Geological Association of Canada and the Alberta Society of Petroleum Geologists, Saskatoon, 1973.

Chairman, Link Award Committee of the Alberta Society of Petroleum Geologists, 1970.

Outside Publications

R.L. Christie, J.Wm. Kerr and R. Thorsteinsson

"Prince of Wales geological survey results soon out"; note for Oilweek, vol. 21, No. 37, p. 46, 1970.

J.Wm. Kerr

"Geology of outstanding Arctic aerial photographs; 1 - Cape Storm Area, southwestern Ellesmere Island, Arctic Canada"; Bull. Can. Petrol. Geol., vol. 18, No. 4, December, 1970.

H.P. Trettin

"Ordovician-Silurian flysch sedimentation in the axial trough of the Franklinian Geosyncline"; in Flysch sedimentology of North America; J. Lajoie ed., Geol. Assoc. Can., Special Paper 7, pp. 13-35.

W.W. Nassichuk and Spinosa, Claude

"Helicoprion sp., A Permian elasmobranch from Ellesmere Island, Canadian Arctic"; J. Paleontol., vol. 44, No. 6, pp. 1130-1132.

"Yobeina and Waagenoceras from the Atlin Horst area, northern British Columbia (co-author Charles A. Ross); J. Paleontol., vol. 44, No. 6, pp. 779-781.

STRUCTURAL GEOLOGY SECTION

D.K. Norris

Activities

D.G. Cook, in collaboration with other members of the Institute and with J.D. Aitken, University of Calgary, continued studies of the regional structural framework of northern Mackenzie Mountains, Franklin Mountains and Interior Plains. With J.D. Aitken, he has completed a preliminary analysis of the geometry and structural development of enigmatic reversals in direction of asymmetry in folds and of relative motion of thrust plates in Colville Hills and northern Franklin Mountains.

In collaboration with C.J. Yorath, Mrs. C.J. Havard carried out a preliminary field study of the sediments of the Beaufort Shelf. Preparation of a paper on the results of this study is in progress. A lithostratigraphic study of the formations encountered in the CPOG Strathmore well was completed with an open-file report and with subsequent preparation of a paper for publication in an outside journal. Investigations of the structural style and physical stratigraphy of the nonmarine Lower Cretaceous in the Waterton-Castle River area were completed; preparation of a final report is now in progress.

D.K. Norris continued field and laboratory studies of the structural and stratigraphic framework of northern Yukon Territory and northwestern District of Mackenzie. Several sequential as well as contemporaneous structural styles were recognized in the region. The nature and history of the Aklavik Arch were studied because of its influence on paleogeography and on distribution of carbonate accumulations and carbonate-shale associations on its flanks. The field phase of a comparative study of the structural fabric of coal mines in northern France was initiated and completed.

N.C. Ollerenshaw continued his studies of the structure and stratigraphy of the Southern Foothills of Alberta. In addition, he continued a study of the tectonic-facies relationships of the Tertiary and Cretaceous sandstones and conglomerates of the eastern Cordillera, with particular emphasis on the igneous-pebble bearing conglomerates of the Beaver Mines Formation. Revised geological maps were prepared for the Canmore East, Morley and Bragg Creek map-areas. The 1:1 million scale map of Athabasca River (NTS 83) map-area was completed.

G.C. Taylor continued his studies of the structural style and stratigraphic framework of the Rocky Mountains. The field investigations are revealing the transition between contrasting types representative of the northern and southern Rockies. These new data have suggested a reinterpretation of the existing tectonic model to one that also satisfies previously enigmatic data west of the Rocky Mountain Trench.

Active projects

670068 - Operation Norman; D.G. Cook.
650023 - Operation Bow-Athabasca; R.A. Price, D.G. Cook.
670577 - Stratigraphy and structure of Lower Cretaceous sedimentary rocks of the Waterton-Castle River area, Alberta; Mrs. C.J. Havard.
690020 - Mesozoic and Tertiary stratigraphy and sedimentation, Beaufort-Mackenzie area; Mrs. C.J. Havard.
700066 - Lithostratigraphic studies of Upper Cretaceous formations encountered in CPOG Strathmore well; Mrs. C.J. Havard.
610007 - Operation Porcupine; D.K. Norris.
660020 - Structure and paleomagnetic fabric of the Mackenzie arc; D.K. Norris.
690005 - Structural geology of northern Yukon Territory and northwestern District of Mackenzie; D.K. Norris.
700050 - Structural prototypes, scale models and stress analysis; D.K. Norris.
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.
700012 - Athabasca River (NTS 83) map-area, 1:1 million geological atlas program; N.C. Ollerenshaw and others.
700037 - Geology of the southern Alberta Foothills, Highwood River to Athabasca River; N.C. Ollerenshaw.
630017 - Operation Liard; G.C. Taylor and others.
680084 - Operation Smoky; G.C. Taylor.

Attendance at Meetings

D.G. Cook

AAPG - SEPM Annual Meeting, Calgary, Alberta, June, 1970.

National Conference on Earth Science, Banff, Alberta, 1970.

Second International Arctic Symposium, San Francisco, California, February, 1971.

C.J. Havard

GSA Rocky Mountain Section Annual Meeting, Rapid City, South Dakota.

D.K. Norris

Second Congress, International Society for Rock Mechanics, Belgrade.

GSA Annual General Meeting, Milwaukee, Wisconsin, November, 1970.

Second International Arctic Symposium, San Francisco, California, February, 1971.

GSA South Central Meetings, College Station, Texas.

N.C. Ollerenshaw

GSA Rocky Mountain Section Meeting, Rapid City, South Dakota.

AAPG - SEPM Annual Meeting, Calgary, Alberta, June, 1970.

G.C. Taylor

National Conference on Earth Science, Banff, Alberta, May, 1970.

Edmonton Geological Society Field trip, Peace River, Pine Pass, Yellowhead Pass, September, 1970.

GAC Cordilleran Section Meeting, Vancouver, British Columbia.

Attendance at Courses

D.G. Cook

ASPG Continuing Education Course on Marine Evaporites, Calgary, Alberta.

C.J. Havard

University of Calgary credit course on Marine Evaporites.

University of Calgary credit course on Micropaleontology.

D.K. Norris

ASPG Continuing Education Course on Marine Evaporites, Calgary, Alberta.

N.C. Ollerenshaw

ASPG Continuing Education Course on Marine Evaporites, Calgary, Alberta.

Special Talks

D.G. Cook

"Tectonics of the northern Franklin Mountains and Colville Hills, N.W.T." (with J.D. Aitken); Second International Arctic Symposium, San Francisco.

D.K. Norris

"Tectonic styles of northern Yukon Territory and northwestern District of Mackenzie, Canada"; Second International Arctic Symposium, San Francisco.
"Inclined flexural-slip folds in the eastern Cordillera of Canada"; South-Central Section Meetings of the G.S.A., College Station, Texas.

G.C. Taylor

"Structural style of northern Mackenzie Mountains"; GAC Cordilleran Section Meeting, Vancouver.

Membership on Committees

D.G. Cook

Member, ASPG Research and Thesis Awards Committee.

D.K. Norris

Commissioner, American Commission on Stratigraphic Nomenclature.
Member, Structural Subcommittee, National Advisory Committee for Research in the Geological Sciences.

N.C. Ollerenshaw

Member, Rocky Mountain Map Project Committee, Alberta Society of Petroleum Geologists.
Chairman, Exhibits Committee, I.S.P.G.

G.C. Taylor

Member, Helicopter Safety Committee, ASPG.

Outside Publications

G.C. Taylor

Paleozoic Stratigraphy of Pine Pass, Northeastern British Columbia; Edm. Geol. Soc. Guidebook, 1970 Field Conference, pp. 46-57, 1970.

PALEOZOIC STRATIGRAPHY SECTION

A.W. Norris

Activities

A.W. Norris spent three months in the field studying Devonian and other rocks in northern Yukon Territory, a continuation of work started in 1962. New Devonian sections were measured, showing marked facies changes in essentially carbonate, carbonate and shale, and shale sequences. Follow-up work of Operation Winisk by D.C. McGregor, B.V. Sandford, and A.W. Norris has shown that the upper member of the Kenogami River Formation is of Early Devonian age rather than Late Silurian as formerly thought.

W.S. MacKenzie and R.W. Macqueen continued to work on Operation Norman material throughout most of the year. MacKenzie studied subsurface data from wells within and adjacent to the Operation Norman area, and prepared for additional field work in the area. The Upper Devonian Miette Reef in Jasper National Park was visited in order to study and compare its stratigraphic phenomena with those of the Middle Devonian reef carbonates in the Lower Mackenzie River area.

R.W. Macqueen continued laboratory work on lower Paleozoic rocks of the Operation Norman area, with the result that the stratigraphy and sedimentology of the "Ronning Group" in Mackenzie and Franklin Mountains, and Mackenzie Plains have now been clarified. Two weeks of field work were spent in northeastern British Columbia delineating a Mississippian facies change of considerable economic significance. Field work was also done in preparation for the International Geological Congress field trip to be held in 1972.

H.L. Martin completed a subsurface study of the Eagle Plain Basin, Yukon Territory, in which he established a more precise correlation between surface and subsurface sequences, and proposed a new formational nomenclature for the exceedingly thick basinal facies. As part of a three-man organizing committee, Martin did field work in preparation for a 2,600 mile, 11-day field trip from Calgary to the Yukon border and return for the 1972 International Geological Congress.

D.C. Pugh continued his studies on subsurface Cambrian stratigraphy and correlation in northern and central Alberta.

E.J. Tassonyi, since rejoining the Survey in October, 1970, has devoted his attention to the subsurface geology of the Great Slave Lake map-area as part of the Northern Basin Analysis Program.

G.R. Davies (NRC postdoctorate fellow) completed work on Middle Devonian laminated sediments of the Elk Point Basin. This work has established long-range correlations between laminae, indicative of a precipitational mechanism in a stratified watermass.

L. F. Jansa (NRC postdoctorate fellow) has worked on three projects as follows: 'Ordovician rocks of the Pine Pass map-area, British Columbia'; 'Subsurface study of Devonian reefs in the Swan Hills area, northern Alberta'; and, with D. K. Norris, 'Origin and depositional environment of the coal-bearing Kootenay Formation, western Alberta.'

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.
670068 - Operation Norman; W.S. MacKenzie and R.W. Macqueen.
700076 - Stratigraphy of the southern part of the Devonian Ancient Wall reef-complex, Alberta; W.S. MacKenzie.
610394 - Schedule of Wells, N.W.T.; W.S. MacKenzie.
700060 - Devonian and older Paleozoic rocks, southern and central District of Mackenzie; W.S. MacKenzie.
New - Northern Basin Analysis Program; Great Bear River map-sheet; W.S. MacKenzie.
New - Northern Basin Analysis Program; Redstone River map-sheet; W.S. MacKenzie.
630021 - Mississippian physical stratigraphy, sedimentology, and correlation; R.W. Macqueen.
670662 - Studies of evaporite - carbonate - clastic suite, Souris River Formation, Saskatchewan; R.W. Macqueen.
670090 - Subsurface upper Paleozoic stratigraphy, Northwest Territories and Yukon Territory; H.L. Martin.
New - Northern Basin Analysis Program; Peel River map-sheet; H.L. Martin.
690003 - Subsurface Cambrian stratigraphy and Granite Wash in northern and central Alberta; D.C. Pugh.
New - Northern Basin Analysis Program; Great Slave Lake map-sheet; E.J. Tassonyi
New - Sedimentological studies of carbonate rocks; G.R. Davies (NRC postdoctorate fellow).
New - Lithostratigraphy and sedimentology of Ordovician rocks of northern British Columbia; L.F. Jansa (NRC postdoctorate fellow).
New - Development of Middle Devonian reefs of Swan Hills area, Alberta; L.F. Jansa (NRC postdoctorate fellow).
690078 - Petrographic norms - clastic rocks of the western Canada sedimentary basin; June E. Rapson-McGugan (Research Associate; R.M. Procter responsible for liaison with I.S.P.G.).
690079 - Condensate deposits of late Paleozoic and Mesozoic age; June E. Rapson-McGugan (Research Associate; R.W. Macqueen responsible for liaison with I.S.P.G.).
New - Petrography of diagenesis; June E. Rapson-McGugan (Research Associate; R.M. Procter responsible for liaison with I.S.P.G.).

Personnel Notes

E.J. Tassonyi rejoined the Geological Survey of Canada in October, 1970, after an absence of four years.

R.M. Procter was transferred from the Paleozoic Stratigraphy Section to the Petroleum Geology Section on October 1, 1970, and was given responsibility for organizing and coordinating the Northern Basin Analysis Program of the Institute.

R.W. Macqueen won the Alberta Society of Petroleum Geologists Link Award for the best oral presentation of a paper of 1970. The paper was a summary of lower Paleozoic rocks of the area covered by Operation Norman.

G.R. Davies from Australia continued doing research work on Paleozoic sedimentary rocks at the Institute under a NRC postdoctorate fellowship. The term of the fellowship was extended to October 1, 1971.

L.F. Jansa from Czechoslovakia is also currently working at the Institute under a NRC postdoctorate fellowship on Paleozoic rocks of northern Alberta and northeastern British Columbia. Jansa accepted a position with the Geological Survey of Canada and will join the Eastern Petroleum Geology Section in Dartmouth, Nova Scotia, in mid summer.

Attendance at Meetings

A.W. Norris

Visited University of Alberta, Edmonton, to act as external examiner of a Ph.D. thesis, May 12-13, 1970.

Geological Association of Canada and Mineralogical Association of Canada, Symposium on the Geology of Manitoba, Winnipeg, August 30 - September 2, 1970.

Visited Geological Survey of Canada, Ottawa, Ontario, to work with B.V. Sanford preparing results of Operation Winisk, January 24-30, 1970.

W.S. MacKenzie

Alberta Society of Petroleum Geologists, Seminar on Marine Evaporites - the anhydrite facies (Part I), University of Calgary, Alberta, March 3-5, 1971.

R.W. Macqueen

American Association of Petroleum Geologists - Society of Economic Paleontologists and Mineralogists, Ann. Meeting, Calgary, Alberta, June 22-24, 1970.

H.L. Martin

Alberta Society of Petroleum Geologists, Seminar on Stratigraphic Petroleum Exploration of Detrital Sequences (Part II), Calgary, Alberta, April 6 - 8, 1970.
Alberta Society of Petroleum Geologists, Seminar on Marine Evaporites - the Anhydrite Facies (Part I), Calgary, Alberta, March 3 - 5, 1971.

E.J. Tassonyi

Alberta Society of Petroleum Geologists, Seminar on Marine Evaporites - the Anhydrite Facies (Part I), Calgary, Alberta, March 3 - 5, 1971.

G.R. Davies (NRC postdoctorate fellow)

American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting, Calgary, Alberta, June 22 - 24, 1970.

L.F. Jansa (NRC postdoctorate fellow)

American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting, Calgary, Alberta, June 22 - 24, 1970.

Special Talks

A.W. Norris

"Stratigraphy and Conodont Faunas of Devonian Outcrop Belts, Manitoba", G.A.C. and M.A.C., Winnipeg, Manitoba, Sept. 1, 1970.

R.W. Macqueen

"Lower Paleozoic Rocks", A.S.P.G., and Edmonton Geological Society.
General talk on carbonates and evaporites, faculty and graduate students, University of British Columbia.
General talk on "Upper Devonian and Lower Carboniferous rocks of Western Canada Sedimentary Basin", staff of GSC, Vancouver office, British Columbia.

G.R. Davies (NRC postdoctorate fellow)

"Modern carbonate sedimentation, Shark Bay, Western Australia"; staff of Imperial Oil Company, Calgary; staff of Shell Oil Company, Edmonton; University of Connecticut, U.S.A.; University of Alberta, Edmonton; S.E.P.M. Carbonate Rock Subcommittee, Calgary; A.A.P.G. - S.E.P.M. Annual Convention, Calgary.

Membership on Committees

R.W. Macqueen

Member of subcommittee on Stratigraphy, Sedimentology and Paleontology, National Advisory Committee on Research in the Geological Sciences, meeting held in Ottawa, Ontario.

Co-chairman, session on Ancient Carbonates, American Association of Petroleum Geologists - Society of Economic Paleontologists and Mineralogists, Annual Meeting, Calgary, Alberta, June 22 - 24, 1970.

Coordinated and helped to organize, as Program Chairman, Rocky Mountain Section Meeting, Calgary, Alberta, May 13 - 14, 1971.

Chairman, General session on 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, Montreal, 1972.

G.R. Davies (NRC postdoctorate fellow)

Member of Medal of Merit Award Committee for 1970, Alberta Society of Petroleum Geologists.

Outside Publications

G.R. Davies[1]

"A Permian hydrozoan mound, northern Yukon Territory"; Can. J. Earth Sci., (in press).

"A basinal model for Middle Devonian laminites, Elk Point Basin of Western Canada"; (Abst.); Geol. Soc. Am., Special Paper (in press).

[1]N.R.C. postdoctorate fellow at I.S.P.G.

L.F. Jansa[2] and M.E. Hriskevich[3]

"Geological-geophysical prospecting for oil and gas in reef carbonates"; Geol. J., Czechoslovakia, (in press).

[2]N.R.C. postdoctorate fellow at I.S.P.G.

[3]Geologist, Banff Oil Company Ltd., Calgary, Alberta.

W.S. MacKenzie

"Allochthonous Reef Debris - Limestone Turbidites, Powell Creek, Northwest Territories"; Bull. Can. Petrol. Geol., vol. 18, No. 4, pp. 474-492, 1970.

R.W. Macqueen and E.D. Ghent[4]

"Electron Microprobe study of magnesium distribution in some Mississippian echinoderm limestones from Western Canada"; Can. J. Earth Sci., vol. 7, No. 5, pp. 1308-1316, 1970.

[4]Department of Geology, University of Calgary.

D.C. McGregor, B.V. Sanford, and A.W. Norris

"Palynology and correlations of Devonian formations in the Moose River Basin, northern Ontario"; Geol. Assoc. Can. Proc., vol. 22, pp. 45-54, 1970.

A.W. Norris and T.T. Uyeno

"Stratigraphy and Conodont Faunas of Devonian outcrop belts, Manitoba"; (Abst.); Geol. Assoc. Can. Min. Assoc. Can., Programme and Abstracts, Ann. Meeting, Aug. 30 - Sept. 2, 1970, Winnipeg, p. 39, 1970.

"Stratigraphy and Conodont Faunas of Devonian outcrop belts, Manitoba"; Geol. Assoc. Can., Special Paper No. 9, (in press).

D.F. Toomey[5], E.W. Mountjoy[6], and W.S. MacKenzie

"Upper Devonian (Frasnian) algae and foraminifera from the Ancient Wall carbonate complex, Jasper National Park, Alberta, Canada"; Can. J. Earth Sci., vol. 7, No. 3, pp. 946-981, 1970.

[5]Pan American Petroleum Corporation, Research Center, Tulsa, Oklahoma 74102, U.S.A.

[6]McGill University, Montreal, Quebec.

MESOZOIC STRATIGRAPHY SECTION

D.F. Stott

Activities

Three members of the section continued their participation in Operation Smoky in northeastern British Columbia. D.W. Gibson completed most of his studies of Triassic rocks, thereby linking previous studies in Alberta Foothills with those in northeastern British Columbia. D.F. Stott completed most of the mapping of Jurassic and Cretaceous strata, but owing to illness was unable to complete his stratigraphic studies. F.G. Young assisted in the final stages of mapping the Precambrian and Cambrian successions and undertook some supplementary stratigraphic studies.

Stratigraphic and sedimentological studies of both surface and subsurface sequences in northern Yukon and District of Mackenzie were continued by C.J. Yorath and F.G. Young. The latter recognized and studied an Albian flysch basin in northern Richardson Mountains and, in addition, examined an Upper Cretaceous molasse succession. Yorath participated in Phase 8 of the "Hudson 70" cruise in Beaufort Sea, obtaining information of both geological and engineering interest. His studies of reflection seismic profiles in the region are providing much needed data concerning structural relationships within the basin

The program in clay mineralogy and chemistry, headed by A.E. Foscolos, continues to develop with the addition of new equipment and growing awareness of the scientific staff of the value of the analyses provided. The major acquisition of the XRF unit during the year has expanded the scope of research that may be carried on.

L.L. Price continued to prepare reports on the geological succession encountered in 8 potash shafts in Saskatchewan.

Reports

A.E. Foscolos produced a total of 51 reports for Institute staff as follows:
27 reports on clay mineralogy containing 1,500 identifications.
24 reports on geochemistry containing 833 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.
670059 - Stratigraphy of Gog and Cariboo Groups near the Rocky Mountain Trench, McBride, B.C.; F.G. Young.
670068 - Operation Norman; C.J. Yorath.
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 evaporite-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.
690048 - Soils in glaciated and unglaciated terrain; A.E. Foscolos.
700003 - Kootenay River: Atlas Program; D.F. Stott.
700007 - Parsnip River: Atlas Program; D.F. Stott.
700012 - Athabasca River: Atlas Program; D.F. Stott.
700027 - Comparative study of ancient and modern sedimentary environments; D.F. Stott, L.L. Price, D.W. Gibson, F.G. Young.
700045 - Belcher Channel: Atlas Program; D.F. Stott.
700068 - Basin analysis of exposed Mesozoic and Tertiary strata, Yukon Territory; F.G. Young.

Clay Mineralogy Laboratory

A.G. Heinrich

This laboratory continues to determine qualitatively and semiquantitatively crystalline minerals, mainly in sedimentary rocks. The clay mineralogy laboratory has been upgraded by the recent acquisition of:

1. An additional panel, recorder, gonimeter with AMR X-ray curved crystal focusing monochromator, and an automatic sample changer for the "Philips" X-ray unit;

2. A flat cassette camera for identification of minerals with large d-spacings;

3. A "Philips" X-ray fluorescence unit for qualitative and quantitative determination of elements in sedimentary rocks and minerals;

4. A "Sonatron" rock chip disintegrator which, by means of ultra waves, loosens clay particles from rock chips.

During the year, some 1,500 mineralogical identifications were made for GSC staff, 4,800 for studies concerning the layer-lattice silicate assemblages of Lower Cretaceous shales, and 165 for the research project concerning the classification of paleosols in glaciated and unglaciated terrains of Yukon Territory.

Clay Chemistry and Geochemistry Laboratory

R.R. Barefoot

This laboratory continues to determine quantities of clay minerals in sedimentary rocks using chemical and phyical methods. New equipment added to this laboratory includes:

1. A Buchler gradient mixer for separating clays and clay-size minerals by density gradient methods.
2. Conductivity meter to measure conductivity in water and solutions.
3. A Kjeldahl apparatus for measuring exchange capacity in shales and soils.

During the year, 833 chemical analyses were made for GSC staff. These included 331 carbon determinations, 258 sulphur determinations and 264 major and minor elements occurring in rock samples. In addition, 120 carbon determinations, 60 sulphur determinations and 120 hydrogen-ion determinations were carried out for the study of Lower Cretaceous shales. Also, 60 mechanical analyses of soils and 155 carbon determinations were done for the study of the classification of Quaternary paleosols.

The technician, R. R. Barefoot, co-authored with A. E. Foscolos three GSC papers concerning analytical methods.

Personnel Notes

A.E. Foscolos visited Professor A. Weiss, Department of Chemistry, University of Munich, Germany, for one week, May 1 - 8, 1970, to discuss problems related to separation of clay minerals. He also visited the Aristotelian University of Thessaloniki, Greece, where he provided advice on the acquisition and operation of an atomic absorption unit.

F.G. Young was given the 1970 award by the Alberta Society of Petroleum Geologists for the best Ph.D. thesis.

D.F. Stott was Acting Director of the Institute during the periods April 22 - 29 and September 10 - 28.

Attendance at Meetings, Conferences, and Courses

A.E. Foscolos

American Society of Agronomy; Tucson, Arizona, August 23 - 28, 1970.

D.W. Gibson

ASPG Continuing Education Series: Marine Evaporites; Calgary, March 3 - 5, 1971.

A.G. Heinrich

Advance Mineralogy, Department of Geology, University of Calgary, September to December, 1970.

X-ray diffraction and X-ray fluorescence spectroscopy Seminar; Philips Electronics, San Francisco, September 13 - 19, 1970.

L.L. Price

National Conference on Earth Science; Evolution of deformed belts; Banff, May 3 - 8, 1970.

AAPG - SEPM annual meeting; Calgary, June 22 - 24, 1970.

Core Conference on Cretaceous Rocks; Saskatchewan Geological Society, Regina, October 28 - 29, 1970.

D.F. Stott

Core Conference on Cretaceous Rocks; Saskatchewan Geological Society, Regina, October 28 - 29, 1970.

Visited Department of Mines and Petroleum Resources in Victoria and offices of GSC in Vancouver, January 31 to February 3, 1971.

Course in French, Department of Extension, University of Calgary, October - December, 1970.

C.J. Yorath

AAPG - SEPM annual meeting, Calgary, June 22 - 24, 1970.

Co-operative planning meeting, Geological Survey and Marine Sciences Branch, Bedford Institute of Oceanography, Dartmouth Nova Scotia, December, 1970.

Second International Symposium on Arctic Geology, San Francisco, February 1 - 4, 1971.

Membership on Committees

D.W. Gibson

Member, Link Award Committee, Alberta Society of Petroleum Geologists.

L.L. Price

Member, Earth Sciences Advisory Committee, Earth Science Symposium, Banff, ASPG - University of Alberta.

C.J. Yorath

Chairman, Education Committee, Alberta Society of Petroleum Geologists.

Chairman, program session, SEPM meeting, Calgary, June 23, 1970.

Special Talks

C.J. Yorath

"Preliminary interpretation of bottom sediments, shallow seismic and side-scan profiles, Beaufort Sea"; Alberta Society of Petroleum Geologists, Calgary, Nov., 1970, Edmonton Geological Society, Edmonton, Nov., 1970, Queen's University, Geology Department, Kingston, Dec., 1970, Second International Symposium on Arctic Geology, San Francisco, Feb., 1971.

"Geology of the eastern Northern Interior Plains and Mackenzie Delta"; Second International Symposium on Arctic Geology, San Francisco, February, 1971.

Outside Publications

D.W. Gibson

"Triassic stratigraphy, Pine Pass area, northeastern British Columbia"; Field Conference Guidebook, Edmonton Geological Society, pp. 23-38, 1970.

A.E. Foscolos

"Factors affecting the rate of the interchange reaction of adsorbed H on the 2:1 clay minerals"; Soil Sci., vol. 11, pp. 52-60, 1970 (co-authored with I. Barshad, Univ. California).

D.F. Stott

"Jurassic and Cretaceous rocks of Pine River region, British Columbia"; Field Conference Guidebook, Edmonton Geological Society, pp. 58-83, 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, France and the United Kingdom.

The Section consists of ten scientists, supported by four technicians with paleontological laboratories and extensive fossil collections. Three members of the Section are stationed in Ottawa and are supervised by E.T. Tozer

In 1970, members of the Section carried out field studies in the Arctic Islands, Mackenzie Mountains, northern Yukon, southwestern Alberta, 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.
550004 - Cretaceous and Jurassic of Richardson Mountains, Porcupine Plains and Eagle Plains; J.A. Jeletzky.
590194 - Monograph of the Canadian belemnites; J.A. Jeletzky.
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 Canadian Cordillera; W.H. Fritz.
660026 - Conodont biostratigraphy of Lower and Middle Devonian strata of southwestern Ontario; T.T. Uyeno.
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
700019 - Biostratigraphic study of Mesozoic and Cenozoic phytoplankton and Cenozoic pollen and spores from the Sverdrup Basin and adjacent regions; R.L. Cox.

700063 - AAPG field trips, June 1970; T.P. Chamney.
700064 - Foraminiferal zonation of the Mesozoic and lower Cenozoic rocks of the Mackenzie Delta and adjacent Arctic Coastal Plain; T.P. Chamney.

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 154 reports for direct quotation in publications, identifying and dating 1,989 lots of fossils as follows:

Bamber	7 reports on 287 lots
Brideaux	4 reports on 44 lots
Chamney	13 reports on 447 lots
Cox	1 report on 2 lots
Fritz	15 reports on 90 lots
Hopkins	17 reports on 63 lots
Jeletzky	22 reports on 271 lots
Norford	8 reports on 91 lots
Pedder	12 reports on 153 lots
Tozer	8 reports on 208 lots
Uyeno	11 reports on 86 lots
Scientists from other sections of the Institute and from outside the Survey	38 reports on 247 lots

Macropaleontology Laboratory and Curating Facilities

S. Carbone

In the past year, the laboratory provided services for thin-sectioning, casting, acid etching, polishing, mechanical extraction, and other preparatory techniques required for the study and identification of fossil specimens.

In June, R.D. Mitchie joined the staff as a macropaleontology technician. In addition to his duties in the macropaleontology laboratory, Mr. Mitchie has been assisting part-time in the conodont laboratory. In September, M.J. Rice was assigned to the laboratory for training in paleontological curating.

During the latter part of the year Mr. Carbone started work on a program of extraction of fossils from well core samples. Under the guidance of a supervising paleontologist, he examined approximately 10 wells from the Northwest Territories.

The laboratory also provided services to other sections of the I.S.P.G., notably the Arctic Section. Mr. Carbone spent approximately three weeks in the Yukon assisting Dr. W.W. Nassichuk of the Arctic Section in field work.

Production

Oriented fossil thin sections	1,250
Plaster replicas of fossils	22
Acid extractions	28
Polished samples	30
Extractions of fossils from cores	100

Curating Facilities (M.J. Rice)

During the year, 3,800 new collections were received, recorded, numbered, and stored. Many collections were shipped to paleontologists elsewhere in Canada and the U.S.A. A total of 500 parcels were shipped and received.

Early in 1971, 70 new rock cabinets were received, and material in the basement was rearranged and consolidated into them. To simplify and standardize curating procedures, 3 new forms were designed: (1) Fossil submission, (2) Loan reminder, and (3) I.S.P.G. Paleontologists loan cards. All micropaleontological material is now being curated here before it is processed, and a start has been made to incorporate into the curating system many old collections that were originally catalogued in Ottawa and are now stored in Calgary.

Micropaleontology Laboratory

G.D. Karg

During the year a total of 1,738 lots of samples were curated and processed as follows:

Core	401 lots
Well cuttings	1,046 lots
Outcrop	291 lots

1,261 samples were picked for microfossils by outside contract. Services performed as direct scientific support included photomicrography, drafting, log plotting, microfossil lists and distribution chart compilation. Other duties included fossil and sample curation and cataloguing, equipment purchasing and maintenance, and investigation and development of new laboratory procedures and techniques.

Two student assistants and a temporary employee were instructed and supervised by the micropaleontology technician during the summer of 1970. Later in the year, the micropaleontology technician assisted in the operation of the newly formed conodont laboratory for one day a week for four months.

Palynology Laboratory

S.L. O'Keefe

The laboratory received and processed 247 samples collected by geologists of the Geological Survey of Canada and by industry from the Arctic Islands, District of Mackenzie, and Eastern and Western Canada. Four months were spent in photomicrography as scientific support for R.L. Cox, and the laboratory became responsible for the maintenance of a darkroom (Room 219). In October, the palynology technician spent one week attending a first aid course given by the St. John Ambulance Association.

Personnel Notes

R.L. Cox resigned from the Survey in July to join the staff of Douglas College, Vancouver. R.D. Michie joined the Section in June from Chevron Standard Limited, Calgary. W.W. Brideaux joined the Section in November from the Research Center, Pan American Petroleum Corporation, Tulsa. T.T. Uyeno transferred from the Ottawa unit of the Section to Calgary in November. M.J. Rice (Institute Custodian, Rocks and Fossils) was assigned to the Section for training.

J.A. Jeletzky was elected a Fellow of the Royal Society of Canada in May 1970.

Attendance at Meetings

W.W. Brideaux

American Association of Stratigraphic Palynologists, Toronto.

T.P. Chamney

American Association of Petroleum Geologists, Calgary.

W.H. Fritz

Geological Society of America, Milwaukee.

J.A. Jeletzky

Royal Society of Canada, Winnipeg.

Second International Symposium on Arctic Geology, San Francisco.

B.S. Norford

American Association of Petroleum Geologists, Calgary

Geological Association of Canada, Winnipeg.

Second International Symposium on Arctic Geology, San Francisco.

A.E.H. Pedder

Electron Microscopy Convention, Systematics Association, Reading, England.

Field Meeting, Committee on Silurian-Devonian Boundary, International Commission on Stratigraphy.

T.T. Uyeno

Geological Society of America, North-Central Section, East Lancing.

Consultations and study of comparative material

W.H. Fritz	- Field Museum of Natural History, Chicago
	- State University of New York (Stony Brook)
J.A. Jeletzky	- Paleontological Institute, University of Kansas
	- United States Geological Survey, Menlo Park
	- Stanford University
	- University of California (Berkeley)
	- University of California (Riverside)
	- California Academy of Sciences
	- University of British Columbia
T.T. Uyeno	- University of Waterloo

Special Talks

W.W. Brideaux

"Palynologic analyses of cored sediments from the Grand Banks, Newfoundland"; American Association of Stratigraphic Palynologists, Toronto (with G.L. Williams).

"Microplankton assemblages from the Middle and Late Albian of central Alberta, Canada"; American Association of Stratigraphic Palynologists, Toronto.

T.P. Chamney and G.D. Karg

"Micropaleontological disintegration, an economic operation for the oil explorationist"; Alberta Society of Petroleum Geologists, Paleontological Group, Calgary.

W.H. Fritz

"Cambrian biochronology in the North American faunal province"; Ottawa University.

W.S. Hopkins, Jr.

"Albian microfloras of the Sverdrup Basin"; American Association of Stratigraphic Palynologists, Toronto (presented by D.J. McIntyre).

"Pleistocene-Quaternary palynology"; University of Calgary, Department of Archaeology.

J.A. Jeletzky

"Cretaceous paleogeography of arctic Canada"; Second International Symposium on Arctic Geology, San Francisco.

B.S. Norford

"Silurian stratigraphy of northern Manitoba"; Geological Association of Canada, Winnipeg.

"Silurian stratigraphy of northwestern Greenland"; McConnell Club, I.S.P.G., Calgary, Alberta Society of Petroleum Geologists, Calgary, Edmonton Geological Society, Second International Symposium on Arctic Geology, San Francisco, University of Saskatchewan, Saskatoon, Saskatchewan Geological Society, Regina.

E.T. Tozer

"Geological problems illustrated by the Triassic".

Membership on Committees

E.W. Bamber

I.S.P.G. Library Committee

XXIV International Geological Congress, 1972, Field Trip Leader

T.P. Chamney

Vice-Chairman, Field Program, American Association of Petroleum Geologists, Annual Meeting, 1970.

W.H. Fritz

XXIV International Geological Congress, 1972, Field Trip Leader.

W.S. Hopkins, Jr.

Thesis Committee, Department of Geology, University of Calgary.

G.D. Karg

I.S.P.G. Safety Committee.

J.A. Jeletzky

Miller Medal Committee of Royal Society of Canada.

XXIV International Geological Congress, 1972, Field Trip Leader.

B.S. Norford

I.S.P.G. Committee on Curation of Rocks and Fossils.

XXIV International Geological Congress, 1972, Field Trip Leader.

E.T. Tozer

Program Committee, International Conference on Permian and Triassic Systems, Calgary, 1971.

XXIV International Geological Congress, 1972, Field Trip Leader.

Outside Publications

E.W. Bamber and J.B. Waterhouse

Carboniferous and Permian stratigraphy and paleontology, northern Yukon Territory, Canada; Bull. Can. Petrol. Geol., vol. 19, pp. 1-120, 1971.

W.W. Brideaux

Recurrent species groupings in fossil microplankton assemblages; Palaeogeogr., Palaeoclim., Palaeoecol., vol. 9, pp. 101-122, 4 pls., 1971.

T.P. Chamney

Calgary, its geological setting; Geotimes, vol. 15, No. 4, pp. 12-15, (contributor), 1970a.

Calgary to Drumheller; in A geological guide along the highways between Drumheller-Calgary-Lake Louise; Alta. Soc. Petrol. Geol., pp. 33-44. 1970b.

W.H. Fritz

Geological setting of the Burgess Shale; North American Paleontological Convention, Proceedings, Pt. 1, pp. 1155-1170, 1971.

M.O. Fuglem and T.P. Chamney

Use of core in evaluation of productive sand, Lloydminster area, Saskatchewan; Sask. Dept. Min. Resources and Sask. Geol. Soc., Core Conference, 11 pp., 1970.

J.A. Jeletzky

Taxonomic status and morphology of "Rhopaloteuthis" somaliensis Spath, 1935; Palaeontology, in press, a.

Mesozoic rocks of Manning Park area; XXIV Internat. Geol. Congress, Guidebook A03-C03 (part of), in press, b.

B.S. Norford

Silurian stratigraphy of northern Manitoba; Geol. Assoc. Can., Special Paper 9 (part of), in press, a.

Acaste birminghamensis, a new Lower Silurian trilobite species from Alabama; J. Paleont., in press, b.

A.W. Norris and T.T. Uyeno

Stratigraphy and conodont faunas of Devonian outcrop belts, Manitoba; Geol. Assoc. Can., Special Paper 9 (part of), in press.

A.E.H. Pedder

Lower Devonian corals and bryozoa from the Lick Hole Formation of New South Wales; Palaeontology, in press.

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. N.S.W., Proceedings, vol. 94, pp. 242-272, pls. 14-24, 1970.

G.E. Rouse, W.S. Hopkins, Jr., and K.M. Piel

Palynology of some Late Cretaceous and Early Tertiary deposits in British Columbia and adjacent Alberta; Geol. Soc. Am., Special Paper 127, pp. 213-246, 1970.

G.C. Taylor and E.W. Bamber

Paleozoic stratigraphy of Pine Pass, northeastern British Columbia; Edmonton Geol. Soc., Field Conf. Guidebook, pp. 46-57, 1970.

E.T. Tozer

Triassic ammonoids from the Nakhlak Group, Anarak Region, Central Iran; United Nations Geol. Survey Inst., in press, a.

Triassic time and ammonoids, problems and proposals; Can. J. Earth Sci., in press, b.

Triassic and Jurassic ammonites, one, two or three connecting links; Nature, in press, c.

M. Waldman and W.S. Hopkins, Jr.

Coprolites from the Upper Cretaceous of Alberta, Canada, with a description of their microflora; Can. J. Earth Sci., vol. 7, pp. 1295-1303, 1970.

PETROLEUM GEOLOGY SECTION

R.G. McCrossan

Activities

The project to evaluate surface geochemical prospecting methods was extended. Two additional sets of test samples that were collected and analyzed are to be used in the statistical analysis of the results of the original sampling program and to test further the analytical techniques employed.

The study of the regional distribution of gaseous hydrocarbons and the determination of source rocks in the Northwest Territories was continued with a geochemical analysis of cuttings from twelve northern wells. The results of this study will be of value in estimating the petroleum potential of these northern areas.

A joint project with the Institut Français du Pétrole was initiated to examine the origin and migration of petroleum in selected areas of Alberta, in order to better evaluate the ultimate hydrocarbon potential of these areas, as well as to develop new techniques for use in evaluating hydrocarbon potential in new basins.

The chemical analysis of organic components of bottom sediment samples collected in the Beaufort Sea was begun to obtain fundamental knowledge of the organic content of the sediments, especially as it pertains to the origin of hydrocarbons in high latitudes. This is a joint project: Dr. G.W. Hodgson of the University of Alberta will make the analyses and C.J. Yorath of the Mesozoic Stratigraphy Section at the Institute will provide the sedimentological and related information.

The Oil and Gas Pools map of Western Canada, depicting oil and gas pools by geological position as well as geographical location was completed and published.

The A.S.P.G. project on the "Future Oil Provinces of Canada", a volume of papers prepared by selected authors and edited by R.G. McCrossan, is well advanced, and is expected to be completed by the end of the year. The purpose of the project is to study the oil potential of the sedimentary basins of Canada.

Active projects

680018 - The environment of oil and gas in Western Canada; R.G. McCrossan, N.L. Ball and L.R. Snowden.

680133 - Correlation of coal ranks and hydrocarbon properties in Mesozoic rocks of Western Canada; R.G. McCrossan, P. Hacquebard, N.L. Ball and J.R. Donaldson.

680134 - Regional distribution of gaseous hydrocarbons in the Northwest Territories; R.G. McCrossan and L.R. Snowden.

690029 - Surface geochemical prospecting for petroleum, central Alberta; R.G. McCrossan and N.L. Ball.
700086 - Petroleum potential of sedimentary basins of Canada; R.G. McCrossan.
710001 - Origin and migration of petroleum in western Canada; R.G. McCrossan, B. Tissot and N.L. Ball.
New - The organic content of sediments from the Beaufort Sea; R.G. McCrossan, G.W. Hodgson and C.J. Yorath.
600206 - Subsurface study of Mississippian and Permian stratigraphy 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; A.E. Foscolos, D.F. Stott and R.M. Procter.

Personnel Notes

R.M. Procter was transferred to this Section to coordinate research in the Northern Basins Analysis group, which will provide a composite geological analysis of the northern basins utilizing detailed and varied information input by many of the scientists of the Institute.

Attendance at Meetings

R.G. McCrossan

Alaska Symposium, University of Missouri, Rolla, Missouri, November, 1970.

CIM Geochemical Symposium, Toronto, Ontario, May, 1970.

Annual Meeting AAPG - SEPM, Calgary, Alberta, June, 1970.

N.L. Ball

Annual Meeting AAPG - SEPM, Calgary, Alberta, June, 1970.

L.R. Snowden

Annual Meeting AAPG - SEPM, Calgary, Alberta, June, 1970.

CIM Geochemical Symposium, Toronto, Ontario, May, 1970.

R.M. Procter

Annual Meeting AAPG - SEPM, Calgary, Alberta, June 1970.

Attendance at Courses

R.G. McCrossan

V.I.F. course in French; University of Calgary evening program.

Recent offshore sedimentation; Vancouver, May, 1970.

N.L. Ball

A.S.P.G. Seminar on marine evaporites; University of Calgary, March, 1971.

Recent offshore sedimentation; Vancouver, May, 1970.

L.R. Snowden

Introductory Statistics; University of Calgary winter session, 1970.

Advanced Programming Techniques; University of Calgary, winter session 1970-1971.

R.M. Procter

Computer Applications in geology; given by Canadian Stratigraphic Services Ltd., Calgary, April, 1970.

Special Talks

R.G. McCrossan

"An evaluation of surface geochemical prospecting for petroleum, Caroline area, Alberta" (McCrossan and N.L. Ball); CIM Geochemical Symposium, Toronto, May, 1970.

"Mineral Resources of Arctic Canada" (R.G. McCrossan and R.M. Procter); Alaska Symposium, University of Missouri.

Membership on Committees

R.G. McCrossan

Member, Council and Discipline Committee, Association of Professional Engineers of Alberta.

Program Chairman, SEPM Meeting, Calgary, June, 1970.

Member, Program Committee, International Exploration Geochemistry Symposium, CIM, Toronto, May, 1970.

Chairman, District Representative Committee, American Association of Petroleum Geologists, Calgary.

Editor and co-ordinator, "Future Petroleum Provinces of Canada" volume.

Member, Program Committee, I.G.C., Montreal, 1972.

Branch representative, Planning Group, Energy sub-program of petroleum, Department of Energy, Mines and Resources.

R.M. Procter

Member, Mattson Committee, SEPM Annual Meeting, Calgary, June, 1970.

Outside Publications

R.G. McCrossan and N.L. Ball

An evaluation of surface geochemical prospecting for petroleum, Caroline area, Alberta; CIM Symposium, Special Volume.

Mineral Resources in Arctic Canada; Alaska Symposium, Special Volume.

DIVISION OF QUATERNARY RESEARCH AND GEOMORPHOLOGY

J.G. Fyles, Chief

B.G. Craig, Assistant Chief

INTRODUCTION

The Division of Quaternary Research and Geomorphology carries out that part of the Departmental Earth Sciences Program that falls within the objectives of the Geological Survey. The work comprises geological, geomorphic, geophysical, geotechnical and related investigations of earth and rock materials and associated dynamic processes. The scientific capacity of the Division is directed towards three sub-objectives; (1) a Canada-wide inventory of surficial geology and terrain conditions at appropriate scales and including specialized studies to provide the necessary reference back-up for a proper understanding of Quaternary stratigraphy, paleontology and geochronology, and to document the physical and chemical properties of earth and rock materials, their stability relations and dynamic behaviour; (2) investigations of terrain hazards to provide an assessment of the geological and terrain factors bearing on man-induced hazards, environmental disturbance or pollution and to recommend measures to avoid, minimize or remedy such hazards; and (3) investigations of land-use, land capability and terrain performance with reference to urban areas, industrial development, northern development and resource management. Although the above are most directly related to the Earth Sciences Program many of these activities contribute as well to the Departmental Mineral and Energy Resources Program.

At the end of the year the staff included 36 research scientists, geographers and scientific officers, 2 term physical scientists, 11 technical and other support staff and 4 administration support personnel. In addition 5 professors of geology and geography and about 50 students were associated with the Division, largely during the field season. Twenty-seven members of the scientific staff were involved in field projects to which were added projects of the 5 professors and 3 graduate students on Ph.D. programs.

For administrative purposes the Division comprises (1) Divisional Headquarters including Scientific Services Unit, Administration and Finance, and Special Projects Unit, (2) Regional and Stratigraphic Projects Section, (3) Engineering Geology and Geodynamics Section, and (4) Paleontology and Geochronology Section. The research functions and program of the various sections are described below. Many projects of the Division, however, are involved in aspects of programs of more than one section.

Although most of the staff of the Division is located in Ottawa, at the end of the year three scientists and one technician were based at the Institute of Sedimentary and Petroleum Geology in Calgary and one scientist was based at the Canada Centre for Inland Waters in Burlington.

During the year the program of the Division has received close support and co-operation from various units of the Branch, from the Great Lakes Division of the Inland Waters Branch at Burlington, and has benefited from considerable in-field logistic support from Polar Continental Shelf Project. In particular seismic surveys have been carried out by the Exploration Geophysics Division in direct support of Quaternary projects and analysis of samples was carried out in various laboratories, chiefly of the Economic Geology and Geochemistry Division and the Institute of Sedimentary and Petroleum Geology.

Activities

The Pleistocene Discussion Group was chaired by D.A. Hodgson prior to, and R.J. Fulton 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.

Mr. H.A. Polach, Australian National University - Problems connected with radiocarbon dating of soils.

Mr. Robin Doak, Brennex Co. - Tracing the source of radioactive boulders in Labrador.

Dr. J-C. Dionne, Department of Fisheries and Forestry - Ice wedge casts in southern Quebec: their climatic significance.

Dr. R.I. Walcott, Earth Physics Branch - A physical model for postglacial isostatic rebound.

Mr. M.J. Dadswell, Carleton University - The use of biological indicator organisms in determining glacial lake and marine limits.

REPORTS ON SECTIONS

DIVISIONAL HEADQUARTERS

In addition to the Division Chief, Secretary and Assistant Division Chief, Divisional Headquarters includes an Administration and Finance Unit comprising Administrative Officer, stenographer and draftsman and a Scientific Services Unit that provides editorial, mathematical, photogrammetric, and related services to scientists of the Division. The Special Projects Unit comprises two research scientists engaged in projects that are part of the program of the Regional and Stratigraphic Projects Section. Projects undertaken by scientists in Divisional Headquarters are listed with those of the appropriate Section.

Attendance at Courses

J.G. Fyles: Senior Executive Development Course, at the National Defence College, in Kingston, September to November.

G.V. Minning: Slope development: forms, processes and stability, Carleton University.

Attendance at Meetings, Talks

J.G. Fyles: attended the field meeting of the Cormorant Lake biophysical pilot project, sponsored by the National Committee on Forest Land at Cranberry Portage, Manitoba, and the meetings of the Canadian Association of Geographers and the Royal Society of Canada in Winnipeg in June.

Miss G.V. Minning: attended the Eastern Friends of the Pleistocene Field Conference at Mount Washington, New Hampshire in May.

Mrs. G. Mizerovsky: attended the 64th Annual Meeting of the Canadian Institute of Surveying in Ottawa in February.

V.K. Prest: attended the Eastern Friends of the Pleistocene Field Conference at Mount Washington, New Hampshire in May.

Membership on Committees

B.G. Craig
- Subcommittee for Pleistocene Shorelines of the Americas, International Shoreline Commission, INQUA
- Departmental Committee on Oil Pollution.

J.G. Fyles
- Chairman, Associate Committee on Quaternary Research
- National Committee on Forest Land
- Subcommittee on Permafrost, Associate Committee on Geotechnical Research, 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 Geotechnical Research, National Research Council
- Editorial board of journal, "Quaternary Research"
- Member of the National Organizing Committee, and Co-Convenor of Section XII, International Geological Congress
- Departmental Co-ordinating Committee on Environmental Matters.

L.A. Jackson
- Branch representative on revision of General Instructions for Field Parties
- Branch representative on Departmental Recreation Association Committee
- Alternate Chairman, Administrative Support Classification and Evaluation Committee
- Member, Administrative Support Appraisal Committee.

Outside Papers

Mathews, W.H., Fyles, J.G., and Nasmith, H.W.
1970: Postglacial crustal movements in southwestern British Columbia and adjacent Washington state; Can. J. Earth Sci., vol. 7, No. 2, Pt. 2, pp. 690-702.

Active Projects

K. Shimizu	680132	Application of mathematics to Quaternary research and geomorphology.

REGIONAL AND STRATIGRAPHIC PROJECTS SECTION

B.G. Craig (Acting Head)

The scientific activities of this Section are largely directed toward a long term program aimed at providing a Canada-wide inventory of the unconsolidated deposits and landforms and establishing their stratigraphic sequence and environmental history. Mapping projects are undertaken at various scales, chosen on the basis of the present state of knowledge and the potential use to forestry, agriculture, engineering construction and to the mineral industry, including petroleum.

In the Arctic islands mapping is carried out on a reconnaissance scale of 8 miles or 16 miles to the inch. In the boreal forest zone a system of ground checked airphoto mapping has been devised whereby the distribution of surface materials, their stratigraphy and geomorphology are presented at 4-mile scale. Major projects of this type were undertaken in southern Labrador, and in the Mackenzie Delta. Compilation and presentation of available data in preparation for a greatly expanded program in the Mackenzie Valley in anticipation of a demand for surficial geology information relative to pipeline and other construction was begun. In the more settled parts of southern Canada more detailed 4-mile mapping projects are carried out. In selected areas, where still more detailed information is required relative to urban expansion and resource planning and management mapping is at one mile or larger scale. In addition, specific studies are carried out to provide the necessary stratigraphic, paleontologic and geochronologic background for a proper understanding of the Quaternary geology of Canada.

Field work was undertaken during the year in all provinces, the Yukon Territory and the Northwest Territories by 15 scientists of the Division, four scientists from Division Administration (including Special Projects Unit), two professors and two graduate students, and as part of the program of other Sections within the Division.

Personnel Notes

D.M. Barnett: completed his residence requirements for his Ph.D. at the University of Western Ontario and returned to Ottawa.

R.J. Fulton: was elected Secretary Treasurer of the Geologists Sub-Group of the Scientific Research Group of the Professional Institute of the Public Service of Canada.

R.W. Klassen: became a representative of the Scientific Research Group of the Professional Institute of the Public Service of Canada in Calgary.

N.W. Rutter: spent two and one half months in Peru participating in an archeological expedition under the direction of R.S. MacNeish, R.S. Peabody Foundation for Archaeology. He also continued to teach a course at the University of Calgary.

D.A. St-Onge: completed his period of leave during which he was a titular professor in the Department of Geography, University of Ottawa, and returned to full time employment.

J.M. Shearer: joined the staff of the Division from the Bedford Institute, in September.

R.G. Skinner: joined the staff of the Division, after completing his residence requirements at the University of Washington, in December.

Attendance at Courses

O.L. Hughes: Oral French, University of Calgary.

Attendance at Meetings, Talks

D.M. Barnett: attended the annual meeting of the Canadian Association of Geographers (Southern Ontario Division) in Guelph in January.

R.J. Fulton: attended the Rocky Mountain Section of the Friends of the Pleistocene Field Conference in Flagstaff, Arizona in October and presented a paper "Radiocarbon dates and Quaternary history of southern British Columbia" at a conference of the Archaeological Association of the University of Calgary in December.

N.R. Gadd: attended the New England Intercollegiate Geological Conference at Rangeley, Maine in October.

E.P. Henderson: attended the Eastern Friends of the Pleistocene Field Conference at Mount Washington, New Hampshire in May.

O.L. Hughes: attended the Fraser Delta field trip organized by the Department of Geology, University of British Columbia in May, and the Second International Symposium on Arctic Geology in San Francisco in February.

R.W. Klassen: presented a paper "Nature and stratigraphy of the drift of southwestern Manitoba" at the Annual Meeting of the Geological Association of Canada in Winnipeg in August.

C.F.M. Lewis: attended the 13th Conference on Great Lakes Research in Buffalo in April, co-chaired a session of the Symposium on Great Lakes Geology at the Annual Meeting of the Geological Society of America Conference in Milwaukee in November and co-authored a paper "Distribution of Lake Ontario surface sediments and their interrelationships" presented at the Symposium.

V.N. Rampton: attended a meeting of the American Quaternary Association (AMQUA) at Bozeman, Montana in September.

S.H. Richard: attended the Eastern Friends of the Pleistocene Field Conference at Mount Washington, New Hampshire in May.

N.W. Rutter: chaired a session at the conference on "Aboriginal man and environments in the plateau of northwest America" in Calgary during November, gave a talk on the glaciation of northeast British Columbia at the University of Alberta in March, and a talk at a seminar at the University of Calgary on "The approach to reconstruction of late Quaternary climates in the central Peruvian Andes".

D.A. St-Onge: was a guest of the Czechoslovakian Academy of Science at a meeting of the Commission on Geomorphological Survey and Mapping of the International Geographical Union in June, and presented a paper "Sequence of glacial lakes in north-central Alberta" at the annual meeting of the Association Canadienne-Française pour l'Avancement des Sciences"at Quebec in October.

J.M. Shearer: with C.J. Yorath presented a paper "Preliminary interpretation of bottom samples, side scan sonar and shallow seismic records from the Beaufort Sea - 1970", co-authored also by C.J. Havard and B.R. Pelletier, to the Alberta Society of Petroleum Geologists and to the Edmonton Geological Society in November.

A.M. Stalker: attended a meeting of the American Quaternary Association (AMQUA) at Bozeman, Montana in September.

Membership on Committees

N.W. Rutter
- Co-chairman, Field Trip Committee and member, Programme Committee, Rocky Mountain Section, Geological Society of America, Calgary meeting, 1971
- G.S.C. Library Committee, Calgary.

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

Barnett, D.M.
1970: An amendment and extension of tide gauge data analysis for Churchill, Manitoba; Can. J. Earth Sci., vol. 7, No. 2, Pt. 2, pp. 626-627.

1970: Generator Lake, Baffin Island, N.W.T. and Tasiujaq Cove, Ekalugad Fiord, Baffin Island, N.W.T. 1968; Can. Oceanographic Data Centre: Oceanographic Data Record Series No. 1; 62 pp.

Churcher, C.S., and Stalker, A.M.
1970: A late postglacial horse from Pashley, Alberta; Can. J. Earth Sci., vol. 7, No. 3, pp. 1020-1026.

Grant, D.R.
1970: Recent coastal submergence of the Maritime Provinces, Canada; Can. J. Earth Sci., vol. 7, No. 2, Pt. 2, pp. 676-689.

Hughes, O.L.
1970: Incidental observations on Quaternary crustal movements, central Yukon Territory; Can. J. Earth Sci., vol. 7, No. 2, Pt. 2, p. 569.

Lewis, C.F.M.
1969: Late Quaternary history of lake levels in the Huron and Erie basins; 12th Conf. Great Lakes Res., Proc., pp. 250-270.

1970: Recent uplift of Manitoulin Island, Ontario; Can. J. Earth Sci., vol. 7, No. 2, Pt. 2, pp. 665-675.

Løken, O.H., and Hodgson, D.A.
1971: On the submarine geomorphology along the east coast of Baffin Island; Can. J. Earth Sci., vol. 8, No. 2, pp. 185-195.

Rampton, V.N.
1970: Neoglacial fluctuations of the Natazhat and Klutlan Glaciers, Yukon Territory, Canada; Can. J. Earth Sci., vol. 7, No. 5, pp. 1236-1263.

1970: Late Quaternary vegetation changes in the western Yukon Territory, Canada: Their relationship to the regional late Wisconsin glacial history; Abstr. Am. Quat. Assoc., 1st Meeting, p. 109.

Stalker, A.M.
1970: Late Wisconsin glaciation, and the Yukon-Alberta ice-free corridor; Abstr. Am. Quat. Assoc., 1st Meeting, p. 126.

Thomas, R.L., Kemp, A.L.W., and Lewis, C.F.M.
1970: The distribution and characteristics of Lake Ontario surface sediments; Geol. Soc. Am., Abstr. with Program, vol. 2, No. 7, p. 703.

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.
	700028	Quaternary reconnaissance, Devon Island.
B.G. Craig	630006	Quaternary reconnaissance, northwest Baffin Island.
	670032	Quaternary geology, Hudson Bay Lowland.
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.
	680032	Quaternary reconnaissance, northwest District of Mackenzie.
	690043	Quaternary geology inventory, southern Labrador.
	700033	Quaternary geology of the southern Canadian Cordillera, I.G.C. field excursion A 02, C 02.
J.G. Fyles	640004	Quaternary reconnaissance, western Arctic Islands.

N.R. Gadd	560019	Quaternary geology, Ottawa map-area.
	620039	Quaternary geology, Chaudière River region, Quebec.
	670037	Quaternary geology, southwest New Brunswick.
	700075	Quaternary geology and geomorphology in southern Quebec - I.G.C. field excursion A 44, C 44.
D.R. Grant	690065	Quaternary geology St. Anthony - Blanc Sablon, Newfoundland.
	700056	Surficial geology, southern Cape Breton Island.
J.E. Harrison	680067	Quaternary geology, North Bay-Mattawa.
J.A. Heginbottom	680129	Quaternary geology, Taseko Lakes.
E.P. Henderson	560029	Quaternary geology, Avalon Peninsula, Newfoundland.
	600033	Postglacial marine shorelines, Trinity Bay to White Bay, Newfoundland.
	680062	Quaternary geology, Kingston N½.
	700093	Pleistocene geology, Lake Ontario Basin.
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.
	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.
	700058	Quaternary stratigraphy, South Saskatchewan Valley in southwest Saskatchewan.
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	660035	Quaternary geology, Sherbrooke.
G.V. Minning	690055	Quaternary geology, Arnprior.
V.K. Prest	510022	Quaternary geology, Montreal Island.
	530030	Geology of Prince Edward Island.
	680004	Quaternary paleogeographic map of Canada.
	680094	Quaternary map, Stephenville.
	700077	Quaternary geology, geomorphology and hydrogeology of the Maritime Provinces - I.G.C. field excursion A 61, C 61.
	700081	Geology of proposed Kouchibouguac National Park site, New Brunswick.
V.N. 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.
	700036	International Geographical Union, 1972 Field Syposium, Commission of Geomorphological Survey and Mapping.
J.M. Shearer	700092	Surficial geology and geomorphology, Mackenzie Bay-Continental Shelf.
R.G. Skinner	690045	Glacial-interglacial stratigraphy, James Bay Lowland.
A.M. Stalker	520024	Surficial geology, Drumheller area.
	640027	Surficial geology, Kananaskis Lakes.
	650027	Quaternary of southern Alberta.

ENGINEERING GEOLOGY AND GEODYNAMICS SECTION

J.S. Scott (Head)

This section is responsible for the activities of the Division concerned with the engineering characteristics and behaviour of geological materials, the study of dynamic landscape processes (including slope movement, erosion, weathering and permafrost phenomena), the development of methods of geological investigation and data presentation for urban growth areas, experimental studies in fluvial sedimentology and the development of mineral prospecting techniques using glacial "drift" as a prospecting medium. These activities are complemented by surface resistivity, various borehole geophysical techniques and sidewall sampling mehtods under the direction of J.E. Wyder who serves to co-ordinate the geophysical requirements of the Division. During the year the geophysical equipment and maintenance facility formerly located at I.S.P.G. in Calgary were transferred to Ottawa.

The Section is also responsible for the operations of the sedimentological laboratories of the Division in Ottawa and Calgary, the hydraulic flume laboratory in Ottawa and for the development of an engineering geology laboratory in conjunction with the sedimentological laboratory in Ottawa.

In addition to carrying out projects within the objectives of the Division the Section responded to requests for geological assistance from the Department of Indian Affairs and Northern Development relating to the formulation of land use regulations for northern territories and to a request by the Department of Regional Economic Expansion for a proposal for a geoscience study in the area of the New Montreal International Airport.

Personnel Notes

R.A. Achard: resigned from the Geological Survey at the end of August to return to Switzerland for employment in the field of civil and military aviation.

J.A. Code: joined the Section at the beginning of June as an engineering geologist.

R.M.F. Isaacs: joined the Section in October as a specialist in soil mechanics.

D.E. Lawrence: following a six month period in industry returned to the Geological Survey in the capacity of supervisor of the laboratory operations of the Division and as an engineering geologist.

J.E. Wyder: transferred from Calgary to Ottawa in August.

Flume Laboratory

B.C. McDonald

In 1968 the Geological Survey of Canada decided to proceed with plans and specifications for a flume facility that would be of sufficiently flexible design that a wide variety of sedimentary environments could be studied experimentally. Consequently, a recirculating tiltable sedimentation flume was designed that, while primarily suited to studies of fluvial processes, can be adapted easily to studies of lacustrine and certain beach phenomena.

Initial requirements, specifications, and designs were drawn up by Dr. I. Banerjee and Dr. B.C. McDonald. Final designs and specifications were drawn up by Dr. B.C. McDonald and F.H. Siemonsen, P. Eng.; the latter supervised construction and installation. Construction of the flume at 299 Carling Avenue, Ottawa, commenced in March, 1970, and was completed in November, 1970. The apparatus is available to any G.S.C. staff member for experimental study of particular sedimentary structures or processes.

The glass-walled main channel is approximately 18 metres long, 0.75 metres wide, and 0.6 metres deep. Discharge, slope, depth, and sediment characteristics are variables that can be controlled. A series of experimental runs is underway to study equilibrium bed forms in a natural glaciofluvial sand, and experiments to study influence of sedimentation rate on the characteristics of sedimentary structures are planned.

Engineering - Sedimentology Laboratories

Analysis and tests are undertaken in three laboratories. The Spencer Street facilities are the most extensive and the majority of routine testing is carried out there. In Calgary a similar facility exists on a smaller scale to serve members of the Division stationed there. The Booth Street facilities are mainly used for non routine jobs or those requiring close supervision. In this capacity the laboratory has been used extensively by W.W. Shilts (Project 700014). Technique development is also undertaken at Booth Street.

Considerable effort has been directed to development of mobile laboratory capability two of which will be in during the 1971 field season. The purpose of these field units is to supply mainly engineering-geology data by means of classification tests, or other tests which may be easily carried out under field conditions. It has been necessary to modify some of the standard procedures to adapt them for field use.

The rapid sediment analyzer has been installed in Room 630 where modifications were undertaken to eliminate some of its instrumental problems. The instrument now supplies analyses on a routine basis for material in the 50 micron to 4 mm size range. Samples as small as 1 gram may be processed.

Reports of material processed at Spencer Street and Calgary laboratories are included below.

Sedimentology Laboratory Report

(45 Spencer Street)

R.G. Kelly

Grain size Analyses, Sieve Only	89
Grain size Analyses, Complete Sieve & Pipette	530
Moisture Content, Moisture Balance	530
Sample Pre-treatments (H_2O_2 & HCL) (NaOH)	6
Calcite - Dolomite Ratios	397
Atterberg Limits	49
Heavy Mineral Separations	147
Freeze Drying for Atterberg Limits	46
Freeze Drying for Grain size	74

Other

Recalculation of Previous Results for Comparison with Present Procedure	37
Munsell Colour Code	95
Material Less than 2 microns retreived from grain size Analyses	95

Calgary Laboratory

A. Vilonyay

Routine procedures continued to be the most important activity in our laboratory. In addition to this, research work has been added. Some 65 soil samples from the Yukon Territory have been analyzed in co-operation with the geochemistry and X-ray laboratories. This proved to be a time-consuming process since the interpretation of the results obtained from our collaboration defined the consecutive procedures to be carried out by us. We also constructed 8 micromonoliths of the soil profiles of these samples.

As time allowed, we have been working on the automated calcite-dolomite analyzer, and at one point we reached the calibration stage but urgent routine work interrupted our effort.

At the request of the Organic Geochemistry Section we fractionated a 22 kg surface sample to the full range of sizes from pebble size down to three fractions of washed and sedimented clays. We also provided assistance and space for 6 more similar fractionations by the Organic Section's own staff.

The conversion from hydrometer to pipette analysis is in progress.

The breakdown of procedures:

Calcite-dolomite analysis	409
Particle size analysis, sieve	68
Particle size analysis, hydrometer	68
Heavy mineral separation, gravity	435
Heavy mineral separation, centrifuge	120
Ostracode separations	120
Soil monolith constructions	8
Total number of procedures	1,228

Attendance at Courses

J.G. Bisson: Electronics Fundamentals, Algonquin College.

J.A. Code: Soil Mechanics, Carleton University; Problems of the Permafrost, American Geological Institute Short Course, Milwaukee.

J.A. Heginbottom: Experimental Geomorphology, Carleton University.

B.C. McDonald: River Mechanics Institute, Colorado State University; Hydraulics of Open Channels, University of Ottawa.

J.S. Scott: Management Development Program of the Public Service Commission, Carleton Place.

Attendance at Meetings, Talks

R.A. Achard: attended the Eastern Friends of the Pleistocene Field Conference at Mount Washington, New Hampshire in May.

J.A. Code: attended the seminar on Construction Problems in Permafrost sponsored in Saskatoon, by the Associate Committee on Geotechnical Research in March.

J.A. Heginbottom: attended the 64th annual meeting of the Canadian Institute of Surveying in Ottawa in February.

R.M.F. Isaacs: attended the 23rd Annual Canadian Geotechnical Conference held in Banff in November and in February he attended the Second International Symposium on Arctic Geology held in San Francisco.

B.C. McDonald: attended the Fraser Delta field trip organized by the Department of Geology, University of British Columbia in May, and gave a seminar "Field measurement and interpretation of sedimentary structures" at the University of Ottawa in January.

J.S. Scott: attended the International Congress of the International Association of Engineering Geologists in Paris in September, the Symposium for Open Pit Mining in Vancouver in November and was speaker for the theme Structural Mapping and the Prediction of Engineering Properties in Rock Masses of the Canadian Symposium on Rock Mechanics held in Edmonton in March. In February he presented a talk on "Engineering geological aspects of the Bearpaw Formation" to geology students at McGill University and in March he presented a public lecture entitled "Engineering geology and urban environment" at Carleton University.

W.W. Shilts: attended the Eastern Friends of the Pleistocene Field Conference at Mount Washington, New Hampshire in May, the New England Intercollegiate Geological Conference at Rangeley, Maine in October and presented a paper entitled "Till studies and their application to regional drift prospecting" at the Prospectors and Developers Association annual convention held in Toronto in March.

Membership on Committees

J.S. Scott
- Co-convenor, Section XIII, International Geological Congress
- Member, Advisory Panel to the Tunnelling Office of Canada
- Member, Pipeline Environmental Subcommittee.

Outside Papers

McDonald, B.C., and Shilts, W.W.
1971: Quaternary events and stratigraphy, southeastern Quebec; Bull. Geol. Soc. Am., vol. 82, No. 3, pp. 683-698.

Active Projects

J.A. Code	700079	Oil pollution investigations, Deception Bay.
P.P. David	670035	Sand dunes and sand movement.
J.A. Heginbottom	690054	Erosion in a permafrost environment.
R.M. Isaacs	700094	Engineering geology, Mackenzie Valley Transportation Corridor.
J.R. Mackay	680047	Geomorphic processes, Mackenzie Valley-Arctic coast.
B.C. McDonald	660030	Sedimentology and morphology of eskers.
	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	700049	Environmental geology of prototype study - Ottawa-Hull region.
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. (Head)

This unit comprises Quaternary Paleoecology and Radiocarbon Laboratory. It provides analyses of fossil materials (especially pollen, mosses, wood and diatoms) and radiocarbon dates as a service to other units and individuals; a particular effort is made to identify all materials dated by the radiocarbon laboratory. 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 the distribution of plants and marine invertebrates during the Quaternary is being conducted. A program of dendrochronological investigations, both applied and in the development of techniques, has been supported and is being continued elsewhere in co-operation with the G.S.C.

Field work by three members of the Section was undertaken in four provinces and in the Districts of Mackenzie and Keewatin, Northwest Territories.

Personnel Notes

M.L. Parker: employed since October 1967 on a term basis to carry out dendrochronolgical investigations, left in July 1970 to take up a new position with the Department of Forestry, University of British Columbia.

Dr. S. Federovich: previously employed as a palynologist in the Palynology Laboratory on a term basis, became a permanent staff member in February 1971.

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 palynological laboratory work in support of field projects by O.L. Hughes, D.A. St-Onge, R.G. Skinner, and W. Blake, Jr.; also, a start was made on analyzing selected samples for diatoms. M. Kuc made 53 bryological reports, which included data on vascular plants and other organic remains as well as on mosses. During the year R.J. Mott produced 37 reports on wood identifications of 65 samples; he also carried out palynological laboratory work in support of field projects by D.R. Grant, N.R. Gadd, E.B. Owen, V.K. Prest, J.M. Shearer, W.W. Shilts, and A.M. Stalker.

Radiocarbon Dating

Laboratory: After six unsuccessful attempts to construct a 1-Litre (1-L) counter with an acceptable low background, one was finally fabricated and put into operation in June, 1970. The laboratory (under the supervision of J.A. Lowdon) now has at its disposal three proportional counters, any two of which may be used at the same time. The 1-L counter was operated for five months; the 2-L for eight months; and the 5-L for eleven months. The counter background levels remained constant throughout the year. In addition to the continuing program of monitoring atmospheric fluctuations of radiocarbon at Ottawa, another research project involves testing the validity of dates obtained from bone apatite as opposed to bone collagen.

Program: Samples for age determination in the Radiocarbon Dating Laboratory were selected by an informal committee, headed by W. Blake, Jr., in consultation with J.A. Lowdon and 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 224 age determinations were carried out on 198 samples: of these 172 were on geological samples, 14 were on samples from archeological sites (mostly submitted by the National Museum of Canada), and in addition 12 analyses were carried out on geochemical samples. Also, six samples were converted to gas but insufficient CO_2 was produced for counting purposes. One hundred and twenty-three samples of CO_2 gas were submitted for C^{13}/C^{12} determinations in order to determine the possible effects of carbon isotope fractionation in various materials; i.e. wood, charcoal, peat, gyttja, soil, bone, and shell. These analyses were carried out by the 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 X, which includes 26 determinations on archeological samples, has been published; date list XI, which includes 247 determinations on 238 geological samples, has been submitted.

Attendance at Courses

L. Wilson: General geology, University of Ottawa.

Attendance at Meetings, Talks

W. Blake, Jr.: attended the annual meeting of the Geological Society of America in Milwaukee in November, and while there substituted for B.G. Craig at a meeting of the INQUA Subcommittee for Pleistocene Shorelines of the Americas; he also attended the 2nd International Symposium on Arctic Geology in San Francisco in February, and the Earth Sciences Symposium on Offshore Eastern Canada in March; lectured at the Department of Geography, McMaster University in February on the "Glacial History of Arctic Canada" (continuing a series begun in March 1970 at the Department of Geology, University of Calgary) and conducted a seminar on "Radiocarbon Dating"; and in March acted as one member of the jury judging a doctoral seminar on "La methode de datation au radiocarbone et son application en morphologie quantitative" presented by M. Kugler at the Department of Geography, University of Ottawa.

S. Federovich: attended the annual convention of the American Association of Stratigraphic Palynologists in Toronto in October.

M. Kuc: lectured at the Department of Biology, Queen's University, on the "Interglacial Flora of Banks Island" in April, and together with the late R.E. Beschel conducted a seminar at the same department in November on the "Ecology and Mapping of Tundra Vegetation".

R.J. Mott: attended the annual convention of the American Association of Stratigraphic Palynologists in Toronto in October.

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.
1970: Studies of glacial history in Arctic Canada. I. Pumice, radiocarbon dates, and differential postglacial uplift in the eastern Queen Elizabeth Islands; Can. J. Earth Sci., vol. 7, No. 2, Pt. 2, pp. 634-664.

Kuc, M.
1968-69: Additions to the Arctic Moss Flora-I; Revue Bryologique et Lichénologique (Paris, France), vol. 36, No. 3-4, pp. 635-642.

1968-69: Additions to the Arctic Moss Flora-II. Bryophytes and lichens of Good Friday Bay (Axel Heiberg Island, N.W.T.-Canada); Revue Bryologique et Lichénologique, vol. 36, No. 3-4, pp. 643-653.

1970: Vascular plants from some localities in the western and northern parts of the Canadian Arctic Archipelago; Can. J. Botany, vol. 48, No. 11, pp. 1931-1938.

1970: Additions to the Arctic Moss Flora-III. Mosses of Meighen Island (Canada); Revue Bryologique et Lichénologique, vol. 37, No. 2.

Lichti-Federovich, S.
1970: The pollen stratigraphy of a dated section of Late Pleistocene lake sediment from central Alberta; Can. J. Earth Sci., vol. 7, No. 3, pp. 938-945.

Lowdon, J.A.
1970: Carbon-isotope fractionation during dry combustion of oxalic acid; Radiocarbon, vol. 12, No. 2, pp. 347-349.

Lowdon, J.A., Wilmeth, R., and Blake, W., Jr.
1970: Geological Survey of Canada radiocarbon dates X; Radiocarbon, vol. 12, No. 2, pp. 472-485.

Active Projects

W. Blake, Jr.	570148	Radiocarbon laboratory program.
	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.

National Advisory Committee on Research in the Geological Sciences

J. F. Henderson, Secretary

No formal meetings of the National Advisory Committee were held during 1970-71 while awaiting the final report of the Solid Earth Sciences Committee survey. The fourth Canadian Symposium on Research in Tectonics, held at the University of Alberta, Edmonton, March, 1971, for the first time in conjunction with the seventh Canadian Symposium on Rock Mechanics, was organized on behalf of the Structural Geology Subcommittee of the National Advisory Committee by K. Barron, H. Bielenstein and H. K. Charlesworth; the general theme was Applications of Structural Geology to Rock Mechanics Problems. The Subcommittee on Mineral Deposits, H. K. Conn, Chairman, commenced a survey of special facilities available for research in the various Canadian Earth Science University Departments, and the needs of and possible contributions available from industry towards research in the Earth Sciences.

The annual compilation of current research projects in the geological sciences in Canada for 1969-70 was published in February, 1971 (Geol. Surv. Can. Paper 70-5 1970). It records information on current research by the universities, federal and provincial department of mines and research councils.

Thomas E. Bolton assumed secretarial duties on February 1, 1971.

Research Grants to Universities

In 1970-71 the Geological Survey of Canada on the advice of the National Advisory Committee awarded a total of $228,000. general (undirected) grants-in-aid of geological research in Canadian universities - an increase of a little over $2,700. over the previous year. An additional $50,000. was provided for special grants for research in the development of computer processable files of geologic data, as recommended by the National Advisory Committee.

The National Research Council of Canada awards grant-in-aid of geological research on a much more substantial scale. In 1970-71, National Research Council grants to our universities for research in the geological sciences (including geophysical projects applied to solution of geological problems) totalled $2,300,000.

SECRETARIAL SERVICES

Mrs. B. Richard

Summary of work executed by the Secretarial Services Section for the year 1970/1971.

Letters from stenorette	197	
Letters from manuscript	3,151	
Letters (French)	125	
Pages of reports from stenorette	325	
Pages of reports from manuscript	10,217	
Pages of reports (French)	167	
Pages of Preliminary reports	8,952	
Pages of Preliminary reports (French)	48	
Publication lists	361	
Tabulated pages	1,040	
Envelopes and labels	2,932	
Cards and forms	10,162	
Total of carbon copies produced	10,839	
Secretarial relief supplied – days	236	
Daily average number of operators in pool	8.34)	= 9.27
Daily average of personnel on secretarial relief duties	.93)	
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 1/2" 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 previous years; there has been a continued demand for typing in French.

For six months we hired 3 casual typists and rented 3 IBM Executive typewriters to cover the increased Preliminary Report typing.

Instrumental Development Shop

Summary of Activities for 1970-71

During the past year, services requested have once again greatly exceded the potential available in the shop and the rate of demand is expected to continue to grwo during the coming year.

A number of jobs totaling over 1600 man-hours have been given to commercial enterprises, with the hope of eliminating the back log accumulated during the course of the past year.

Aquisition of new equipment such as a High Speed powered hacksaw and a Hardness tester have also contributed in the efforts toward better services. Services in general have been very good considering a reduction over last year in the total man-hour available against an increase in services requested.

Distribution

Maximum man-hours available 6450

Crustal Geology	67%
Exploration Geophysics	18%
Others	15%

Estimated man-hours sent to industries 1650

Estimated man-hours in back log 1800

G.A. Meilleur

APPENDIX I

STAFF LIST

Geological Survey of Canada

(as supplied by reporting units; August 1, 1971)

DIRECTOR'S OFFICE

Fortier, Y.O., Director
De Laet, Mrs. G., Secretary
Lord, C.S., Chief Geologist
Derry, Miss G.E.
Wright, G.M.
Hall, E.

Special Projects

Douglas, R.J.W.

Secretary Natl. Adv. Comm.

Bolton, T.E.

Canadian Centre for Geoscience Data

Burk, C.F.
McGee, B.A.

Intl. Geol. Congress

Armstrong, J.E.
Stevenson, I.

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.

Purchasing and Supplies

Bowes, G.R.
Meehan, Miss C.L.
Charlebois, G.J.
Moreau, V.
Smith, D.D.
Davidson, D.D.
Salter, I.

Equipment Office

Rozon, R.

Branch Registry

Robillard, R.D.
Begin, Mrs. G.M.
Casey, A.J.
Belanger, Miss M.
Ganim, T.

Secretarial Services

Richard, Mrs. B.G.
Cantin, Mrs. L.S.
Evans, Mrs. B.
Hodges, Miss D.A.
Nellis, Miss L.
Murphy, Miss M.
Lauzier, Miss P.K.
McMillan, Miss J.M.
Brownlee, Miss E.

Instrumental Development Shop

Meilleur, G.A.
Cregheur, A.Y.
Fournier, J.P.

CRUSTAL GEOLOGY DIVISION

Wheeler, J.O., Chief
Duffell, S., Assist. Chief
Gougeon, Mrs. C.L., Secretary
Arnold, J.G. Admin.

Special Projects

Eisbacher, G.H.

Eastern Petroleum Geology Section

Sanford, B.V.
Howie, R.D.
Barss, M.S.
Janza, A.
Williams, A.
Ter Haar Romeny, W.U.
Seguin, A.

Precambrian Shield

Frarey, M.J.
Baer, A.J.
Baragar, W.R.A.
Bell, C.K.
Bostock, H.H.
Davison, W.L.
Davidson, A.
Eade, K.E.
Ermanovics. I.F.
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.
Ridler, R.
Taylor, F.C.
Tremblay, L.P.

Appalachian Eastern Lowlands and Atlantic Margin

Poole, W.H.
Anderson, F.D.
Benson, D.G.
Cumming, L.M.
Helmstaedt, H.
Skinner, R.

Petrology

Reesor, J.E.
Beaulne, M.
Currie, K.L.
Demers, A.Y.
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.

Paleomagnetic Section

Fahrig, W.F.
Schwartz, E.J.
Foster, J.
Christie, K.W.
Freda, G.N.

Cordillera and Pacific Margin

Gabrielse, H.
Blusson, S.L.
Cameron, B.E.B.
Campbell, R.B.
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.
Tiffin, D.L.

Eastern Paleontology

Dean, W.T.
Botte, B.J.
Callahan, J.J.
Camfield, Mrs. M.
Copeland, M.J.
Jarvis, D.C.
McGregor, D.C.
Murphy, Mrs. F.M.
Nash, D.K.

ECONOMIC GEOLOGY AND GEOCHEMISTRY DIVISION

Robinson, S.C., Chief
Gorman, Mrs. M., Secretary
Maxwell, J.A., Asst. Chief
Jones, F.W.
Lapp, J.H., Admin. Officer

Geochemistry

Cameron, E.M.
Dyck, W.
Bristow, Q.
Garrett, R.G.
Allen, R.J.
Lynch, J.J.

Geochemistry (Cont'd)

Hornbrook, E.H.W.
Jonasson, I.R.
Hobbs, J.D.
Durham, C.C.
Horton, R.E.
Gauthier, G.
Pelchat, J.C.
Gaumont, G.
Lavergne, P.J.

Mineralogy

Traill, R.J.
Rimsaite, Miss J.
Lachance, G.R.
Jambor, J.L.
Steacy, H.R.
Delabio, R.N.
Plant, A.G.
Stenson, Mrs. A.P.
Bonardi, M.
Gravel, J.

Mineral Separation Lab

Paris, J.C.
Machin, B.D.
Charbonneau, R.
Brown, A.G.
Huot, J.M.R.

Mineral & Rock Sets

Larose, J.M.
Turpin, J.
Racine, T.H.

Mineral Deposits

Rose, E.R.
Gross, G.A.
Kindle, E.D.
Leech, G.B.
Kirkham, R.V.
Mulligan, R.
Sangster, D.F.

Mineral Deposits (Cont'd)

Eckstrand, O.R.
Thorpe, R.I.
Whitmore, D.R.E.
McLeod, C.R.
Edmond, Mrs. K.
Johnston, A.G.
Burke, R.D.
Burns, Miss E.M.

Analytical Chemistry

Abbey, S.

Chemical Lab

Courville, S.
Sen Gupta, J.G.
Bouvier, J.L.
Seymour, Miss L.J.
Belanger, Mrs. G.C.
Watson, Mrs. F.J.
Grushman, Mrs. V.
Vickers, G.

Spectrographic Lab

Champ, W.H.
Bander, G.
Church, K.A.
Brown, D.A.
Crook, Mrs. J.W.

ADMINISTRATION (Spec. Proj.)

Boyle, R.W.
Dawson, K.R.

Geomathematics Program

Agterberg, F.P.
Kelly, A.M.
Crain, I.K.
Lepinis, Y.J.

Uranium Program

Little, H.W.
Boyer, A.

EXPLORATION GEOPHYSICS DIVISION

Darnley, A.G., Chief
Goodman, Mrs. N.D., Secretary
Artichuk, G.
McDowell, Mrs. J.K.

Special Projects

Bhattacharyya, B.K.

Electrical Methods

Collett, L.S.
Ahrens, R.H.
Becker, A.
Katsube, T.J.
Scott, W.J.
Sinha, A.K.
Butterfield, D.C.
Dyck, A.V.
Frechette, J.P.
Gauvreau, C.
McAllister, M.E.
Stauffer, W.J.

Magnetic Methods

Hood, P.J.
Bower, Miss M.E.
Kornik, L.J.
McGrath, P.H.
Washkurak, S.

Remote Sensing Methods

Richardson, K.A.
Charbonneau, B.W.
Grasty, R.L.
Gross, H. (Inland Waters)
Parker, J.
Slaney, V.R.

Data Reduction

Holroyd, M.
Abbinett, D.D.
Dods, S.D.
Langlois, R.J.
Zieman, F.W.

Seismic Methods

Hobson, G.D.
Burns, R.A.
Gagne, R.M.
Hunter, J.A.M.
MacAulay, H.A.
Overton, A.

Contract Surveys

Larochelle, A.
Ready, E.E.
Chretien, Miss M.B.
Derouin, E.J.
Haley, E.L.
Reveler, D.

Aircraft Operations

Holman, P.B.
Owens, K.H.

Instrument Development

Sawatzky, P.
Dicaire, A.
Flint, T.R.
Knapp, H.W.C.

GEOLOGICAL INFORMATION PROCESSING DIVISION

Harker, P., Chief
Blackadar, R.G.
Mahoney, Mrs. L.R.
St. Pierre, L.P.

Publications and Information

Touchette, J.L.
Clarke, C.R.
Drapeau, Mrs. G.M.
Letang, E.G.
Murphy, B.P.
Rail, E.J.
Marriner, Miss L.

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.
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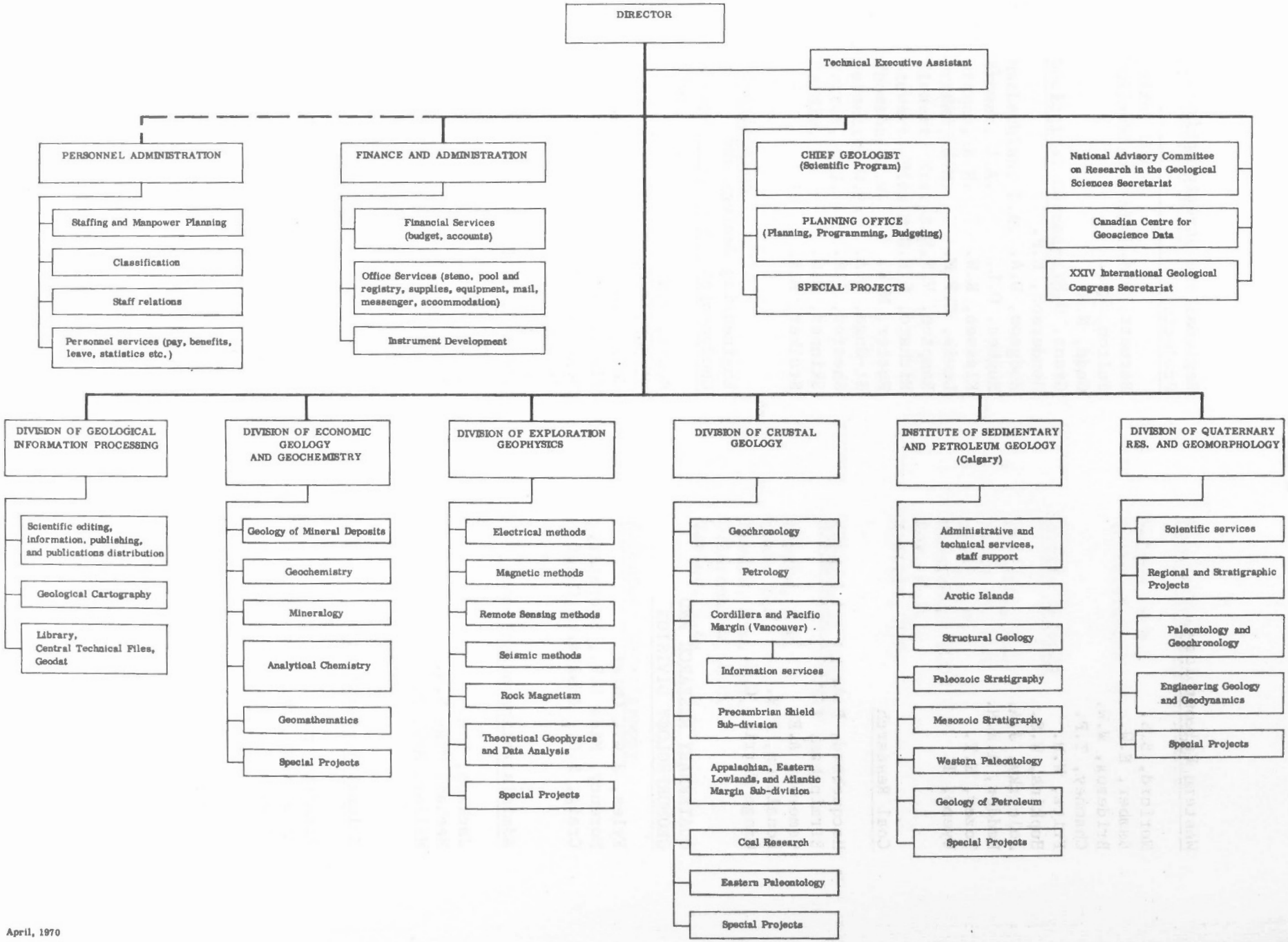

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