MC82
.8C21an
1962
RES
Room 353
JUL 26 1963

CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT

CALENDAR YEAR 1962

FOR GEOLOGICAL SURVEY USE ONLY

This document was produced
by scanning the original publication.

Ce document est le produit d'une
numérisation par balayage
de la publication originale.

OTTAWA
1963

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

ANNUAL REPORT - CALENDAR YEAR 1962

Note - The enclosed data are those submitted for the 1962 Departmental Annual Report. They have been re-arranged somewhat for ready reference, but have not been carefully edited. They are intended only for Geological Survey office use and record.

---

2 April, 1963

CONTENTS

	Page
Introduction ..... by J.M. Harrison, Director ...	1
Regional Geology Division	8
Introduction ..... by L.J. Weeks	8
Reports on sections	9
Appalachian Section .... by E.R.W. Neale	9
Activities	9
Special talks	10
Personnel	11
Membership on committees	11
Outside publications	12
Eastern Shield Section .. by S. Duffell	12
Personnel and activities	12
Membership on committees	13
Outside publications	14
Western Shield Section.. by G.M. Wright	14
Activities and personnel	14
Membership on committees	15
Cordilleran Section..... by H.S. Bostock.....	16
Personnel	16
Membership on committees	17
Outside publications	18
Fuels and Stratigraphy Division	18
Introduction ..... by J.F. Caley	18
General	19
Personnel	20
Membership on committees	20
Senior research palaeontologist	21
Reports on sections and laboratories	21
Petroleum Geology Section .. by R.J.W. Douglas	21
Activities	22
Personnel	26
Membership on committees	26
Outside publications	27
Stratigraphic Palaeontology Section by D.J. McLaren	28
General	28
Type Collections	29
Field and office activities	30
Palaeontology preparation laboratory	35
Outside publications	36
Arctic Islands Section ...by R. Thorsteinsson	37
Activities	37
Outside publications	39

Page

Coal Research Section .. by P.A. Hacquebard 39
Coal petrography 39
Carboniferous palynology 44
Other activities and projects 48
Personnel 51
Membership on committees 51
Outside publications 51
Reports with outside circulation 52
Western Plains Office ... by R.T.D. Wickenden 52
General 52
Activities 54
Membership on committees 55

Economic Geology Division 56
Introduction ..... by Y.O. Fortier 56
Reports on sections 58
Geology of Mineral Deposits Section
by R. Mulligan 58
Activities 59
Meetings attended 62
Membership on committees 62
Outside publications 63
Geochemical Section .... by R.W. Boyle 63
Summary of field work 64
Laboratory and office work 66
Outside talks and attendance at meetings
and conferences 68
Membership on committees 69
Outside publications 70
Summary of work completed in geochemical
preparation laboratory .. by P. Lavergne 71
Summary of analyses completed.. by J. Lynch ... 72
Pleistocene Section .....by V.K. Prest..... 74
Activities 74
Membership on committees 76
Outside publications 77
Sedimentology laboratory report...by H.A. Lee . 77
Palynology laboratory report...by J. Terasmae . 80
Engineering and Groundwater Geology Section
by I.C. Brown 80
Personnel 81
Field and office activities 82
Membership on committees 85
Attendance at meetings 85
Outside publications 86

Page

Geophysics Division 86
Introduction ..... by L.W. Morley 86
Personnel 88
Reports on sections 90
Magnetic Surveys and Interpretation Section
by A.S. MacLaren 90
Aeromagnetic compilation 90
Federal-provincial aeromagnetic surveys 90
Interpretation 91
Seismic and Resistivity Surveys Section
by G.D. Hobson 91
Palaeomagnetism Section... by A. Larochelle 91
Electronic Instrumentation and Research Section
by L.S. Collett 92
Membership on committees 94
Outside publications 95

Petrological Sciences Division 95
Introduction ..... by S.C. Robinson 95
Personnel 98
Attendance at meetings 101
Reports on sections 103
Analytical Chemistry Section ... by J.A. Maxwell 103
Introduction 103
Statistics 103
Chemical 105
Spectrographic 106
Isotope and Nuclear Geology Section .. by R.K. Wanless 107
Introduction 107
Age determination program 109
Mass spectrometer development program 110
Radiocarbon dating laboratory 111
Statistics 111
Mineralogy Section ..... by R.J. Traill 112
Introduction 112
Activities 113
Petrology Section ..... by K.R. Dawson 121
Report on the Upper Mantle Project .. by C.H. Smith 124
Membership on committees 126
Outside publications 127

Marine Geology 129
Introduction ..... by B.R. Pelletier 129
Activities 131
Attendance at Conventions 132
Visits to other institutions and special talks 132
Membership on committees 133
Outside reports 133

Page

Special Projects 133
Report on activities ..... by C.H. Stockwell 133
Tectonic map of Canada 133
Membership on committees 134
Outside publications 134
Report on activities ..... by A.H. Lang 135
Membership on committees 135
Outside publication 135

British Columbia Office Report .....by J.E. Armstrong 136
General 136
Activities 137

Whitehorse Office Report ..... by L.H. Green 139

Yellowknife Office Report ..... by W.R.A. Baragar and E.H. Hornbrook 142

Geological Manuscripts Unit..... by H.M.A. Rice..... 143
Area of Canada mapped 145
Seasonal employees .....by E. Hall 146
Student program 146

Geological Cartography ..... by G.S. Daughtry 156
General 156
Personnel 156
Production data 156
Maps printed from Jan. 1, 1962 to Dec. 31, 1962 158

Administrative Services 166
Library ..... by Mrs. N.L. Kummermann ... 166
Publication Distribution Office .. by L. Touchette 168
Photographic Section ..... by E.C. Elliott 169
Stenographic Pool ..... by Mrs. M. Shanks ... 172
Lapidary Section ..... by H.W. Hay..... 173
Research and Development Shop . by A.G. Meilleur 173

Research Grants to Canadian Universities by J.F. Henderson 174

Comprehensive Study of a Canadian Ore Deposit by J.F. Henderson 175

Annual Report, National Advisory Committee on Research in the Geological Sciences ..... by J.F. Henderson 176
Post-Doctorate Fellows 176

Page

Appendix I Staff list 178

Appendix II Organizational chart.....

Appendix III Geological map coverage (bedrock, surficial, aeromagnetic, groundwater) ..... In pocket

ANNUAL REPORT - CALENDAR YEAR 1962

GEOLOGICAL SURVEY OF CANADA

INTRODUCTION

by

J.M. Harrison, Director

In 1962, the Geological Survey placed 94 parties in the field. Of these, 28 parties conducted systematic bedrock mapping, much of which was reconnaissance mapping of remote or little-known areas; 17 parties mapped surficial deposits or investigated groundwater and engineering geology problems; 16 parties examined mineral deposits and/or made mineralogical and petrological studies of granitic, basic, and ultrabasic rocks; 13 parties undertook stratigraphic and palaeontological investigations; 10 parties conducted geophysical studies; and 10 parties were active in geochemical, structural, marine geology, and other projects. The distribution of the parties is indicated by province on page 4.

Field work was completed (or nearly so) on 39 of the 94 field projects, covering more than 200,000 square miles. Three projects alone completed the reconnaissance bedrock and surficial geology mapping of approximately 175,000 square miles of Canada's northland. Several thousand square miles are under investigation in mapping projects not yet completed.

Parties used helicopters and/or fixed-wing aircraft for reconnaissance mapping in the Arctic Islands, Northwest Territories, Yukon, and British Columbia. Seven parties used helicopters on a full-time basis during the summer months; others used fixed-wing aircraft for periodic transportation within their field areas. Use of such aircraft for geological mapping during the past several years has greatly speeded up the date by which all of Canada will have been mapped systematically to a scale of 1 inch to 8 miles or better.

At the end of 1962 the Geological Survey had published geological maps on about 61 per cent of Canada, and had completed the preliminary field mapping of about another 10 per cent.

A gradual change in emphasis of the Geological Survey's field program from the geological mapping of specific geographic areas to investigations of geological problems in several or many areas, has been taking place in the past few years, and many staff geologists are now undertaking other types of geological investigations than systematic bedrock mapping. This change in emphasis is reflected in the Survey's publications, with the appearance of an increasing proportion of Bulletins (which deal with special studies) to Memoirs (which deal largely with areal studies). In 1962, just over one third of the Survey's geologists were on reconnaissance or detailed bedrock mapping projects, involving almost two-thirds of the money allotted to the Survey's field program.

Grants-in-aid by the Geological Survey of Canada to Canadian universities have been increased more than sevenfold since their initiation in 1951. In 1962 they amounted to $75,000, contributed to 16 universities in support of 28 new projects and 15 continuing studies. The grants are awarded on the advice of the National Advisory Committee on Research in the Geological Sciences, and are a valuable extension of the research undertaken by Survey officers in the field and laboratory.

By the end of 1962, most basic data required for the preparation of the Tectonic Map of Canada had been compiled. These should be assembled and readied for submission for publication by late 1963.

Completion of 198 potassium-argon age determinations from many parts of Canada during 1962 brought to 654 the number of such determinations completed by the Geological Survey since 1959. During 1962 efforts were made to broaden the activity in this field to embrace the measurement of the ratios of rubidium and strontium in whole rocks and minerals, and the lead, uranium, and thorium concentrations in zircons. Some 58 strontium-rubidium age determinations were made during 1962. Radiocarbon dating, which the Survey commenced early in 1961, provided 85 age determinations in 1962.

The International Upper Mantle Project is a program of studies initiated for a 3 year period (1962-64) to obtain and interpret geophysical and geological data on the upper mantle of the earth. The Geological Survey's contribution to this project during 1962 included planning for the drilling of several deep holes, geophysical surveys, and laboratory studies of ultrabasic rocks and minerals to provide quantitative data needed to fill gaps in our knowledge of 'mantle' material. Detailed surveys were made over the proposed drilling areas in the Muskox Intrusion in the Northwest

Territories, and at Mount Albert in the Gaspé region of Quebec. These combined detailed mapping and magnetometer surveys, and in places gravity surveys by the Dominion Observatory, to determine features that might affect the drilling. A seismic survey in the Mount Albert area determined the depths of overburden. Plans for 1963 call for two 5,000-foot drill holes in the Muskox Intrusion. Detailed petrographical and mineralogical studies of both Mount Albert and Muskox Intrusions continued during the year.

The $18,000,000 cooperative Federal-Provincial program, inaugurated in 1961, to complete within about twelve years an aeromagnetic survey of most of the Canadian Shield and adjacent areas, was in full swing in 1962. Six 4-year contracts were let, in Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and the Northwest Territories, totalling more than a million line-miles of survey. Of these, 404,700 line-miles were completed in 1962. This amounts to approximately 500 1-mile map-sheets, most of which will be published before the 1963 field season. The distribution of the six aeromagnetic surveys is shown on Geological Survey Map 34-1962 ("Geological Survey of Canada Field Parties, 1962").

DISTRIBUTION OF PARTIES BY AREA AND FUNCTION

Province or District	Bedrock Mapping	Surficial Mapping	Groundwater & Engineering	Geophysics	Geochemistry	Stratigraphy & Palaeontology	Structure	Marine Geology	Mineral Deposits, Mineralogy, Petrology	Other	Totals
Franklin	2							2			4
Keewatin	1							1			2
Mackenzie	5				1	1			1		8
Mackenzie & Yukon	1								1		2
Yukon									1		1
British Columbia	7	3		1		2			6		19
British Columbia & Alberta						1					1
Alberta		1				4					5
Saskatchewan			3								3
Saskatchewan & Manitoba			1	1					1		3
Manitoba	2	1	1								4
Ontario	2	2		1	1						6
Ontario & Quebec			1								1
Quebec		1		1		1			1		4
New Quebec & Labrador	1						1				2
New Brunswick	1		1		1						3
Nova Scotia	3							1			4
Prince Edward Island	1										1
Newfoundland (Island)	2			1							3
Miscellaneous			2	5	1	4			5	1	18
Totals	28	8	9	10	4	13	1	4	16	1	94

Committees

- President, International Union of Geological Sciences.
- Member, Executive Board, International Council of Scientific Unions.
- Member, Bureau, International Council of Scientific Unions.
- Vice-President for North America, Society of Economic Geologists.
- Councillor and Past-President, Member of Executive Committee, Geological Association of Canada.
- Councillor of Geological Society of America and Member of its Executive Committee, Budget Committee, and 75th Anniversary Committee.
- Chairman, National Advisory Committee on Research in Geological Sciences.
- Member, Screening Committee for Grants-in-Aid of Earth Sciences, National Research Council.
- Member, Associate Committee on Geodesy and Geophysics, N.R.C.
- Member, Associate Committee on Research in Natural Sciences, UNESCO.
- Member, Advisory Committee on Scientific Personnel in Civil Service.

Field Trips

- Vancouver and Calgary offices, March, 5 days.
- Yellowknife office, July, 2 days.
- Field Inspection, Helicopter Operations in Arctic, July ($2\frac{1}{2}$ weeks).
- Field Inspection, Kirkland Lake, August, (2 days) with Dr. B.V. Tkachenko, Director, Institute of Arctic Geology, USSR.

Meetings

- Society of Economic Geology, New York, February.
- Prospectors and Developers Assoc'n., Toronto, March.
- A.A.P.G., San Francisco, March.
- Intl. Assoc. Volcanology, Japan, May.
- Intl. Union Geological Sciences, Copenhagen, June.
- Commonwealth Scientific Office, London, June.
- International Council Scientific Unions, Prague, October.
- Geological Society America, and Soc. Ec. Geol., Houston, November.
- In addition, there were several executive committee meetings in Toronto, New York, and Ottawa.

Papers: "Frontiers in Geology", Presidential Address for Geol. Association Canada. (Although this paper was presented well before, it was published only after the "Frontiers" had been pre-empted by Mr. Kennedy).

Many of you may wonder what is the International Council of Scientific Unions (ICSU). It is the umbrella under which the major international scientific unions take shelter. It receives rather large sums of money from UNESCO, which it disburses to the unions according to specified rates, and to special committees or organizations according to the situation. Thus, the International Union of Geological Sciences, for example, will benefit by a few thousand dollars per year, and the Scientific Committee on Oceanographic Research (which includes representatives from several unions) submits an annual or biennial budget.

The General Assembly of ICSU meets every 3 years - the last meeting was in London in October, 1961 - and at these times determines the general field of activities to be supported by ICSU, and the general policies to be followed. Representatives from each union and from many national scientific academies or other scientific agency

attend. Each union and national academy represented pays an annual fee, even though the unions are granted sums much larger than the fee.

Between General Assemblies, the implementation of policy is carried out by the Bureau. It consists of the President, Past-President, two Vice-Presidents, two Members, the Secretary-General of ICSU, and the Treasurer of ICSU. All are elected by the General Assembly, except that a vacancy may be filled by co-opting a suitable individual. I was co-opted to fill the vacancy created by the death of Dr. E.W.R. Steacie. The Bureau meets at least twice a year - it will meet in Rome in March, 1963 - and must answer to the General Assembly for all its activities.

Once a year the Bureau meets with the Executive Board of ICSU, the Board being composed of representatives of the Unions only. The Executive Board is, to a large degree, advisory but it has certain actions delegated to it by the Assembly. It advises on scientific projects, but can approve the formation of inter-union committees. The Bureau is a unit that carries on the business of ICSU, with the advice of the Executive Board, and both are responsible to the Assembly.

The present composition of the Bureau is:-

President:	Prof. S. Horstadius (Sweden)
Past-President:	Sir Rudolph Peters (U.K.)
Vice-Presidents:	Professor W.A. Englehard (USSR)
	Professor S. Kaya (Japan)
Members:	Dr. R.F. Bacher (U.S.A.)
	Dr. J.M. Harrison (Canada)
Sec. General:	Prof. J. Van Mieghem (Belgium)
Treasurer:	Ing. Gen. Geo. Laclavere (France)

REGIONAL GEOLOGY DIVISION

L.J. Weeks, Chief

INTRODUCTION

The Regional Geology Division is responsible for geological mapping and basic research in the Appalachian, Cordilleran, and Canadian Shield physiographic provinces, or more simply - in those parts of Canada underlain by folded rocks, but excluding the Arctic Islands north and west of Baffin Island.

Active field projects totalled 97 at the close of this year, of which 15 were commenced in 1962. During the year 13 projects were completed, 4 were transferred to later projects, 5 were classed as inactive, 4 were abandoned and one, formerly abandoned, was re-activated.

The current procedure in regard to manuscript maps and reports is that they are submitted to Division where they are read critically, generally by the Section Head, or by an officer familiar with the region under consideration; then recommended for publication by the Division Chief; and finally forwarded to the Geological Manuscripts Unit. The following table summarizes these activities for 1962:

	On hand Jan. 1, 1962	Submitted by Authors 1962	Forwarded to Mss. Sec. 1962	On hand Dec. 31, 1962
Prelim. Maps	4	26	28	2
Papers	-	7	7	-
Bulletins	-	2	2	-
Memoirs	2	5	4	3
Final Maps	2	3	2	9*

*This discrepancy is caused because 6 final maps, previously submitted, were returned to Division for compilation on a smaller scale.

A staff of 37 permanent officers and 3 seasonal officers were employed during the field season as follows:

	Permanent Officers		Seasonal Officers
	No.	% staff	
Primary mapping	16	43.2%	-
Problem mapping	9	24.5%	3
Office duties & Inspection	12	32.4%	-

REPORTS ON SECTIONS

APPALACHIAN SECTION

E.R.W. Neale

The Appalachian section is responsible for primary mapping and geological research in the folded rocks of the Appalachian Region, which includes Newfoundland Island; the Provinces of Nova Scotia, New Brunswick, and Prince Edward Island; and that part of Quebec lying southeast of the Logan fault, an irregular line extending, in part, from the St. Lawrence River at Quebec to the U.S. border at Lake Champlain. Primary mapping in the three Maritime Provinces is now considered to be complete and all work to be carried on there is directly related to one or more research problems. Six field parties were operative in 1962, of which two were engaged in primary mapping and four in problem (or research) mapping.

Activities

In addition to the six field studies just mentioned, and described in Geological Survey Paper 63-1 (1963), members of the section engaged in the following activities.

Attendance at Field Trips, Meetings, etc.

Some or all of the Tectonic Seminars of the St. Lawrence Valley Universities, held at McGill in January, February, and March, and at Ottawa University in November, were attended by all members of the section.

The Annual Meetings of the Canadian Institute of Mining and Metallurgy and the Geological Association of Canada, held in Ottawa in April, were attended by all members of the section.

D.G. Benson, J.W. Gillis, and D.G. Kelley joined Prof. V. Walmsley (University of Wales), A. Boucot (Cal. Tech.), and W.S. McKerrow (Oxford) on a field study of the Silurian section at Arisaig, N.S. in August.

D.G. Kelley and L.J. Weeks attended the Annual Meeting of the Nova Scotia Mining Society and led a geological field excursion in northern Cape Breton.

D.G. Kelley, E.R.W. Neale, and R.R. Potter (seasonal), participated in a joint G.S.C. - U.S.G.S. field conference in N.E. Maine and S.E. New Brunswick, August 4-11 inclusive.

D.G. Kelley, E.R.W. Neale, E.A. Schiller (seasonal), and W.H. Poole participated in the 54th Annual Meeting of the New England Intercollegiate Geological Field Conference at Montreal, October 5-7 inclusive. They took part in a field study of the alkalic rocks of Oka, and a structural study across the Appalachian front in the Eastern Townships of Quebec.

H. Williams attended the Annual Field Meeting of the Newfoundland Branch, Canadian Institute of Mining and Metallurgy, at Tilt Cove in June. Following this, he participated in a study of Ordovician - Silurian relationships in Notre Dame Bay together with Prof. Marshall Kay (Columbia University).

Special Talks

The Appalachian Discussion Group during 1962 was addressed by A. Boucot (Cal. Tech.), W. Fyson (Ottawa), Marshal Kay (Columbia), D.M. Baird (Ottawa), P. Clifford (McMaster), C. Drake (Lamont Observatory), and E.R.W. Neale (2) and H. Williams of the section.

E.R.W. Neale presented a paper on "Possible Taconic Klippen in Western Newfoundland" to the Geology Department, Memorial University of Newfoundland, November 8, and a paper on "Geological Problems of the Baie Verte Peninsula, Newfoundland" to the Newfoundland Branch, Canadian Institute of Mining and Metallurgy, at their annual meeting in St. John's, Nov. 8-10.

W.H. Poole presented two papers, — (a) "Geological Survey of Canada and Summer Employment" and (b) A Tectonic Map of the Canadian Appalachians" — to each of the following universities during a recruiting tour: Univ. of New Brunswick, Mount Allison University, Acadia University, Dalhousie University, St. Francis Xavier University, Memorial University and Ottawa University. He also presented a paper on "The Russian Concept of Tectonic Analysis" to a Tectonic Seminar of the St. Lawrence Valley Universities at McGill in March, 1962.

Personnel

F.C. Taylor was transferred to Western Shield Section, May 1962.

J.W. Gillis joined the section as a new recruit in May 1962.

W.H. Poole was on temporary loan to the Western Shield Section during the 1962 field season.

Membership on Committees

F.D. Anderson	-	Chairman, Branch Equipment Committee Member, Departmental Equipment Committee Member, Advisory Committee on Files
D.G. Benson	-	Chairman, Appalachian Discussion Group 1962-63.
D.G. Kelley	-	Member, C.I.M.M., Annual Gen. Meeting Committee. Member, C.I.M.M., Ottawa Branch Executive Chairman, Geologists Group, Professional Institute. Member, Finance Committee, Professional Institute.
E.R.W. Neale	-	Chairman, Logan Club - 1961-62 Member, Seismic Regionalization Committee Member, Geology Div. Executive, C.I.M.M. 1961-62. Member, C.I.M.M., Annual Gen. Meeting Committee
W.H. Poole	-	Vice-Chairman, Geologists Group, Professional Institute. Member, Legislation Committee, Professional Institute. Chairman, Committee on Absolute Age Member, Subcommittee on Structural Geology Member, National Advisory Committee on Research in Geological Sciences.
F.C. Taylor	-	Chairman, Appalachian Discussion Group 1961-62.

Outside Publications

Rodgers, J. and Neale, E.R.W.: Possible Taconic Klippen in Western Newfoundland; (Abst.) Geol. Soc. America, Program of 1962 Annual Meeting, p. 126A.

Kay, M. and Williams, H.: Ordovician Silurian Relationships on New World Island, N.D.B., Newfoundland; (Abst.) Geol. Soc. America, Spec. Paper, (in press).

EASTERN SHIELD SECTION

S. Duffell

The Eastern Shield section is responsible for primary mapping and geological research in that part of the Canadian Precambrian Shield lying east of the Ontario-Manitoba border, and including Baffin Island. Two permanent officers were engaged in primary mapping, one in western Ontario and one in Ungava. In addition one permanent officer and one seasonal officer carried out problem (research) mapping projects in Ontario. Brief statements of their field work appear in Geol. Surv., Paper 63-1.

Personnel and Activities

G.D. Jackson completed his thesis requirements and passed his final orals for Ph.D. from McGill University. He was reclassified from T.O. 3 to Geologist 2 category on Aug. 1, 1962.

R.G. Blackadar was transferred from the Arctic Islands section of the Fuels and Stratigraphy Division to the Eastern Shield section of the Regional Geology Division in October.

S. Duffell and I.M. Stevenson attended the Prospectors and Developers convention in Toronto in March.

All members of the section attended the C.I.M.M. convention held in Ottawa in April.

S. Duffell, along with A.S. MacLaren of the Geophysics Division, and V.K. Prest and R.H. Holman of the Economic Geology Division, visited the Ontario Department of Mines in Toronto during March, to discuss results of the Survey's work on the "Roads to Resources" program in N.W. Ontario.

R.F. Emslie along with R.H. Holman of the Economic Geology Division spoke to the Geochemical Discussion Group at Carleton University and to the C.I.M.M. group in Quebec City during April on "Problems of Data Reduction Analyses and Prediction in dealing with large numbers of Geochemical Observations".

R.F. Emslie also took 3 courses of instruction covering the IBM - 1620 Computer.

W.F. Fahrig spoke at the C.I.M.M. Convention at Ottawa in April on "Influence of Normal Faulting on Soft Iron Ores of the Labrador Trough".

G.D. Jackson, R.F. Emslie, and H.H. Bostock in October moved from 601 Booth St. to offices in No. 8 Temporary Building.

K.E. Eade and W.F. Fahrig in conjunction with J.A. Maxwell commenced an office project on the element abundances of a part of the Canadian Shield. This is a natural outgrowth of the Helicopter Reconnaissance surveys. This office project will help to complement the field work and is really part of it.

Membership on Committees

W.F. Fahrig - Member, G.S.C. Committee on Absolute Age

In October was appointed to the National Advisory Council's subcommittee on Mineralogy, Geochemistry, and Petrography under Chairmanship of D.M. Shaw.

S. Duffell - Member, executive Committee, Ottawa Branch, C.I.M.M.

Convener of Ticket Committee for C.I.M.M. convention in Ottawa during April.

M.J. Frarey - Member, Alumni Advisory Committee for Department of Geology, University of Western Ontario.

R.G. Blackadar - Member, Equipment Committee, G.S.C.
Member, Departmental Equipment Committee.
Secretary, Arctic Circle Club - Ottawa.
Assistant to the Editor, Arctic Circular (quarterly publication)

R.F. Emslie - Member, Stable Isotope Committee of the G.S.C.

Outside Publications

S. Duffell with R.J.W. Douglas: Some Aspects of Phanerozoic, Epeirogenic and Orogenic Events that Involve Precambrian Rocks; The Tectonics of the Canadian Shield, Roy. Soc. Canada, Spec. Pub. No. 4 (1962).

R.G. Blackadar: Field Activities of the Geological Survey in the Canadian Arctic 1961; Arctic Circular, Vol. 15, No. 4, (1962).

R.F. Emslie with J.M. Moore: Geological Studies of the Area Between Lynn Lake and Fraser Lake, Manitoba; Manitoba Dept. of Mines & Natural Resources Publication 59-4 (1962).

WESTERN SHIELD SECTION

G.M. Wright

The Western Shield section is responsible for primary mapping and geological research in those parts of the mainland Canadian Precambrian Shield lying west of the Ontario-Manitoba boundary. Five permanent officers were engaged in primary mapping in 1962 and five permanent officers and one seasonal officer in problem (research) mapping. Statements of their field work appear in Geological Survey Paper 63-1.

Activities and Personnel

F.C. Taylor was transferred from the Appalachian Section to the Western Shield Section and immediately loaned to Fuels and Stratigraphy Division for an Arctic airborne operation.

H.H. Bostock, J.A. Donaldson, and W.H. Poole were loaned to Western Shield for participation in Operation Bathurst Inlet.

K.E. Eade was transferred from Eastern Shield to Western Shield.

L.P. Tremblay continued to check French translations of abstracts for the Geological Manuscripts unit.

Peter Smith completed field work on his Ph.D. area north of Yellowknife. This work was done as a constituent part of J.C. McGlynn's regional correlation study.

G.M. Wright lectured in March to the Defence Research Board on northern operations of the Geological Survey.

Membership on Committees

K.E. Eade	-	Member, Ad Hoc Committee to advise on Survey Collections and Sample Numbering.
J.A. Fraser	-	Fulfilled his term as Chairman of the Geologists' Group of the Professional Institute.
G.M. Wright	-	Completed his term as Western Shield representative on the G.S.C. Committee on Absolute Age.
J.C. McGlynn	-	Western Shield representative, G.S.C. Committee on Absolute Age.
	-	Secretary of Geologists' Group of Professional Institute.
	-	Secretary of Logan Club as of April, 1962.
	-	C.I.M.M. Annual General Meeting (Ottawa) Committee.
	-	Appointed in November, 1962 to American Commission on Stratigraphic Nomenclature, subsequent to his appointment to the G.S.C.'s equivalent (Stratigraphic Committee).

CORDILLERAN SECTION

H.S. Bostock (Ottawa office), H.W. Little (Vancouver office)

The Cordilleran section is responsible for primary mapping and geological research in the Cordilleran Physiographic Province, which may be defined as a belt of folded and igneous rocks lying to the west of the Great Plains. The section, as presently constituted, is divided between Ottawa and Vancouver, thus creating what may be termed Ottawa and Vancouver subsections, both of which are responsible directly to the Division Chief.

Six field parties were operative in 1962 of which five were carrying out primary mapping and one was devoted to problem (research) mapping. Brief statements of their field results are reported in Geol. Surv. Paper 63-1.

Personnel

Ottawa office

G.B. Leech attended the 12th Field Conference of the Alberta Society of Petroleum Geologists and addressed the group at five localities along the Rocky Mountain Trench.

H. Gabrielse, G.B. Leech, and H.W. Tipper attended the C.I.M.M. and G.A.C. meetings in Ottawa.

L.H. Green transferred to Admin. and moved to Whitehorse replacing R. Skinner who moved to Ottawa.

Vancouver office

J.A. Roddick transferred to the Vancouver office in January.

All members of the sub-section attended the Vancouver meetings of the B.C. and Yukon Chamber of Mines in February, and the Annual Western Meeting of the C.I.M.M. in October.

H.W. Little, J.E. Muller, J.A. Roddick, J.G. Souther, and J.O. Wheeler attended the Vancouver Geological Discussion Group field trip to San Juan Islands, Washington, in May.

H.W. Little attended the Annual Meeting of the Cordilleran Section of the G.S.A. in Los Angeles in April. J.A. Roddick attended the Annual General Meeting of the G.S.A. in Houston in November, and the field trip to Grand Salinas salt dome.

H.W. Little visited the B.C. Department of Mines office in Victoria in January and the Menlo Park, California office of the U.S. Geological Survey, and the Washington Division of Mines and Geology in Olympia in April to discuss with other geologists problems of mutual interest. He was in turn visited in the field at Rossland, B.C. in July and August by Drs. R.G. Yates and G. Becraft of the U.S. Geological Survey, and by Drs. M. Huntting, W.A.G. Bennett, and J.W. Mills of Washington State for the same purpose. J.O. Wheeler visited the B.C. Department of Mines office in Victoria for geological discussions with their staff in October.

J.O. Wheeler and J.G. Souther were joint speakers on "Tectonic Framework of Southern Yukon and Northwestern British Columbia", presented before the Vancouver Geological Discussion Group in February. H.W. Little addressed the G.M. Dawson Club at U.B.C. in February on "Recent Interpretations of the Geology of the South Part of Nelson Map-area (West Half), B.C.".

J.O. Wheeler addressed the Vancouver Mining and Exploration Geologists Group in January on recent interpretations of the geology in southeastern B.C. He and R.B. Campbell and H.W. Little (with others) gave brief talks on the regional geology of B.C. to the same group in November and December.

J.O. Wheeler in December advised the Subcommittee on Glaciology of the Associate Committee of Geodesy and Geophysics of N.R.C. regarding glaciers in Western Canada most suitable for regimen studies.

H.W. Little, at the request of the U.B.C. Department of Geology, addressed the geology and mining students in January on the work of the Geological Survey with special reference to the use of field assistants, and with R.B. Campbell later interviewed students on behalf of the Civil Service Commission.

Membership on Committees

G.B. Leech - Secretary, Exhibitions Committee
Member, Absolute Age Committee
Member, Program Committee of the Geological Division, Section III, Royal Society of Canada.

J.O. Wheeler - Member, National Advisory Committee on Structural Geology, 1962-63.

H.W. Tipper - Member, Equipment Committee, G.S.C.

Outside Publications

Leech, G.B.: Some Highlights of 40 years of Geological Progress in the Canadian Cordillera, C.I.M.M. Trans., Vol. 65, p. 137-142 (1962).

Leech, G.B.: The Structure of the Bull River Valley near Latitude 49°35'; Jour. Alberta Soc. Petrol., Geol., Vol. X, p. 396-407 (1962).

Leech, G.B. and Wanless, R.K.: Lead Isotope and Potassium-Argon Studies in the East Kootenay District of British Columbia; in Petrologic Studies: a Volume in Honor of A.F. Buddington; Geol. Soc. America Buddington Volume (1962).

FUELS AND STRATIGRAPHY DIVISION

J.F. Caley, Chief

INTRODUCTION

The principal work of the division is to determine the succession, lithology, structure, age, and correlation of the sedimentary bedrock formations in Canada; to map the surface and subsurface distribution of these formations in specified areas; to carry on research in palaeontology, including palaeobotany and palynology, and to study the petrographic and organic constitution of coal seams. This work is aimed at providing basic data and information necessary in the exploration for and development of oil, gas, and coal, and to the assessment of the general mineral potential of a given area.

To carry out these functions the division is constituted as follows:

(a) Petroleum Geology Section - R.J.W. Douglas, Head. The section is primarily responsible for stratigraphic studies, geological mapping, and basic research necessary to the assessment of the oil

and gas potential of specific areas.

(b) Stratigraphic Palaeontology Section - D.J. McLaren, Head.
Responsible for palaeontological research, biostratigraphy, and providing data on age and correlation as a service to mapping geologists.

(c) Arctic Islands Section - R. Thorsteinsson, Head.
Responsible for geological mapping and stratigraphic studies in the Arctic Archipelago.

(d) Coal Research Section - P.A. Hacquebard, Head.
Investigates the character of coal seams by means of petrographic and spore analysis with a view to providing data on their utilization, correlation, and development, and to supply information on the stratigraphic value of spores.

(e) Western Plains Oil and Gas Office - Calgary, Alberta - R.T.D. Wickenden, Head.
Responsible for regional subsurface studies and mapping in western Canada as an aid to exploration for and development of oil and gas accumulations.

GENERAL

The Division at Ottawa maintains a permanent repository for rock cuttings from all wells drilled for oil and gas in Ontario. During the year, 45,108 samples representing 235 wells in Ontario, were received and prepared for microscopic examination. These samples are made available for study by visiting geologists. Representatives of the following companies availed themselves of this service: Imperial Oil Limited; Blue Water Oil & Gas Company; Texaco Exploration Company; Union Carbide; Skelly Oil Company; New York Natural Gas Company; British Petroleum Company; Panhandle Eastern Company; Alleghany Producing Corporation; Mobil Oil of Canada; Canadian Oil Companies Limited; California Standard Company; United States Gypsum Company; Triad Oil Company; Consumers Gas Company.

Samples from wells drilled in western Canada are made available for study at the Western Plains Oil and Gas Office in Calgary. However, samples for certain exploratory wells are received at Ottawa where they are prepared for study by geologists based at headquarters. (See report of Petroleum Geology Section.)

Acknowledgment is made to the following persons and organizations through whose cooperation information and/or drilling samples were received: W.A. Roliff, Imperial Oil Limited for samples, cores, and general information on exploratory activity in eastern Canada; B. Graham Rogers, Department of Industry and Natural Resources, Charlottetown, for general information on drilling on P.E.I; W.D. Brittain, Chief Inspector, Department of Energy Resources, for samples of wells drilled in Ontario; Oil and Gas Conservation Board, Province of Alberta, for electric logs and samples of wells drilled in Alberta; Department of Mines and Petroleum Resources, Victoria, for samples of wells drilled in B.C.; Petroleum and Natural Gas Branch, Department of Natural Resources, Regina, for well samples; Quebec Department of Natural Resources, for information on well locations in Quebec; Nova Scotia Department of Mines, for making available drilling information; and to officers of many oil companies for much useful information on exploration for oil and gas in many parts of Canada.

Fairmore Building, Calgary. Space was acquired in the Fairmore Building for the purpose of housing and making available for study the cores resulting from drilling in N.W.T. and Arctic Islands. Examination facilities and service for handling the cores are provided for both visiting and Survey geologists. In addition office and laboratory space is available for several members of the Petroleum Geology and Arctic Islands Sections, who were transferred to Calgary during the year.

PERSONNEL

W.J. Banning and D.L. Herron joined the technical staff of the Calgary Office and G.H. Abbott and S.M. Kasner resigned. Mrs. E.M. Irwin joined as a replacement for Miss Helen Lawson, who is on extended sick leave. F.M. Hueber resigned as palaeobotanist to join the staff of the Smithsonian Institution in Washington, and N.C. Ollerenshaw and Mrs. V.M. McGuire joined the Petroleum Geology Section as geologist and clerk respectively. R.G. Blackadar transferred to the Regional Geology Division. Miss F.J.E. Wagner transferred from Stratigraphic Palaeontology to Marine Geology Unit.

MEMBERSHIP ON COMMITTEES

Caley, J.F. - Associate Editor, Eastern Canada, A.A.P.G., 1961-1964.
Representative for Eastern Canada, Basement Rocks Project, A.A.P.G.
Member, Committee for Publication, A.A.P.G.

Member, Matson Award Committee, A.A.P.G., 1962-1964.
Member, Permanent Council, World Petroleum Congresses, 1959-1964.
Chairman, Miller Medal Award Committee, Royal Society of Canada.
Member, Subcommittee on Stratigraphy, Palaeontology and Fossil Fuels, National Advisory Committee on Research in the Geological Sciences.

SENIOR RESEARCH PALAEONTOLOGIST

Dr. Frebold continued study of the faunas and stratigraphy of the Jurassic System in Canada. Details of this work may be found in Geol. Surv. Papers 63-1 and 63-2. In addition Dr. Frebold spent one month on field work in Alberta and eastern British Columbia determining the subdivision and correlation of the Upper Fernie Group. During the year he also prepared 14 reports on fossil collections from western and northern Canada submitted by Survey staff and oil company geologists. His current research deals with new fossil collections from the Arctic Archipelago. During August and September Dr. Frebold represented Canada at the Colloque du Jurassic, Luxemburg, and studied fossil collections at museums in Brussels, Munich, Innsbruck, Vienna, Tubingen, Erlangen, and Copenhagen.

REPORTS ON SECTIONS AND LABORATORIES

PETROLEUM GEOLOGY SECTION

R.J.W. Douglas

Geologists of the Petroleum Geology Section were engaged in field, office, and laboratory investigations of the sedimentary rocks of the Eastern Cordillera, Interior Plains, and parts of eastern Canada.

Field investigations by 8 members of the section and 4 Ph.D. candidates included the geological reconnaissance of 80,000 square miles of northern Yukon (Operation Porcupine), mapping of the Halfway and Trutch areas of northeastern British Columbia and the Burnt Timber area of the Foothills, and the regional stratigraphy and sedimentary petrology of the Upper Devonian (2),

late Palaeozoic, Triassic (2) and Cretaceous of Alberta, British Columbia and Mackenzie District. Accounts of the objectives and results of these projects are given in Geol. Survey Paper 63-1.

Subsurface investigations in southwestern Ontario, the Maritimes, Alberta Foothills and northeastern British Columbia were carried on. Compilation and appraisal of information and statistics dealing with the oil, gas and coal industries of Canada were continued. Summary accounts of office and laboratory projects pertaining to this work are included in Geol. Survey Paper 63-2.

During the year publications by officers of the section were 3 papers and 3 maps by the G.S.C. and 7 papers by other organizations. Submitted for publication were 3 memoirs, 3 bulletins, 4 papers, and 5 maps by the G.S.C., and 6 papers to other organizations.

Activities

R.J.W. Douglas: prepared, jointly with D.K. Norris manuscript and maps of the Dahadinni River and Wrigley map-area, Mackenzie District, and with D.K. Norris, R. Thorsteinsson and E.T. Tozer a paper on the Geology and Petroleum Potentialities of northern Canada. A paper with S. Duffell was published in the Royal Society of Canada, Spec. Pub. No. 4, 'Tectonics of the Canadian Shield'. With the assistance of Miss von Schoenberg, a Rock Repository was organized in which suites of stratigraphically ordered specimens collected on Operation Mackenzie were made available for reference and study. With the assistance of Mrs. B. Edmond progress was made in the analysis and interpretation of the structures of Mackenzie Mountains. Some 15 manuscripts of all types were critically read and edited for content, including some papers prepared by members of other sections and for other organizations. Administrative duties of the section were carried out and in the absence of the Chief, of the Fuels and Stratigraphy Division.

R.L. Herr: was engaged in examining samples from the deep wells of the Waterton natural gas field of the Alberta Foothills and in conjunction with R.J.W. Douglas in effecting their integration with the structural interpretation of the region.

R.D. Howie: continued examination of wells drilled in the Maritime provinces. He prepared for publication papers jointly with M.S. Barss and P.A. Hacquebard on Palynology and stratigraphy of Upper Palaeozoic sediments of the Maritimes, with L.M. Cumming contributed to the A.A.P.G. Basement map of North America, and a paper on the Stony Creek gas field.

E.J.W. Irish: completed investigations of the Halfway River area of British Columbia, the map of which was published this year (37-1961) and is working on the accompanying report. He did preliminary work on a new project on the stratigraphy of the southern Interior Plains. A paper on the structure of the Rocky Mountains along Peace River was published by the Edmonton Geological Society.

B.A. Latour: continued with the compilation of data pertaining to the coal industry of Canada. He served as Branch liaison officer to assist Departmental and Public Works architects in the planning of the Western Regional Office building in Calgary, and the establishment of equipment and machinery for the Fairmore Building, Calgary.

B.A. Liberty: was engaged in the preparation of a memoir on the Bruce Peninsula of Ontario. He submitted for publication a memoir on the Lake Simcoe area and map and report of the Tweed - Bannockburn - Kaladar area.

B. MacLean: compiled published and unpublished data for geological maps of western Mackenzie District and northern Yukon and isopach and facies maps of various formations incorporating subsurface and surface stratigraphic data. The catalogue and classification of confidential and non-confidential reports received under the Canada Oil and Gas Regulations were maintained.

H.L. Martin: prepared monthly reports summarizing activities of the oil and gas industries in western Canada and completed the ninth edition of Map 1039A, showing oil and gas fields and discoveries of Alberta and northeastern British Columbia. This latter was a complete revision on a newly revised base. Mr. Martin, R.L. Herr, B. MacLean and Mrs. V.M. McGuire reorganized the oil and gas files in accordance with a location system and initiated year books of records giving well status, classification and geological and engineering data for wells drilled during the year in western Canada. Preparation of a map showing Mississippian oil and gas occurrences and relationships to facies and isopachs in Southern Alberta was begun.

E.W. Mountjoy: was engaged in preparations for Mesozoic stratigraphic investigations on Operation Porcupine and carrying them out during the field season. He supervised Ph.D. Thesis projects on the Upper Devonian by W.S. Mackenzie and the Triassic by D.W. Gibson. He submitted manuscripts for a Memoir on the Miette Area of Alberta, and a Bulletin on the Upper Devonian Miette Reef complex of Jasper Park. His publications were a map (41-61) of the Mount Robson area (83 SE) with accompanying paper on the stratigraphy (61-31) and, jointly with D.J. McLaren, a paper on the Alexo Equivalents of the Jasper Regions (62-23).

D.K. Norris: as officer-in-charge of Operation Porcupine was engaged in the organization of that undertaking, in advance compilation and appraisal of the geology of northern Yukon, in the conduct of the operation May to September and in completing the administrative aspects afterwards. He submitted for publication manuscripts for a Bulletin on the Stratigraphy of the Rocky Mountain Group and, jointly with R.J.W. Douglas, maps and report on the Dahadinni River and Wrigley map-area District of Mackenzie and, with R.J.W. Douglas, R. Thorsteinsson, and E.T. Tozer on the Geology and Petroleum Potentialities of Northern Canada. A paper with R.F. Black on Palaeomagnetism and Differential Rotation in the Lewis Thrust Sheet was published by the A.S.P.G.

N.C. Ollerenshaw: began investigations in the Burnt Timber area of the Alberta Foothills and has been engaged in compilation of this data and completing his Ph.D. thesis on the Geology of the Cuoq-Langis area of Quebec.

R.A. Price: was engaged in advance preparations for the mapping and structural aspects of Operation Porcupine, assessing and compiling all available information, including interpretation of the air photographs. After field work he began compilations for publication and continued with analysis of structural elements connected with his research on the mechanics of folding in the southern Rocky Mountains. His map and paper on the Fernie E½ area (61-24), was published and a paper on the structure of the Rocky Mountains vicinity of Crowsnest Pass was published by the A.S.P.G. Dr. Price supervised the Ph.D. project of D.L. Scott on late Palaeozoic stratigraphy.

B.V. Sanford: in addition to compilation of data on the Silurian of southwestern Ontario, prepared for publication papers on Oil and Gas Developments in Eastern Canada for the A.A.P.G., on the source and occurrence of Oil and Gas in Ontario for the G.A.C. and on the Saline Deposits of southwestern Ontario for presentation at the Salt Symposium of the G.S.A. at Houston. He was consulted extensively by representatives of oil and gas companies, resident in Ottawa or visiting, which are engaged or about to be engaged in exploration in Ontario.

D.F. Stott: continued preparation of reports dealing with Cretaceous stratigraphy of Alberta and British Columbia, submitting a Memoir on the Smoky Group, a paper on the Fort St. John Group, Gething and Cadmin Formations, and a map and report of the Trutch area jointly with B.R. Pelletier. His publications were a paper on Upper Cretaceous Marine rocks in the A.S.P.G., and on the Cretaceous of the Peace River region in the Edmonton Geological Society. Study of subsurface data from critical wells drilled in the Peace River region of Alberta and British Columbia was begun to correlate the surface and subsurface successions.

G.C. Taylor: established the principal gas caches for Operation Porcupine in the spring. He was engaged in the compilation of map and report on the MacDonald Creek Map-area of northeastern British Columbia.

Well Sample Preparation Laboratory: The work of this unit was reorganized under the new supervisor W.U. ter Haar Romeny. Output of processed samples totalled 268.429 which represents an increase of 35% over that of recent years and exceeds number of samples received, thereby permitting processing of back-log material (See Table). An examination room adjacent to the repository was built in the latter part of the year and has been fully occupied by visiting geologists examining Eastern Canada wells. The following table shows samples received and processed and other data; a sample commonly represents 10 feet of drilling.

Province or District	Received		Processed		Reprocessed	
	Samples	Wells	Samples	Wells	Samples	Wells
Alberta	131,267	691	222,321	1,274	-	-
British Columbia	-	-	-	-	128	1
Mackenzie	6,842	17	1,000	2	-	-
Ontario	45,108	235	45,108	235	250	2
Totals	183,217	943	268,429	1,511	378	3

Days worked ---------- 1,557 man-days

Overtime ---------- 18.5 " "

Leave ---------- 188 " "

Total Man-days ---------- 1,313 " "

Personnel

N.C. Ollerenshaw completed his graduate studies at the University of Toronto and joined the staff in June.

Mrs. V.M. McGuire joined the section in January as Clerk in charge of the subsurface files.

E.J.W. Irish transferred to the Western Office in Calgary in August.

Miss E.R. Jamieson left to enroll at Reading University, England, on a Commonwealth Fellowship.

D.K. Norris gave a talk to the A.S.P.G. on Operation Porcupine after completion of the field program.

R.A. Price addressed the Miller Geology Club of Queen's University on the Lewis Thrust Sheet of the Rocky Mountains.

E.W. Mountjoy lectured at McGill University on Upper Devonian Reefs of the Alberta Rocky Mountains.

B.A. Liberty attended the Michigan Basin Geological Society field trip in Indiana and Illinois and a field conference on the Silurian rocks of New York and Ontario.

R.L. Herr and H. Martin attended the C.I.M. conference in Ottawa.

Membership on Committees

R.J.W. Douglas
- Member, Canadian National Committee World Petroleum Congress 1960-1963.
- Member, Technical Program Committee, A.A.P.G. meeting Toronto 1964.
- Member, G.S.C. Committee on Stable Isotopes.
- Member, G.S.C. Committee on Age Determination.
- Member, Subcommittee on Structural Geology, National Advisory Committee.

B.A. Liberty
- Chairman, Field Trip Committee, A.A.P.G. Meeting Toronto 1964.
- Chairman, Field Trip Committee, 1964 Michigan Basin Geological Society.

H.L. Martin - Treasurer, Dept. of Mines and Tech. Surveys, Community Chest Campaign.

E.W. Mountjoy - Member, Library Committee, Secretary, Logan Club 1961-62.

R.A. Price - Member, Committee on Rock Collections and Numbering.

D.K. Norris
- Advisor to the Dominion Observatory on the geological aspects of circular features in Canada.
- Member, Seismic Regionalization Committee of the Dept. of Mines and Technical Surveys.
- Member, G.S.C. Exhibits Committee
- Member, Satellite Information Committee of the Dept. of Mines and Technical Surveys.

Outside Publications

R.J.W. Douglas and S. Duffell: Some Aspects of Phanerozoic Epeirogenic and Orogenic Events that Involve Precambrian Rocks; in Tectonics of the Canadian Shield; Royal Society, Canada, Spec. Pub. No. 4, 1962.

E.J.W. Irish: Diagrammatic Structure Cross-sections Along the North and South Sides of Peace River Valley, B.C.; Edmonton Geological Society Guide Book, August, 1962.

B. MacLean: Petroleum in Canada; in Encyclopaedia Britannica Year Book 1962.

D.K. Norris and R.F. Black: Palaeomagnetism and Differential Rotation in the Lewis Thrust Sheet; Jour. Alberta Soc. Petrol. Geol., vol. 10, pp. 13-21, 1962.

R.A. Price: Geologic Structure of the Central Part of the Rocky Mountains in the Vicinity of Crowsnest Pass; Jour. Alberta Soc. Petrol. Geol., vol. 10, pp. 341-351, 1962.

B.V. Sanford, J.G.S. Milne, and S.B. MacEachern: Developments in Eastern Canada in 1961; Bull. Am. Assoc. Petrol. Geol., vol. 46, pp. 1025-1031, 1962.

B.V. Sanford: Source and Occurrences of Oil and Gas in the Sedimentary Basins of Ontario; Proc. Geol. Assoc. Can., vol. 14, pp. 59-89, 1962.

D.F. Stott: Upper Cretaceous Marine Rocks of Rocky Mountain Foothills; Jour. A.S.P.G., vol. 10, No. 5, pp. 228-240, 1962.

Cretaceous Rocks of Peace River Foothills; Edmonton Geol. Soc. Guide Book, pp. 22-45, 1962.

STRATIGRAPHIC PALAEONTOLOGY SECTION

D.J. McLaren

General

A total of 161 reports were prepared by members of the Section on 1,746 lots of fossils. These lots were submitted by the following:

GSC Field Officers	1,086 lots
Other Government Departments	192
Industry	426
Miscellaneous	42

Loans totalling 800 fossil lots, other than types, were made to 28 individuals or institutions throughout the world. Some of these loans were to 11 outside experts on particular classes of fossils who are carrying out research on them specifically for the Geological Survey of Canada. A total of 131 fossil lots and 110 plaster replicas were sent as gifts or exchange material to 14 individuals and institutions.

Thirty-one geologists from Universities, Oil Companies, and foreign Surveys have visited the Section in order to examine collections or to consult with members of the Section.

During the year 6 Papers, 5 Bulletins, and one Type Catalogue by members or past members of the Section were published by the Geological Survey.

Type Collection

A total of 1,059 types described in both Survey and outside publications were added to the Type Collection of the Survey in 1962. Publications in which these types were reported are as follows:

Bull.	78	Silurian Fauna, British Columbia	136 types
	80	Ordovician Corals, N. Ontario	6
	81	Jurassic Ammonites, British Columbia	37
	86	Devonian Brachiopods, W. Canada	117
	88	Cambrian Trilobites, Newfoundland	316
	91	Non-trilobite Arthropoda	230
Paper	62-4	Devonian Fossils, W. Canada	67
	62-14	L. Palaeozoic Fossils, W. Canada	66
	62-19	Triassic Fossils, W. Canada	58
			1,033

Outside Publications:

Fagerstrom, J.A. (Univ. Nebraska), J. Pal., vol. 36, No. 3	7
Westermann, G.E.G. (McMaster Univ.), J. Pal., vol. 36, No. 4	5
Jeletzky, J.A. (GSC), J. Pal., vol. 36, No. 5	5
Fritz, M.A. (Univ. Toronto) and Bolton, T.E. (GSC) Proc. Geol. Assoc. Can., vol. 13 ..	9
Total	26

Numerous type specimens of the Survey Collection have been refigured and/or redescribed during the year as well, not only in the publications noted, but also in the following:

Berry, W.B.N. (Univ. California), J. Pal., vol. 36, No. 2

Fay, R.O. (Oklahoma Geol. Surv.), J. Pal., vol. 36, No. 2

House, M.R. (Univ. Durham), J. Pal., vol. 36, No. 2

Nelson, S.J. (Univ. Alberta), J. Pal., vol. 36, No. 3

Sohn, I.G. (USGS), J. Pal., vol. 36, No. 6

Eighteen outside specialists have borrowed, at their request, 126 type specimens.

Field and Office Activities

E.W. Bamber prepared 11 reports on 80 lots of Carboniferous fossils for field officers of the Survey. He continued his studies of Mississippian coral type specimens in the Geological Survey collections and began work on processing field observations made on Carboniferous and Permian rocks of Northern Yukon during Operation-Porcupine.

T.E. Bolton continued his studies of late Silurian trilobites from the Arctic Islands; and completed a preliminary catalogue of Arthropoda in the GSC type collections as part of the continuing compilation of the Catalogue of Type Invertebrates. He completed a manuscript for outside publication, with M.J. Copeland, on some problematical Middle Cambrian fossils. He began studying Silurian corals from Ontario and Arctic Canada. He supervised the sorting and reorganization of the main collections of Lower Palaeozoic fossils from Eastern Canada stored in the basement. He attended the C.I.M.M. Convention in Ottawa, the G.S.A. in Houston, Texas, the Michigan Basin Geological Society Field Trip to study Silurian rocks in Indiana and Illinois, and a field trip to study the Middle Silurian of Southwestern Ontario and New York. He reviewed and read critically nine manuscripts for publication in the Proceedings of the Geological Association of Canada and the Bulletin of the A.A.P.G. He was Chairman of the GSC Committee on Stratigraphic Nomenclature; Chairman of the American Commission on Stratigraphic Nomenclature; Assistant Editor to the Geological Association of Canada; and member of the International Commission on Stratigraphy. He was the author of Geol. Survey Paper 61-26, published during the year.

T.P. Chamney established a micropalaeontology laboratory in Calgary and began work on determinations of referred collections by field men and others. He commenced field and laboratory studies of Lower Cretaceous microfaunas in Western Canada. He visited Operation Porcupine in order to collect from key sections in detail, and began laboratory work on separation and determination of the microfaunas.

M.J. Copeland wrote 10 fossil reports on 28 lots of Palaeozoic microfossils for field officers, industry, and other organizations. He spent part of a field season collecting Silurian and Devonian microfossils in Gaspé, attended a field trip of the joint U.S. - Canadian Appalachian Group in southwestern New Brunswick and Maine, and a field trip to study Middle Silurian rocks in southwestern Ontario

and New York. He completed a manuscript on distribution of Ostracoda in the Stonehouse Formation of Nova Scotia for publication by the Geological Survey, and another, with T.E. Bolton, for outside publication, on some problematical Middle Cambrian fossils. He continued his studies of Palaeozoic Ostracoda from Eastern and Arctic Canada, and began examination of Hamilton (Devonian) ostracods in drill cores from Southwestern Ontario. He attended the C.I.M.M. convention in Ottawa and spent two weeks in Washington, D.C., examining type specimens of Palaeozoic ostracods in the U.S. National Museum. He began duties as editor for a Field Guide-book for the A.A.P.G. Toronto Convention in 1964, and acted as critical reader of a manuscript for the Alberta Society of Petroleum Geologists. He was author of Bulletin 91, published during the year; this contains 6 papers on Canadian arthropods.

L.M. Cumming wrote one fossil report on nine lots from Palaeozoic formations in Eastern Canada for a field officer, and continued work on Lower Ordovician Graptolites from New Brunswick. He prepared a field excursion Guide-book on part of New Brunswick for the joint U.S.-Canadian Appalachian Field trip, and attended the trip as one of the excursion leaders. He prepared a guide to Palaeozoic fossils to assist field mapping in New Brunswick. He attended the C.I.M.M. Convention in Ottawa and visited the New Brunswick Mines Branch for 3 days. He reviewed or critically read seven manuscripts for the AAPG, GSA, American Journal of Science, and others.

F.M. Hueber wrote 19 reports on 88 lots of plant fossils from all parts of Canada, for field officers, industry, and other organizations. He spent half of the field season with D.C. McGregor examining and collecting plant fossils from Devonian and Permian rocks in Eastern Canada and Maine; the remainder was spent in collecting Cretaceous plants in B.C. He visited the University of California and read a paper on Devonian psilophytes and the origin of ferns to the Botanical Society of America in Cornwallis, Oregon. He began work on Devonian megafloras of eastern Canada. He edited and proff-read two manuscripts for publication by the GSC. In September Hueber left the Survey to join the staff of the Smithsonian Institution in Washington.

J.A. Jeletzky prepared 17 fossil reports on 431 lots from Cretaceous rocks of Western and Arctic Canada, for field officers, industry, and other organizations. He read a paper to the Royal Society of Canada at Hamilton on the Pre-Cretaceous Richardson Mountain Trough in the Tectonic Framework of Northern Yukon and Mackenzie District. He completed a manuscript for publication by the GSC on late Jurassic and early Cretaceous *Buchia* Zones in the Western Cordillera; his continued research on *Buchia* also

resulted in one manuscript for outside publication and an abstract. Work was continued on Cretaceous Index fossils in the west and arctic; during the year one manuscript has been submitted to the GSC and one published outside. He has collaborated with W.A. Cobban of the U.S. Geological Survey in research on Scaphites of the Bearpaw Formation and completed his part of one manuscript. He has continued work on Canadian Belemnites, part of which will be incorporated in the Treatise on Invertebrate Palaeontology. Office work was continued on two field projects: on the Mesozoic rocks of Quatsino Sound, Vancouver Island, for which one memoir and two preliminary papers are well advanced; and on aspects of the geology of the Richardson Mountains region, Y.T., - three preliminary papers are in preparation. He spent three months selecting and compiling key sections from his field notes and maps for use by Operation Porcupine personnel, in advance of publication. He submitted a critical discussion to the Chief Geologist of the policy concerning Mesozoic stratigraphy and correlation on Operations Porcupine and Mackenzie. He submitted a suggestion concerning the need for closer liaison between workers using isotope age determination and palaeontologists, to the National Advisory Committee on Research in the Geological Sciences. He has continued to check Russian translations of Title, Author, and Summary included in GSC final reports. He acted as critical reader for two major manuscripts for the GSC. He continued to serve as a member of the Cretaceous Subcommittee of the Stratigraphic Committee of the U.S. National Research Council and as a member of the Standing Committee on Datum-Planes in the Geological History of the Pacific Region.

D.C. McGregor wrote 13 reports on 41 lots of plant microfossils from all parts of Canada, for field officers, industry, and other organizations. He spent 2 months in the field visiting Devonian and Permian collecting sites in Eastern Canada and Maine with F.M. Hueber. An abstract outlining some preliminary results was published during the year. He completed a manuscript on Devonian Miospores from the Ghost River Formation, Alberta, for publication as a Bulletin, and an outside paper on plants from the same formation, in conjunction with R.G. Greggs and J.E. Rouse, was published. He completed a GSC paper jointly with D.J. McLaren and A.W. Norris on illustrations of Devonian fossils from Western Canada, and a manuscript for outside publication, jointly with I.M. Stevenson, on Cretaceous sediments in central Nova Scotia. He completed a manuscript on microfossils from Ordovician Red River Formation of Manitoba for inclusion in a joint Bulletin with G.W. Sinclair and W.L. Fry on that formation. He continued compilation of a reference collection of spores and pollen of pre-Pleistocene age; widespread exchanges of material were effected during the year in many parts of the world. He began work on a series of short reports on Mesozoic palynology to deal with the botanical and geological significance of such fossils, for publication by the GSC. In the laboratory he investigated 89 samples for microfossils, ranging in age from Precambrian to

Tertiary, prepared 270 microfossil slides, and made 650 photomicrographs of plant microfossils. He critically read two major manuscripts for publication by the GSC and outside. Since the resignation of F.M. Hueber, he has been responsible for the organization and supervision of all matters relating to fossil plants, micro- and mega-, within the Section.

D.J. McLaren wrote 14 fossil reports, 3 jointly with A.W. Norris, on 77 lots of Devonian fossils from Western and Arctic Canada. He made short visits to the field in the Alberta Rocky Mountains to make further observations on Devonian stratigraphy, and to Western New York State to collect from the classical Devonian sections in company with members of the New York Geological Survey. With A.W. Norris and D.C. McGregor he completed a manuscript on illustrations of Devonian fossils from Western Canada; with H.R. Belyea he completed a manuscript on Upper Devonian formations in the southern District of Mackenzie, and, with E.W. Mountjoy, a manuscript on Alexo equivalents in the Jasper region. He continued his studies of Devonian rhynchonelloid brachiopods, completed the description of Middle Devonian corals from the Horn Plateau Formation, began a paper on the stratigraphy of Stanley Smith's Mackenzie River Devonian corals, and began preliminary work on other Devonian coral faunas. He commenced examination of the megafossils from two boreholes through the Hamilton Group of Southwestern Ontario. He critically read six manuscripts for publication by the Survey. He attended the Annual Meeting of the AAPG in San Francisco in March, and served as a member of the Research Committee of the Society of Economic Palaeontologists and Mineralogists. He was a member of a subcommittee of the National Advisory Committee for Research in the Geological Sciences on a proposed Canadian Journal of Earth Sciences. He gave a talk on the Origin of Life to the geology club at Queen's University. He was author of Bulletin 86, published during the year, and joint author of Papers 61-29, 62-4, and 62-23.

B.S. Norford wrote 16 fossil reports on 375 lots from Cordilleran Lower Palaeozoic rocks for field officers, industry, and other organizations. He assisted in the preparations for Operation Porcupine and subsequently began work on compiling field data on stratigraphy and palaeontology of the Lower Palaeozoic rocks of Northern Yukon. He continued work also on Ordovician and Silurian biostratigraphy of southern British Columbia and southern Alberta, both in the field and laboratory. With H.R. Belyea he began a study of a basal Devonian unit in southeastern British Columbia. During the year he submitted a manuscript to the Survey on illustrations of fossils from the Cordilleran Lower Palaeozoic; another manuscript was submitted for outside publication on the Beaverfoot-Brisco Formation in the Stanford Range. He was author

of Paper 62-4 and Bulletin 78, published during the year.

A.W. Norris wrote 6 fossil reports on 99 lots of Devonian fossils from Western Canada for field officers, industry, and other organizations. He took part in Operation Porcupine and commenced work on preliminary results of his studies of Devonian stratigraphy in the Northern Yukon. He completed manuscripts on a brachiopod fauna from the Horn Plateau Formation; and, jointly with H.R. Belyea, on Middle Devonian and older formations in the southern District of Mackenzie; and, jointly with D.J. McLaren and D.C. McGregor, on illustrations of Devonian fossils from Western Canada. He critically read four manuscripts for publication by the GSC and other institutions. He was joint author of Paper 62-4, published during the year.

G.W. Sinclair wrote 5 fossil reports on 16 lots of Ordovician fossils for field officers and other organizations. He held a field conference on the geology of the Percé district with officers of the Quebec Bureau of Mines. He continued studies of Ordovician faunas from Manicouagan Lake, Percé, Lake Temiskaming, and Manitoba. He completed manuscript notes on the stratigraphy of the Cat Head Formation, Manitoba. He continued studies of local geology in excavations, and new exposures generally, and assisted some 50 students and visitors who made inquiries on the local geology.

E.T. Tozer wrote 18 fossil reports on 312 lots of Triassic fossils from Western and Arctic Canada for field officers, industry, and others. He carried out regional mapping and studies of Mesozoic stratigraphy on Axel Heiberg and Western Ellesmere Islands and continued preparing a geological map of Axel Heiberg for publication. He completed two manuscripts for publication by the GSC on Western Canadian Triassic ammonoids, and one on illustrations of Canadian Triassic fossils. Jointly with R.J.W. Douglas and others he prepared a paper on the geology of Northern Canada for presentation to the World Petroleum Congress. He gave talks on Arctic Geology and Triassic biostratigraphy in the Geology Departments of Dartmouth College, New Hampshire, and Western Reserve University, Ohio. With R. Thorsteinsson, he was the joint recipient of the Alberta Society of Petroleum Geologists Medal of Merit for their paper on the Structure of Canadian Arctic Archipelago. He was author of Paper 62-19, published during the year.

T.T. Uyeno was on educational leave at the State University of Iowa during most of the year. During the field season he collected samples for microfossil analysis in Gaspé, in company of M.J. Copeland, and attended a field trip of the joint U.S.-Canadian Appalachian Group in southwestern New Brunswick and Maine. Additional collections were made locally for conodont analysis from the Ottawa Formation.

F.J. Wagner wrote 5 fossil reports on 28 lots of Pleistocene and Recent collections for field officers. As most of her office and laboratory work arises out of her studies in Arctic marine microfaunas, during the year she was transferred to the Marine Geology Unit under B.R. Pelletier. She will continue to write reports on collections of Pleistocene or Recent fossils submitted to the Palaeontology Section.

Palaeontology Preparation Laboratory

Preparators: B.J. Botte (in charge), J.J. Callahan, J.E.A. Matte (Micropalaeontology), R. Shea.

Labourers: H. Claude, G. Prudhomme.

The project to clean, file, and cross-reference all Fossil Plants held in the Palaeontological collections, begun in 1961, was completed during this year. Over 6,400 plant localities were checked, and the collection from them cleaned, re-boxed, and stored in indexed drawers and cabinets. A start was made on sorting, indexing, and cleaning the collections of Silurian invertebrates.

Services performed in the general laboratory are outlined below:

	Thin Sections	Saw Cuts	Plaster Casts	Rubber Molds	Polished
Bamber, W.E.	92	136			
Blackadar, R.G.	1	1			1
Bolton, T.E.	51	170		1	
Frebold, H.			75	35	
Herr, R.L.	10				
Hueber, F.	23	150		4	
Jeletzky, J.A.			197	98	
McLaren, D.J.	151	263	154	65	
Norford, B.S.	78	154			
Norris, A.W.			4		
Prest, V.K.	4	14			1
Thorsteinsson, R.	527				
Tozer, E.T.			40	23	
Uyeno, T.	32	170			
Total:	969	1,058	470	226	2

Boxes Received During 1962 Field Season	593
Fossil Localities Catalogued (Invert.)	4,666
Fossil Localities Catalogued (Plant.)	6,480
Parcels Shipped	97

In the micropalaeontology laboratory, 681 samples were washed or disintegrated and subsequently picked for microfossils. They were distributed as follows:

	Quebec	Ontario	Alberta	British Columbia	Arctic	Foreign
Recent					125	
Cretaceous					6	
Devonian		500	8	8	2	
Silurian	2	12	2			3
Ordovician		5				
Cambrian				8		
Total	2	517	10	16	133	3

Outside Publications

T.E. Bolton: Additional Arcticopora from the Triassic of Northwestern Ellesmere Island; Proceedings Geological Association of Canada, vol. 13, (1962).

J.A. Jeletzky: Age, Tectonic Setting and Pre-Cretaceous Structural History of the Richardson Mountains Trough; (Abstract), Roy. Soc. Canada, Program for 1962 Ann. Meeting, June, p. 22, 1962.

Cretaceous Belemnites of New Jersey in The Cretaceous Fossils of New Jersey (by H.G. Richards, et al); Bull. No. 61 (Part II), Pal. Series, Bureau Geol. & Topography, New Jersey, Trenton, pp. 139-161, (1962).

The Allegedly Danian Dinosaur-Bearing Rocks of the Globe and the Problem of the Mesozoic-Cenozoic Boundary; J. Pal., vol. 36, (5) pp. 1005-1018, pl. 141, 2 text-figs., 1962.

Evolution and Biochronology of North American Buchia in Latest Jurassic and Early Early Cretaceous Time (Abstract), Geol. Soc. America, Program of 1962 Ann. Meeting, p. 79A, 1962.

D.C. McGregor: "Plants" - in McLaren, D.J., Norris, A.W., and McGregor, D.C., "Illustrations of Canadian Fossils, Devonian of Western Canada"; Geol. Surv., Canada, Paper 62-4, (1962).

Large Spores from the Gaspé Sandstone; Internat. Conference on Palynology, Volume of abstracts.

(With Greggs, R.G. and Rouse, G.E.): Devonian Plants from the Type Section of the Ghost River Formation of Western Canada; Science, vol. 135, pp. 930-931, 1 fig., (1962).

B.S. Norford: The Beaverfoot-Brisco Formation in the Stanford Range, British Columbia: Jour. Alberta Soc. Petrol. Geol., vol. 10, pp. 443-453, (1962).

ARCTIC ISLAND SECTION

R. Thorsteinsson

Activities

Members of the Arctic Islands Section were engaged in reconnaissance mapping and stratigraphic studies on two airborne projects. The projects were:

(1) Operation Eureka which ranged over Axel Heiberg Island, and eastern regions of Ellesmere Island. Operation Eureka commenced in 1961 and was completed in 1962. During both field seasons members of this project included, J.W. Kerr, R. Thorsteinsson (officer-in-charge), E.T. Tozer (Stratigraphic Palaeontology Section), and H.P. Trettin.

(2) Operation Prince of Wales (R.G. Blackadar, officer-in-charge), which included R.L. Christie. This project covered, King William, Prince of Wales, and Sommerset Islands, and Boothia Peninsula. Salient geological results of each of these projects is given in Geol. Survey Paper 63-1.

R. Thorsteinsson carried out organization of Operation Eureka and continued reconnaissance mapping and stratigraphic studies of upper Palaeozoic rocks of Axel Heiberg and Ellesmere Islands. He is currently engaged in: (1) preparation of preliminary report and map of regions of Axel Heiberg and Ellesmere Islands, which are underlain by upper Palaeozoic rocks, and (2) systematic study of Pennsylvanian and Permian fusulinids. He was a participating member of the International Conference on Saline Deposits held in U.S.A. (November 2-23). Thorsteinsson prepared, jointly with R.J.W. Douglas, D.K. Norris, and E.T. Tozer, a paper on the geology and petroleum potential of northern Canada to be presented at the Sixth World Petroleum Congress at Frankfurt, West Germany, in June 1963. He also carried on the technical administration of the Arctic Islands Section.

R.L. Christie was engaged in the study and mapping of Palaeozoic rocks on Operation Prince of Wales; has submitted a preliminary report and map of region investigated. A report and preliminary map of northeastern Ellesmere Island was completed (Paper 62-10). He has completed a final report and map of that same region. A manuscript (and map) on the surficial geology of northeastern Ellesmere has been submitted for publication. Also completed was a reconnaissance map (1962-12) of southeast Ellesmere Island. Christie is currently engaged in: (1) preparation of a final report and map on the Precambrian and Lower Palaeozoic rocks of Bache Peninsula of Ellesmere Island; (2) final report and map of King William, Somerset, and Prince of Wales Islands, and (3) final report on the Precambrian rocks of southeastern Ellesmere Island.

J.W. Kerr completed reconnaissance mapping and stratigraphic studies of part of the miogeosynclinal belt on Ellesmere Island that extends from Baumann Fiord to Kennedy Channel. A preliminary map of parts of this region investigated in 1961 was submitted for publication. Kerr is currently engaged in: (1) study of problematic fossils of late Precambrian or early Cambrian age, which he discovered in northeastern Ellesmere Island; (2) a preliminary map of regions of the miogeosynclinal belt investigated in 1962; and (3) a final report and map of his 1961 and 1962 investigations on Ellesmere Island. With H.P. Trettin as co-author, Kerr published a paper in the A.S.P.G., on the discovery of Mississippian rocks in the Arctic Archipelago. A paper dealing with structure and stratigraphy of Palaeozoic rocks in Elko County, Nevada was published in the bulletin of the G.S.A.

H.P. Trettin continued mapping and geological studies, commenced in 1961, in the eugeosynclinal belt of northern Axel Heiberg Island and northwestern Ellesmere Island. He prepared, jointly with P.E. Fricker of the Jacabson-McGill University Expedition, a paper and map on pre-Mississippian rocks of northernmost Axel Heiberg Island (62-18). He also published jointly with J.W. Kerr a paper in the A.S.P.G., on the discovery of Mississippian rocks in the Arctic Archipelago. He is presently engaged in preparation of a final report and map of his 1961 and 1962 investigations of Axel Heiberg Island and Ellesmere Island.

Trettin has been transferred to the Geological Survey office in Calgary.

Outside Publications

J.W. Kerr: Paleozoic Sequences and Thrust Slices of the Seetoya Mountains, Independence Range, Elko County, Nevada; Bull. Geol. Soc. Amer., vol. 73, pp. 439-460, 1962.

J.W. Kerr and H.P. Trettin: Mississippian Rocks and the Mid-Palaeozoic Earthmovements in the Canadian Arctic Archipelago; Jour. Alberta Soc. Petrol. Geol., vol. 10, pp. 247-255, 1962.

COAL RESEARCH SECTION

P.A. Hacquebard

Coal Petrography

Study of Coking Coals, by A.R. Cameron

Research on the coking characteristics of coals is conducted cooperatively by the Coal Research Section and the Fuels and Mining Practice Division of the Mines Branch. The microscopic aspects of this work are carried out by the former, and the physico-chemical and technological properties are determined by the latter organization.

In 1962 a most valuable item was added to this research project, namely a movable wall, experimental coke oven of 500 lbs. capacity, constructed on the premises of the Mines Branch in Ottawa.

With this oven, which closely simulates actual operating conditions of large commercial coke ovens, it is now possible to test the value of petrographic studies in the preparation of coal blends, most suitable to obtain the best types of coke. During the last quarter of 1962 several coals of which a petrographic examination is in progress, have already been carbonized by this oven, and results of this will become available next year.

1. An Examination of the Coking Coal Blends used by the Steel Company of Canada, Ltd.

This study was completed in 1962 and a report on the results obtained was forwarded to Stelco. Examined were three coals from the Appalachian Coalfield in the United States, - two of high volatile "A" rank and one low volatile coal. Various blends of these coals were carbonized in the experimental oven at the Mines Branch, and the following results were obtained.

a) A comparison of final expansion data with petrography suggested that an increase in the proportions of dull components in the coal was accompanied by a decrease in after-shrinkage.

b) It was indicated that the maximum fluidity of the coals, as determined by the Gieseler plastometer, decreased with increase in the content of dull components. However, the temperature of maximum fluidity and the temperature of fusion and solidification were progressively higher with increases in dull coal.

c) The size distribution data, when compared with petrography, confirmed the commonly held view that the fragile and brittle components (vitrite and fusite) concentrate in the finer sizes of a given size range.

This study, together with the technological results obtained by the Fuels Division of the Mines Branch, is of direct practical value. It was undertaken by request of Stelco, in view of a contemplated change in blends of their coking coals. Such a change needs careful evaluation, because it not only affects the quality of the coke, but also the carbonization characteristics in the coke ovens. Expansion and after-shrinkage in particular are highly significant, because high expansion pressures can have disastrous effects on the oven walls, while after-shrinkage is related to the fissuring and hence the strength of the resulting coke.

2. Petrographic Studies of Cretaceous Coking Coals from the Fernie-Michel Areas of British Columbia

This project, which was initiated in 1961, has been greatly enlarged during the present year. In June A.R. Cameron and J.R. Donaldson collected 10 column and channel samples, with an aggregate thickness of 217 feet of coal, from the "A", Balmer, and No. 1 seams of the Michel area. In addition, two 900 lb. samples of megascopically dissimilar benches in the Balmer seam were taken for carbonization tests in the 500 lb. coke oven at the Mines Branch.

All samples were collected in consultation with the Crow's Nest Pass Coal Company Ltd., who intend to use their large reserves on the Balmer seam for the production of coke, if proved feasible. This seam is 59 feet thick, and the objective of the investigation is to find those portions of the seam that either alone or in blends with other portions (or other seams) will produce the best coke obtainable.

By the end of the year three coke tests had been carried out on the two benches collected, namely on the bright, the dull and a 50-50 blend of both. The chemical and physical properties of both coal and coke have been made by the Fuels Division, and the petrographic examination of these samples is in progress. They will be followed by detailed studies of the column samples that were also obtained, as well as a microscopic study of the coke substance itself.

Petrographic Investigation of Subbituminous Coals of the Edmonton Formation of Alberta, by T.F. Birmingham

This study commenced during 1961 when 14 column samples from at least 6 different seams in the Drumheller, Stettler, and Edmonton areas were collected. The purpose of this investigation is to acquire more knowledge on the petrography of extremely low rank, high moisture coals, and to test the possibility of correlating such coals by means of petrographic profiles.

During the year a satisfactory method of preparing polished sections of these high moisture coals was developed. Paraplex resin with a catalyst and accelerator are used to bind these friable coals together and retain their moisture content. This impregnation method is carried out by means of a vacuum pump. The resultant sections, although more difficult to prepare than those embedded in plaster of Paris, which is used for bituminous coals, permit a petrographic study of the entire thickness of the seam. The method employed is the same as that used on higher rank bituminous

coals, but preparation of the samples takes considerably longer. (N.B. The Coal Research Section has no Technician at its disposal, and accordingly the Coal Petrographers have to prepare their own samples.)

In 1962 two complete columns have been studied, namely one from Rosedale and the other from Carbon. The samples represent two separate seams, and it was very encouraging to note that their petrographic composition is entirely different. Study of a third column sample is in progress. It is thought to be on the same seam as the Rosedale sample, and will permit an evaluation of the lateral changes in petrographic composition. If these changes are considerably less than between two separate seams, then the method can be used for seam correlation purposes, in the same manner as was done in the Sydney and Canmore Coalfields.

Petrographic Study of Major Coal Seams of the Springhill Coalfield, by J.R. Donaldson

This project was initiated in 1962 with the objective of trying out a petrographic correlation of the seams in the area south of Miller's Corner, where the 1959 drilling program had outlined mineable reserves. Correlation of the Springhill coal seams by means of fossil spores had previously been found to be impossible, due to the great similarities in spore content between overlying seams (see 1961 Annual Report, p. 43).

A difficulty encountered in applying the petrographic method, which has been successfully employed in other coal areas in Nova Scotia, was the unavailability of column samples, which unfortunately were not taken from the borehole sections. This was not done, partly because the coal cores were split with a core splitter, in order to obtain samples for proximate analyses, and partly because it was felt that spore correlations on the seam as a whole would give satisfactory results.

However, following results obtained by G.H. Taylor on Australian coals, in which the petrographic composition of the whole seam (obtained at many localities), was used for correlation, it was decided to apply this method to the Springhill coals in the area south of Miller's Corner.

In this area a correlation problem exists between the No. 3 and No. 1 seams, which are displaced by a series of normal faults. A total of 34 seam samples, mostly from boreholes, and representing either the No. 3 or the No. 1 seam were analyzed. When the overall petrographic compositions were plotted on a ternary diagram, it was found that the samples occur in two groups, both possessing its

own characteristic petrographic composition. One group, contained known samples from the No. 1 seam and the other, known samples from the No. 3 seam. Samples from boreholes of questionable identity clustered around the known samples, and could then be identified. This method proved to be useful in the limited area examined.

The general application, however, is restricted, in that recognition of samples of intermediate composition remains difficult. Also the identification of all major coals at Springhill by this method was found to be impossible. The Nos. 2, 7, and 6 seams, of which an additional 10 samples were examined, could be separated from the Nos. 3 and 1 seams, but not from each other. However, as the immediate correlation problem was between the two last-mentioned seams in the area south of Miller's Corner, this study has produced a worthwhile result.

During the year a complete column sample of the No. 3 seam, obtained in the Syndicate Mine, has also been examined. It showed that the relatively high ash content of the mined coal is caused by several distinct layers of impure coal. Accordingly, a simple coal washing procedure can substantially improve the quality of the coal produced by this mine.

Special Projects

1. Study of Facies Changes in Harbour Seam, Sydney Coalfield, by A.R. Cameron

This topic formed the theme of Cameron's Ph.D. thesis, which was submitted and accepted at the Pennsylvania State University in February, 1961.

During 1962 the author has completed revision of the original manuscript preparatory to submitting it to the Editorial Staff for publication as a G.S.C. Bulletin.

2. Reflectance Measurements of Coal

Because of his investigations of the coals of the Edmonton Formation; Birmingham was unable to pursue this project during 1962. In connection with the coke research projects now underway, the reflectance measurements of the vitrinite component will play an important role. All necessary equipment has been assembled and is practically ready for use. During 1963 we hope to integrate the reflectance measurements with a special research project on coking coals, to be carried

out by a post-doctorate fellow who has considerable experience in this field.

3. Commonwealth Committee on Fuel Research Project on Exchange of Foreign Coals for Petrographic Analyses, by P.A. Hacquebard and T.F. Birmingham

The final interim reports on the comparative studies of coals from South Africa, New Zealand, and India were received in June. Birmingham plotted a series of line graphs and ternary diagrams showing the variations in the 60 analyses that were prepared by five different coal petrology laboratories on the 30 different coal samples studied. They show a general agreement in regard to the maceral analyses, more so than in the microlithotype percentages, which had relevant though persistent differences. In view of this, Hacquebard has made a number of suggestions for the continuation of this very worthwhile international project in Coal Petrography. A reaction to these suggestions has not yet been received, but they were discussed during the 1962 meetings of the Commonwealth Committee on Fuel Research, held in Sydney, Australia.

4. Review Article on "Industrial Applications of Coal Petrography" by A.R. Cameron, P.A. Hacquebard and J. Harrison (of Illinois Geol. Survey)

Some additional time was spent by Cameron in literature research leading to the completion of this manuscript for publication.

Carboniferous Palynology

Spore Investigation of the Coal Seams of the Pictou Coalfield, by M.S. Barss

All samples pertaining to this study have been examined, but the report still remains to be written. Other activities carried out during 1962 left insufficient time for this, and accordingly the termination of this project had to be postponed till 1963.

Spore Study of the Coal Seams of the Springhill Coalfield, by J.R. Donaldson

The actual spore examinations of the Springhill coals have been completed. As was mentioned in last year's Annual Report, reliable seam correlations by means of spore histograms cannot be made in this field.

During the last quarter of 1962 a start was made on studying the spore content of the shales, immediately overlying several of the major coal seams. This study is undertaken to give a complete representation of the microflora present in the Springhill section (of Westphalian B age), and to examine the ecological differences between the shales and the underlying coals.

Spore Study of Upper Palaeozoic Sediments of Prince Edward Island and New Brunswick, by M.S. Barss

During 1962 an additional 26 samples were examined, bringing the total to 48 samples. The results of this study will be published in a G.S.C. paper by M.S. Barss, P.A. Hacquebard, and R.D. Howie; many of the results were made public by Barss in a paper presented at the International Conference on Palynology, held at Tucson, Arizona, in April 1962.

The study of additional samples, largely obtained through the drilling program on Prince Edward Island carried out during the winter of 1962 under the supervision of R.D. Howie, showed the following: a) There are no Cretaceous sediments in western Prince Edward Island. The samples from the Wellington borehole at a depth of 20 to 40 feet, referred to in the 1961 Annual Report on page 44, are unquestionably a contamination of the rotary cuttings obtained in this interval. The drill had previously been used in western Canada, and it is therefore most likely that the material containing definite Cretaceous pollen grains was derived from there. b) In eastern Prince Edward Island the presence of Permian sediments, long in dispute, could be definitely indicated by means of fossil spores. c) Between Minto in New Brunswick and western Prince Edward Island there is a complete sequence of Upper Pennsylvanian sediments, ranging in age from Westphalian C to the Stephanian, inclusive. These beds represent Morien equivalents (of the Sydney, N.S. area) and post-Morien sediments, hitherto unknown in the Maritime Provinces.

Spore Study of Samples submitted for Age Determinations, examined by M.S. Barss

During 1962 the following reports on samples submitted by other members of the G.S.C. were compiled.

1, 2. Two reports on 7 samples submitted by R.D. Howie and obtained from a drilling project at Moncton carried out by the C.N.R. to find water.
Age: Pictou (*Louchopteris* zone)

3. Report on 20 samples provided by D. Benson from the Lochaber map-area of Nova Scotia.
   Age: Horton Group.

4. Report on 1 sample submitted by E. Schiller from the Guysborough area, N.S.
   Age: Horton Group.

5. Report on 1 sample from Axel Heiberg Is., Canadian Arctic; provided by H.P. Trettin, submitted for publication in 1963 by the G.S.C.
   Age: Mississippian (Viséan)

6. Report on 17 samples submitted by P. Carr from Moncton map-area, N.B.
   Age: Post-Morien, Morien, Mississippian, and possibly Devonian.

7. Report on 1 sample from Parrsboro limestone quarry, requested by M. Copeland.
   Age: Riversdale Group.

8. Report on 2 samples from the Creignish Formation for D.G. Kelley.
   Age: Horton Group. (lower)

Spore Study of the Coal Horizons of New Brunswick, by M.S. Barss and P.A. Hacquebard

During 1962 an additional 20 samples were macerated for this project. Studies on this project have been carried out intermittently, and progress depends to a large extent on the urgency of obtaining results with the other investigations, particularly those mentioned in the preceding project.

Special Projects

1. Spore Study of Canso and Riversdale Sediments of Nova Scotia, by M.S. Barss

   A preliminary report was prepared on the study of 40 samples in 1961. They were provided by E.S. Belt, of Yale University, who examined the Canso and Riversdale succession for his Ph.D. thesis. An additional 10 samples were examined during 1962. This study forms a part of our overall spore investigation of the entire Carboniferous succession of the Maritimes, which is of particular significance for rapid age determinations requested by field geologists.

2. Spore Study of the Horton Sediments of Nova Scotia and New Brunswick, by G. Playford

G. Playford, a recipient of a N.R.C. Post-Doctorate Research Fellowship terminated his one year tenure in December 1962. The results of his detailed spore investigations, carried out for taxonomic and stratigraphic purposes are described in a manuscript submitted for publication in 1963 by the G.S.C. Briefly they can be summarized as follows:

a) An examination has been made of miospore assemblages recovered from numerous samples of the Horton Group, many of which were collected by Hacquebard and Playford in June 1962.

b) Fourteen of the samples yielded diverse and well-preserved assemblages; these served as a basis for detailed taxonomic studies of the microflora. Approximately 50 miospore species are represented, of which 26 types are described as new.

c) Assemblages attributable to the Horton Bluff Formation are very similar to those described by Hacquebard (1957). The younger unit of the Horton Group, the Cheverie Formation, contains rather less diverse assemblages which, at specific level, are clearly different from the Horton Bluff microflora.

Hitherto it has not been possible to extend with confidence the biformational subdivisions of the Horton Group beyond the type area. However, the present study indicates the unique value of the plant microfossils in the correlation of scattered exposures of the Horton Group with either its constituent Horton Bluff or Cheverie Formations.

Playford's study has therefore been a most valuable contribution to our knowledge of the spores of the Horton Group. Characteristic miospore assemblages for the upper and lower parts of this group in the type area, have been established. This will permit a more precise dating of Mississippian samples submitted by field geologists, than hitherto was possible, and accordingly will be of great stratigraphic value.

Other Activities And Projects

Project: Springhill Coalfield, P.A. Hacquebard and J.R. Donaldson

Between December 1961 and February 1962 four new boreholes were drilled for the Nos. 3 and 1 seams in the area south of Miller's Corner. The drilling was requested by Springhill Coal Mines Ltd., to obtain additional information on these seams in their lease area. The borehole locations were given by us, and the Nova Scotia Department of Mines carried out the drilling.

The four boreholes gave additional information, which necessitated some changes in our seam contour-maps, which at present have only been indicated on draft copies. The Company and the Nova Scotia Department of Mines have been informed about these.

In order to complete the manuscript on our work of the Springhill Coalfield, which will include the structural, stratigraphic, coal petrological and palynological studies, a considerable amount of drafting remains to be done.

Exchange of Slides with Miospores and Contribution for I.C.M.P., by M.S. Barss

During 1962, slides with Carboniferous miospores were prepared and exchanged with Palynological Laboratories of, respectively, Mobil Oil Co. in Calgary, Alta; Sun Oil Co. in Dallas, Texas; Sinclair Research Laboratory in Tulsa, Okla.; Gulf Oil Co. in Coral Gables, Florida; and Penn. State University.

For the International Committee on the Microflora of the Palaeozoic (I.C.M.P.) a range chart of certain index miospore genera, recorded in the Pennsylvanian of the Maritime Provinces, has been prepared. It will be compared with similar charts submitted from other regions, in an effort to determine the world-wide significance of certain types that are of stratigraphic importance.

Preparation of Coal Samples for Mineral Collection by T.F. Birmingham

A series of coal samples of subbituminous rank were prepared and handed to C.H.R. Gauthier, for the mineral collections, distributed by the G.S.C.

Tour of Maritime Universities by P.A. Hacquebard

During March 1962, lectures in Coal Petrology and Palynology were given at the following Maritime Universities: U.N.B., Mount Allison, Acadia, Dalhousie, St. Francis Xavier, and Memorial. One day was spent at each university, with the exception of Dalhousie University where besides four lectures, two practical sessions were also given, which lasted four days.

Visit to Coal Petrological and Palynological Laboratories in the U.S.S.R., by P.A. Hacquebard

As part of the agreement between the N.R.C. and the Soviet Academy of Sciences, which provides for an annual exchange between seven Canadian and seven Russian scientists, Hacquebard spent six weeks in the U.S.S.R., from October 2 to November 14. During this time the following four institutes and laboratories were visited.

In Moscow: 1) The Coal and Palynology Sections of the Geological Institute, resorting under the Soviet Academy of Sciences. Here, discussions took place, and microscopic observations were made in the fields of Coal Petrology as applied to coal geology, and Carboniferous Palynology. 2) The Coal Petrography Laboratory of the Institute of Geology and Exploitation of Useful Minerals, resorting under the State Committee of the Ministerial Council of the U.S.S.R. At this laboratory a discussion was held on applied Coal Petrography in the field of coke research. 3) The Geological Faculty of the State University of Moscow, where discussions were held in the Department of Coal Geology.

In Leningrad: 4) The Coal and Palynology Sections of VSEGEI (All Union Geological Institute), where discussions and microscopic observations took place, similar to those at the Geological Institute in Moscow.

Field Activities

1. Nova Scotia and New Brunswick

From June 4 to July 3, 1962, P.A. Hacquebard and G. Playford collected 90 samples for the spore investigations, of which 61 were taken from the Horton Group at various locations throughout Nova Scotia and in the Moncton Basin of New Brunswick. In Nova Scotia particular attention was paid to the type areas along the Avon River in the Horton-Windsor District. (See also item 2 under Special Projects.)

In the Syndicate mine of the Springhill coalfield a complete column sample was taken of the No. 3 seam for a petrographic study. (See also report on petrographic study of major coal seams of the Springhill Coalfield, by J.R. Donaldson, on previous page.)

2. British Columbia

During the month of June, 1962, A.R. Cameron and J.R. Donaldson collected coal samples in collieries at Michel. They obtained 10 column and channel samples from the "A", Balmer, and No. 1 seams, with a total aggregate thickness of 217 feet of coal, plus two 900 lb. samples for carbonization tests in the experimental coke oven in Ottawa. (See also item 2 under Study of Coking Coals, by A.R. Cameron, on previous page.)

Attendance at Conferences and Meetings

1. International Conference on Palynology at Tucson, Arizona in April 1962, was attended by M.S. Barss and G. Playford.

2. C.I.M.M. meetings in Ottawa in April 1962, were attended by P.A. Hacquebard, T.F. Birmingham, J.R. Donaldson, and A.R. Cameron.

3. Mining Society of Nova Scotia meetings at Ingonish, N.S., in June 1962, were attended by P.A. Hacquebard.

4. Meeting of Coal Petrographers at the Bituminous Coal Research Laboratories at Pittsburgh, in October 1962, was attended by A.R. Cameron.

5. Joint Solid Fuels Conference A.S.M.E. and A.I.M.E., Pittsburgh, October 1962, was attended by A.R. Cameron.

Outside Talks

In addition to the lectures given at the Maritime Universities during March 1962, P.A. Hacquebard also gave two talks in the U.S.S.R., entitled: "Review of Coal Petrological Investigations in Canada", and "Canadian Contributions in Carboniferous Palynology, with a discussion of 'The regional distribution of several selected miospores that are typical of the Lower Carboniferous of Canada'".

At the International Meeting on Palynology held in Tucson, Arizona, in April 1962, M.S. Barss presented "Palynology and Stratigraphy of Upper Palaeozoic Sediments of the Maritime Provinces, Canada", and G. Playford presented "Similarities between Lower Carboniferous Microfloras of Spitsbergen, Canada, and the U.S.S.R."

At the joint Solid Fuel Conference held in Pittsburgh, in October, the following paper was presented: "Coal Seam Composition as an Assist to the Manipulation of Product Quality", by Thompson, R.R., Cameron, A.R., and Spackman, W.

Personnel

In December 1962, G. Playford terminated his one year tenure of the N.R.C. post-doctorate fellowship with the Geological Survey, and returned to Australia, where he has accepted a position as lecturer in Micropalaeontology at the University of Queensland (Brisbane).

Membership on Committees

P.A. Hacquebard
- International Committee on Coal Petrology, Nomenclature Subcommittee.
- International Committee on the Microflora of the Palaeozoic.
- Member of Council of C.I.M.M. for Mining Society of Nova Scotia (until July 1962).
- Vice-Chairman, Coal Group, G.S.A. (since November 1962).
- Member, National Advisory Committee on Coal Research.

A.R. Cameron
- Member, National Advisory Committee on Coal Research.

Outside Publications

Barss, M.S., Hacquebard, P.A., and Howie, R.D.: Palynology and Stratigraphy of Upper Palaeozoic Sediments of the Maritime Provinces, Canada; Abstract in "Pollen et Spores".

Hacquebard, P.A.: Palynological Studies of Some Upper and Lower Carboniferous Strata in Nova Scotia. Part I. The Mabou Coal Area; Proc. Third Conf. Origin and Constitution of Coal, Crystal Cliffs, N.S., June 1956, pp. 227-256, published in 1961, by the Nova Scotia Research Foundation, Halifax, N.S.

Reports with Outside Circulation

Cameron, A.R.: Petrographic Compositions of Coking Coal Blends under Investigation by the Steel Company of Canada, Ltd., 32 pp.; 8 figs., 1 plate. 1962.

WESTERN PLAINS OFFICE

R.T.D. Wickenden

General

The principal purpose of the office is the study of stratigraphic problems related to the oil and gas developments in Western Canada and the collection and storage of drilling samples, cores and information about wells drilled in the region. This includes the custody of all cores and drilling samples from wells in the Yukon Territory, Northwest Territories, and the Arctic Islands. The collection is available for examination by geologists from the oil and gas industry. Approval from the operators must be obtained before samples and cores from wells on which the information is confidential, are examined.

During the first eleven months of 1962, 2,571 visitors came to the office to buy publications, study samples and core, and consult with members of the staff. Publications numbering 3,888, with a value of $1,915.45, were sold during the same period. These figures indicate the slow down in oil and gas exploration, although the number of publications sold, and visitors, increased during the last two months of the year.

Altogether 223,146 samples were received. These included 28,074 from Saskatchewan; 126,809 from Alberta; 61,570 from British Columbia; and 6,693 from the Northwest Territories, Yukon Territory, and Arctic Islands. A total of 5,683 electric and other mechanical logs were added to the well information files.

In October, additional office and storage space became available in the Fairmore Building at 725 - 11th Ave. West, in Calgary. All cores from the Yukon and Northwest Territories were moved to that location. An area with three roller equipped tables for examining cores is available at this new office. It is expected that all cores from the Territories and the District of Franklin will be stored at the Fairmore Building early in 1963. This arrangement will provide a convenient central location where any qualified person may study cores.

Besides offices for geologists being transferred from Ottawa, the Fairmore Building also has a Petrological laboratory equipped for sedimentary studies, and a Micropalaeontological laboratory.

Messrs. D.L. Herron and S.M. Kasner joined the staff as Assistant Technician and Technician respectively; Mr. Kasner transferred to another government department in June. Mr. W.J. Banning was appointed as Technician. Mr. G.H. Abbott resigned from the staff in October. Dr. E.J.W. Irish and H.P. Trettin were moved from Ottawa to Calgary, although their work continues to be under other sections of the Fuels and Stratigraphic Division.

Mr. V.V. Sastri, Senior Palaeontologist of the Oil and Gas Commission of India, in Canada under the Colombo Plan, spent the summer season studying methods and completing a study of smaller foraminifera that was started when Dr. R.T.D. Wickenden was in India in 1960.

Attendance at Meetings

Drs. C.F. Burk and R.T.D. Wickenden attended the Annual Meetings of the American Association of Petroleum Geologists in San Francisco in March.

Dr. R.T.D. Wickenden, attended the meetings of the Royal Society of Canada in Hamilton, Ontario, in June.

Drs. Helen R. Belyea and J.D. Aitken attended the Alberta Society of Petroleum Geologists Field Conference in September.

Dr. C.F. Burk and Mr. E.J. Tassonyi attended the Schlumberger well logging conference in Calgary in April.

Dr. C.F. Burk attended the Society of Exploration Geophysicists 32nd Annual Meeting in Calgary in September.

Activities

Dr. J.D. Aitken continued field work on pre-Devonian formations. He presented a paper prepared with Dr. Eric W. Mountjoy at the Symposium on Sandstone Deposition, held in October by the Alberta Society of Petroleum Geologists. The title was: "Paleocurrent Studies in Sandstones of Early Cambrian and Later Precambrian Age, Banff and Jasper National Parks". The paper will be submitted for publication in The Journal of the A.S.P.G. early in 1963.

Dr. Helen R. Belyea continued to study subsurface formations of Devonian age in Alberta, British Columbia, and the Northwest Territories. At present she is preparing a paper on the relationship between the Slave Point and Beaverhill Lake Formations. She is also cooperating with Dr. B.S. Norford on a study of the Middle Devonian Harrogate Formation and older Devonian formations of the Stanford and Beaverfoot-Briscoe Ranges in British Columbia. She addressed a meeting of the Alberta Society of Petroleum Geologists on her observations on reef occurrences in the Devonian and Triassic of Belgium, Germany, Austria, and northern Italy. This talk was illustrated by colour slides that Dr. Belyea had taken while on a trip in Europe. She presented the results of the studies she and Dr. D.J. McLaren had made on the Upper Devonian for Geol. Survey Paper 61-29, and with Dr. A.W. Norris on the Middle Devonian and older Palaeozoic Formations prepared for Geol. Survey Paper 62-15, in an address to the Alberta Society of Petroleum Geologists in Calgary, and the Edmonton Geological Society, in Edmonton. Dr. Belyea spoke at the Annual Field Conference of the Alberta Society of Petroleum Geologists in the Crowsnest Pass area.

Dr. C.F. Burk continued to study the subsurface Upper Cretaceous Marine beds in West-central Alberta, paying particular attention to the potential Oil and Gas reservoirs such as the Cardium, Dunvegan, and Bad Heart sandstones. A paper entitled "Upper Cretaceous Structural Development of the Southern Flank of the Peace River Arch" was published in the Journal of the Alberta Society of Petroleum Geologists, vol. 10, No. 5, May 1962, pp. 223-227.

A manuscript on the Regional Silurian Stratigraphy of the Gaspé Peninsula, Quebec, Canada, was prepared for publication outside the Department.

Mr. R.L. Cox started a study of the Lower Cretaceous Paddy Member of the Peace River Formation in northern Alberta.

Mr. L.L. Price continued studies of the subsurface Lower Cretaceous of Saskatchewan. During the field season he studied exposures of beds of this age along the extension of the Manitoba escarpment in northern Saskatchewan.

Dr. R.M. Procter continued studying the subsurface Mississippian Formation in Northeastern British Columbia during the first quarter of the year. The remainder of the year was concerned with Operation Porcupine where he was responsible for the stratigraphy of Cambrian and Precambrian rocks. A paper entitled "Semiquantitative Clay Mineralogy in Subsurface Studies" was published in the Journal of the Alberta Society of Petroleum Geologists, volume 10, No. 5, May 1962, pp. 257-270.

Dr. D.C. Pugh maintained the Keysort punch cards and studied insoluble residues from Upper Devonian beds in wells in Alberta.

Mr. E.J. Tassonyi helped compile information for the Schedule of Wells of Yukon and Northwest Territories and started a study of the subsurface geology of Lower Mackenzie River and Anderson River areas, District of Mackenzie.

The following members of the Staff contributed information to the geological part of the Schedule of Wells of the Northwest Territories and Yukon Territories, published by the Department of Northern Affairs and National Resources: J.D. Aitken, H.R. Belyea, T.P. Chamney, R.M. Procter, D.F. Stott, and E.J. Tassonyi. The compilation was done by Dr. Helen R. Belyea and Mr. E.J. Tassonyi.

Dr. R.T.D. Wickenden administered the office.

Membership on Committees

Dr. J.D. Aitken served on the Alberta Society of Petroleum Geologists Research Committee.

Dr. Helen R. Belyea served on the Nomenclature Committee and the Medal of Merit Committee of the Alberta Society of Petroleum Geologists and was a District Representative of the American Association of Petroleum Geologists.

Dr. C.F. Burk was Chairman of the Program Committee of the Alberta Society of Petroleum Geologists.

Mr. R.L. Cox served on the Alberta Society of Petroleum Geologists Speaker Committee.

Dr. R.M. Procter continued on as a member of the Carboniferous Committee of the Alberta Society of Petroleum Geologists.

ECONOMIC GEOLOGY DIVISION

Y.O. Fortier, Chief

INTRODUCTION

The activities of the division are directed to metallogeny, geochemistry, hydrogeology, geological engineering, and the surficial geology of Canada. The efforts are not immediately directed to the making of resource inventories but rather to providing a basis for such inventories and for the promotion of exploration and development of resources. The studies bear on providing basic descriptive data, on identifying the natural systems, and on understanding the processes, past or present.

In metallogeny, an effort is made to identify the major systems, in time and space, of ore forming, and to relate such systems to the all encompassing geological framework. On the one hand, such an effort depends on available knowledge of this geological framework and, at least, of the geographical location of known occurrences of ore minerals. On the other hand, the effort results in the production of new data and information issuing from the laboratory investigations and the field observations as required by the study. All this should lead to some forecasting in examining mineral potentials, regionally or nationally, all of which demands intelligence in natural processes. This is gained by the metallogenists resorting to mineralogical, petrological, stratigraphical, structural, and chemical studies.

The specific concentration on the study of the role of chemistry in nature is the domain of geochemistry. Within the division, geochemists for certainty address themselves to the study of ore deposits, but their interest extends to all levels of natural concentration and to all natural chemical processes leading to whatever concentrations. The geochemists, to gain such knowledge, must search nature itself in the field, but the determinative and the experimental laboratories are also their home. Ready chemical field methods for use by all are first evolved in the laboratory. Both the metallogenist and the geochemist also study and develop techniques for mineral exploration and these are communicated to all in the appropriate publications.

The metallogenetic and geochemical activities bear a very close relation to hydrogeology. It is in its geological bed that the groundwater obtains its chemistry, can or cannot become mineralized, may act as a mineralizer, or may remain the relative meteorological virgin sought by one and all. The study of groundwater is a dynamic one. It must determine the path the water follows down the established underground hydraulic gradient and through the geological materials; it must establish how and at what rate it may be chemically affected; it must sum up the water budget, to know the economic availability, to distinguish between the renewable, meteorological water, and the old water which could be mined without foreseeable replacement. In his overall quantitative and qualitative study of that part of the hydrological cycle buried in the geological domain, the hydrogeologist must keep very close contacts with the geological investigation and, at the same time, maintain intimate associations with the meteorologists, the various agricultural scientists and the surface water hydraulic engineers. In giving guidance for groundwater prospecting, the hydrogeologist must work in close association with the subsurface stratigraphers, the experimental geophysicists, and the investigators of the surficial geology.

Surficial geology deals with unconsolidated deposits formed during Pleistocene time and largely under glacial and related environments. These deposits constitute the foundations beneath many engineering structures; the parent materials of agricultural and forest soils; the source of gravels, sands, and other construction aggregates; and the reservoir enclosing much of the groundwater. The chronology of deposits constitutes the last part of geological history. Investigation of this facet of geology makes demands on supporting services and requires discipline associations comparable to those involved in the work of many other sections of the Geological Survey.

To carry out the above activities, the division makes many demands for basic data on other areas of activities within the branch. It must also systematize the collation of data on which it feeds. Through various evolutions, this has become a natural funnelling of information and has lead to the operation by the division of a Central Technical File service. A.G. Johnston, who has very substantially contributed to the establishment of this service, is now devoting his professional time to metallogenetic studies. Mrs. P.K. Shurben, after two years of preparation, is now the file librarian.

The sketched scientific functions of the division are distributed between four sections. These are -

Geology of Mineral Deposits

Geochemistry

Pleistocene Geology

Engineering and Groundwater Geology

The activities of each section in 1962, are described in detail on the following pages.

REPORTS ON SECTIONS

Geology of Mineral Deposits Section

R. Mulligan

Activities of Survey officers in the Section include both intensive studies whose aim is an understanding of the geology of one mineral commodity, or group of commodities, and more widely based theoretical studies, whose object is to discover the conditions of deposition and the geological relations of mineral deposits of various structural and mineralogical types. The two kinds of studies are interrelated and, although emphasis recently has tended to shift towards studies of the second group, both are important.

A new activity of the section was the institution of an internal discussion group. The meetings so far held have proved useful as a forum for the expression of ideas as well as for mutual information regarding current research activities by the members.

Facilities for research in the metallogenic laboratory have been expanded by the acquisition of several new pieces of equipment. These include:

1. A Frantz Isodynamic Magnetic Separator used so far in the study of heavy minerals project.

2. A photometer for reflectivity measurements in polished sections.

3. A Durener polishing machine was received in December. This machine, to be housed in room 625, is capable of superpolishing 6 ore sections at one time. It is hoped that it can be put into limited operation in a few weeks.

4. A 4" x 5" cut film adapter for Polaroid P N film is being obtained for the Pan Phot research microscope. This should enable Survey geologists to quickly produce photomicrographic prints at any stage of laboratory work.

The nucleus for a suite of ore specimens was assembled. It is planned to have polished sections of these on hand.

Enquiries regarding mineral commodities and economic geology by visitors and by correspondence, commonly devolve on members of the section and they also carry on liaison, on an opposite number basis, with members of the Mines Branch and other research institutions.

Activities

Fuller details of field work than those given below will be found in Geol. Survey Paper 63-1. Field activities are briefly summarized below where necessary to provide background for office and laboratory activities.

J.A. Chamberlain completed for publication a study of uranium distribution in natural waters of the Bancroft-Haliburton region, Ontario.

He also began the study of the occurrence and distribution of sulphide and oxide phases in the Muskox Intrusion and associated country rocks. To date, approximately 250 polished sections of sulphide-bearing specimens have been examined using the facilities of the metallogenic laboratory. The prime object of the study is to provide information that can be used to explain the genesis of the Muskox sulphide and oxides relative to the history of the entire igneous body. Assistance has been provided for 6 weeks by Colombo plan student, Mr. T.B. Sundara of India.

Chamberlain also continued to devote a considerable portion of his time to the equipment, maintenance, and supervision of the metallogenic laboratory.

C.F. Gleeson continued field work and research supervision in connection with heavy mineral studies of the Klondike Placer deposits. Proposed related studies include:

(a) Investigations of trace elements in magnetites and in gold from Klondike and other placer fields.

(b) Origin of stream tin.

(c) Micrometeorite occurrences in the Klondike, involving a proposed paper in collaboration with G.M. Archibald.

G.A. Gross continued studies of iron formations in Eastern Canada and submitted a manuscript for an Economic Geology series report on Iron Deposits. He directed the study of contact metamorphic iron deposits in southern B.C., by D.F. Sangster and that of iron silicate minerals by K.L. Chakraborty.

He attended the annual meeting of the Lake Superior Institute. In the course of a U.N. assignment to British Guiana he visited iron fields in Venezuela, Peru, and Brazil.

E.D. Kindle continued field studies on copper deposits of Yukon and northern B.C. for an Economic Geology Series report. Forty samples will be analyzed also for gold and silver and 80 for various metals, including gallium, by spectrographic methods.

He also collected material on copper properties in Canada for a metallogenic map.

W.D. McCartney continued work on barite and fluorite deposits in Canada with exploratory research on the possible interrelation of geological environment, temperature of formation (using fluid inclusion and decrepitation methods), major and minor element variations in megascopically pure barite, and the presence or absence of economic sulphide minerals in or near barite deposits.

Dr. McCartney continued work in several aspects of metallogenic study, which included a brief field season in the Canadian Appalachians and responsibility for the renewal of publication of metallogenic maps in Canada, aided by A.G. Johnston for part of the time. These maps and continuing discussions may contribute to a world metallogenic map for the International Congress in 1968. In addition he gave a reading course at Carleton University on Metallogenic Concepts.

C.R. McLeod remained in Ottawa to supervise laboratory phases of research connected with heavy mineral studies of Klondike Placer Deposits.

R. Mulligan continued field and laboratory work on tin and beryllium, including:

1. Sampling and analysis, of granites associated with occurrences of beryllium, tin, and geochemically-related elements.

2. Study of heavy mineral concentrates for beryllium minerals other than beryl.

3. Application of x-ray fluorimetry to polished and cut specimens for tin (special adaptors made).

4. Investigation of tin content in wolframite, also in placer magnetite and gold (by arrangement with C.F. Gleeson), and in collaboration with Gleeson on origin of stream tin.

5. Distribution of tin between mineral phases in stanniferous mixed sulphide deposits.

Dr. Mulligan with F.C. Taylor, completed final map of Hill Island Lake (75C) map-area, for publication.

S.M. Roscoe continued work on reports of studies of Elliot Lake uranium deposits. These reports include: regional and local geological relationships of radioactive conglomerates in Huronian rocks; mineralogy and geochemistry of Elliot Lake Uranium deposits; isotopic constitution of sulphur in sulphides in Elliot Lake ores and other Huronian rocks. A bulletin, "Geochronological Evidence for the Origin of Elliot Lake Uranium Deposits", was completed.

Dr. Roscoe supervised work on samples collected in 1961 between Kirkland Lake and Lake Huron as part of a metallogenic study in the region between Lake Superior and Chibougamau.

He also served on an advisory committee that considered projects that might aid mining exploration at Kirkland Lake, Ontario, and in the adjacent region.

E.R. Rose submitted a manuscript for an Economic Geology series publication on "Titanium and Titaniferous Deposits of Canada".

Investigation of the ferride element content of titaniferous rocks and ores is continuing. Further work is required to study the relationship between chemical composition and magnetic properties of the materials.

D.R.E. Whitmore completed surface and underground mapping at Coronation Mines as part of Geological Survey contribution to this cooperative project. A preliminary map and report are being prepared for publication. E. Froese, senior assistant on Dr. Whitmore's field party has been retained as a winter assistant to complete a petrological study of the metamorphic rocks of the map-area and in particular the rocks immediately surrounding the orebody.

Preliminary groundwork was done for a metallogenic study of massive sulphide deposits, including a systematic collection of sulphides and wall rocks from a large number of deposits in Manitoba and Saskatchewan. Material was also collected from New Brunswick (Heath Steele) and the Northwest Territories (Rankin Inlet).

Besides coordination of Coronation Mine Study project, Dr. Whitmore's studies involved the geology of Heath Steele massive sulphide deposits, and of the massive sulphide deposits of Yukon and Northwest Territories as office projects.

Meetings Attended

	Prospectors	C.I.M.	G.S.A.
Chamberlain, J.A.	X	X	
Gleeson, C.F.		X	
Gross, G.A.	X	X	
Kindle, E.D.		X	
McCartney, W.D.	X	X	
Mulligan, R.		X	
Roscoe, S.M.		X	X
Rose, E.R.		X	
Whitmore, D.R.E.		X	

Membership on Committees

J.A. Chamberlain	-	Council Member, Geologists Group Professional Institute. Member Executive, Ottawa Branch C.I.M.
W.D. McCartney	-	Branch Equipment Committee and Departmental.
S.M. Roscoe	-	Age Determinations. Absolute Age.
D.R.E. Whitmore	-	Stable Isotope Committee Associated Secretary, Ottawa Branch, C.I.M.

Outside Publications

W.D. McCartney and R.R. Potter: Mineralization as Related to Structural Deformation, Igneous Activity and Sedimentation In Folded Geosynclines; Can. Min. Jour. vol. 83, No. 4, pp. 83-87 (1962).

W.D. McCartney: Mineralization in Mobile Belts; Econ Geol. vol. 57, No. 7, pp. 1131-1132 (1962).

R. Mulligan: Origin of Lithium-Beryllium Pegmatites; C.I.M. Bull. Dec. 1962.

S.M. Roscoe: "Evidence for Placer Origin of Elliot Lake Uranium Deposits", (Abst.), Program of Geol. Soc. America Ann. Meeting, p. 128A, 1962.

Talks

W.D. McCartney: Presented a paper "Mineralization in Folded Geosynclines" at the Annual Meeting of Prospectors and Developers Association, Toronto, March 1962, and a paper "Geology of Gold Deposits", to the Ottawa Branch, Can. Inst. of Min. and Met.

E.R. Rose: Addressed the Logan Club on "Anorthosites and Titaniferous Deposits of Canada".

D.R.E. Whitmore: Addressed the Carleton University Geological Club on "Exploration Geology".

GEOCHEMICAL SECTION

R.W. Boyle

During 1962 geochemical field work was carried out in three areas, one in the Bathurst mineral belt of New Brunswick, another in the Kirkland Lake mineralized belt of Ontario, and the third in the Grenville rocks of southeastern Ontario. In addition one member of the section examined the area of the New Quebec Crater to shed further light on the crater's origin, and another member of the section examined a number of silver deposits in northwestern Ontario and southern British Columbia.

Laboratory research on the chemistry of ore deposition, metamorphism, isotope geochemistry, radiochemistry, geochemical prospecting, and sedimentary geochemistry was continued and expanded.

A mobile spectrographic laboratory for all types of geochemical work was designed, built, and put into service.

Work proceeded on the design and installation of high temperature-high pressure apparatus for the study of metamorphic and igneous processes.

In December a start was made on the installation of specialized equipment for work in the greenhouse.

Additions to the permanent staff during 1962 included Dr. J.A.C. Fortescue, a biogeochemist who is charged with the development of biogeochemical research in the Survey.

Summary of Field Work

Geochemical and geological work continued in the Bathurst-Newcastle mineral belt of New Brunswick under the supervision of R.W. Boyle.

J.L. Davies, a survey assistant, continued the geological mapping of the Rocky Brook-Millstream River area in the Bathurst mineral belt at a scale of 1 inch to 2,000 feet. A geological map, now in preparation, will provide a clearer picture of the geological environment of the Nigadoo and Sturgeon River deposits, as well as other smaller deposits. This map should serve as a good guide in further geochemical work and aid future prospecting by the mining industry.

W.M. Tupper completed the surface mapping of the Nigadoo, Orvan Brook, and Captain Yellowknife deposits in the Bathurst-Newcastle mineral belt at a scale of 1 inch to 100 feet. The subsurface geology was mapped where drill core was available, and all three deposits were sampled for sulphur isotope analysis, trace element analysis, and petrographic work.

A.Y. Smith commenced preliminary geochemical work on the stream sediments and stream waters of the Bathurst-Newcastle mineral belt. The Millstream River system was selected for a pilot study of methods of sampling and analysis. The elements chosen for study included Cu, Zn, Pb, As, Sb, Ag, Mo, Sn, W, V, Ni, Co, and Mn.

M. Tauchid, a Colombo plant student, commenced a study of the geochemistry of molybdenum in the Bathurst mineral belt. The object of this project is to determine the distribution of molybdenum in the rocks, soils and waters of the area and particularly to observe its migratory habit as an aid in using the element in geochemical prospecting methods as an indicator of the copper-lead-zinc deposits.

Other geochemical work in the Bathurst-Newcastle area included an investigation by W.M. Tupper of the geochemistry of the precipitation of iron under the existing pH-Eh-temperature conditions of the area, and a granite sampling program. Several granite and porphyry bodies were sampled in detail and the samples were forwarded to Ottawa for analysis. The object of the project is to see whether or not the stocks and batholiths of the mineral belt reflect the presence of the lead-zinc deposits through their trace element content.

R.W. Boyle examined several silver deposits in Northwestern Ontario and Southern British Columbia. The data collected from these investigations will be incorporated in a future bulletin on the geochemistry of silver deposits in Canada.

R.H.C. Holman commenced a geochemical investigation of the Kirkland Lake mineralized belt with a view to appraising the possibility of applying geochemical techniques to mineral exploration in the belt and to elucidation of the geology of the gold deposits. To assist in this work a mobile spectrographic laboratory mounted in a trailer was put into service. A total of 450 rock samples were collected from underground sites at three operating gold mines, from outcrops on the surface within the mineralized belt, and from the surrounding area. These samples were analyzed by a semi-quantitative method for Ti, Mn, V, Cr, Cu, Co, Ni, Pb, Sn, Ag, B, Mo, and Zr by emission spectrography in the mobile laboratory.

K.L. Currie spent part of the summer field season examining the geology in the vicinity of the New Quebec Crater. No new evidence of impact origin by a meteorite was found. Structures in the foliation, and the presence of hydrothermal alteration do not agree with the impact hypothesis. The origin of the crater is considered to be still uncertain.

A.H. Debnam, an N.R.C. Post-Doctorate fellow, spent the month of June collecting soil samples over oil and gas fields in SW Ontario (Gables and Colchester) and Alberta (Innisfail and Pincher Creek), as part of a study of the geochemical methods of prospecting for oil and gas. Sampling was in much greater detail than that carried out during a preliminary survey in 1961 in the same area.

Laboratory and Office Work

During 1962, the Geochemical Trace Elements Laboratory under the supervision of J. Lynch analyzed 3,379 samples including rocks, soils, stream sediments, minerals, natural spring precipitates, water and biological materials. In all a total of 19,291 analyses were carried out on these samples. A copy of Mr. Lynch's report covering the activities of the Trace Elements Laboratories is appended.

J. Lynch and R. Boyle continued their cooperative efforts with the biologists of the Fisheries Research Board, St. Andrews, New Brunswick, on the trace element content of various biological materials in the ocean, particularly oysters, quahaugs, and scallops. The project is a long term one and seeks to determine the role of zinc, cadmium, copper, lead, arsenic, and antimony in the life processes of oceanic creatures. The work has proven of great value to the Fisheries people in controlling the environment for oyster and quahaug culture. To the geologist the results are of great importance in understanding the role of living creatures in concentrating metals in a sedimentary environment. For instance it has been found that oysters and other shell fish concentrate up to 10% Zn in the ash of their living parts.

J. Lynch continued research on new and better analytical methods for geochemical materials. Development work on the spectrophotometric methods for the determination of arsenic and silver were investigated and should be ready for field applications in the near future.

The geochemical preparation laboratory under the supervision of P. Lavergne continued to develop more rapid and effective methods of sample preparation. In addition a rock preparation laboratory for use in conjunction with the field spectrograph was designed and put in operation. During the year 1,779 samples were crushed and ground and 1,925 were powdered for trace element analysis. Some 1,981 samples received special treatment. A complete breakdown of the work in the preparation laboratory in Ottawa is given in Mr. Lavergne's report.

R.A. Washington continued detailed studies on the adsorption characteristics of Co^{60} tracer on quartz and feldspar over a range of pH values from 3 to 7. Similar work using Zn^{65} is continuing.

He also did a large amount of development work on neutron activation methods, particularly for the determination of cadmium in igneous and sedimentary rocks. The preliminary results are satisfactory and the sensitivity of the methods is better than the spectrographic methods especially where the contents are less than a few parts per million.

R.W. Boyle continued laboratory work on the geochemistry of silver, especially the migratory habit of the element in the presence of arsenic, antimony, iron, and manganese in solution. The Eh and pH conditions of precipitation of silver have been worked out in detail. Work on the solubility of barium in NaCl solutions and the precipitation of the element in the presence of natural sulphates (gypsum) was started and is continuing.

R.W. Boyle completed a laboratory study of the barium content of soils, waters, and rocks in the Walton-Cheverie area, Nova Scotia. Work on the complex sulphides of the Walton deposit has begun in cooperation with J.L. Jambor of the Mineralogy Section.

J. Fortescue collected 130 samples of plant material in the vicinity of two mineral deposits in the Ottawa area for preliminary studies in biogeochemistry. Progress was also made in the development of a spectrochemical method for the analysis of various metals in plant material.

A.H. Debnam completed the laboratory examination of soils by means of gas chromatography for traces of hydrocarbons over several oil and gas fields in Ontario and Alberta. Compilation and correlation of the results is now in progress and Dr. Debnam has promised a final report in the near future.

K.L. Currie continued the construction of high temperature-high pressure apparatus for the study of metamorphic and igneous processes in rocks. Experiments will begin in the new year after the apparatus is adequately tested.

R.H.C. Holman continued the development of spectrographic methods for use in the field laboratory. New techniques for use with solutions and for the determination of gold in rocks and ores are being studied. The preparation of improved standards for use in the field has also received considerable attention.

Mrs. J. Vollrath, M.Sc. candidate, Carleton University, working under the direction of R.H.C. Holman completed the analysis of several hundred samples of leucocratic granites from Northwestern Ontario for sodium and potassium. In addition the analysis of separated rock forming minerals for several trace elements was completed on the same leucocratic granites.

E.M. Cameron and Mrs. T.D. Dawes continued the development of spectrographic methods by means of the quantograph. Analytical methods for Si, Al, Ca, Mg, Fe, Mn, Ti, and Na, the major elements in rocks, have been developed and the conditions for sample preparation, and temperature and humidity control have been

worked out in detail. In addition the best source conditions for the analysis of trace elements was investigated. An arc-like, low voltage spark was found to give the best sensitivity, and an analytical method based on these findings will be developed in the new year.

E.M. Cameron completed the correlation of geochemical data on the Lower Cretaceous of Alberta and the chemical correlations and geochemistry of the Cretaceous sandstones in the Foothills.

Outside Talks and Attendance at Meetings and Conferences

R.A. Washington presented a paper titled "Neutron Activation Analyses of Silicate Rocks", at the joint C.I.C.-C.A.A.S. symposium in Ottawa, September 19, 1962. He delivered a lecture on the same subject to the Ottawa Branch of the C.A.A.S. (Can. Assoc. Applied Spectroscopy) on December 10, 1962.

R.H.C. Holman and R.F. Emslie gave a talk on "Some Problems of Data Reduction, Analyses, and Prediction in Dealing with Large Quantities of Geochemical Data" to the Geochemical Discussion group in Ottawa in April. R.F. Emslie gave a talk entitled "Problems of Regional Geochemistry Applied to Bedrock", based partly on R.H.C. Holman's work, to the C.I.M.M., Quebec City Branch in May.

R.W. Boyle visited several geochemical and geological institutes in the Soviet Union as part of the joint exchange program of scientists sponsored by the National Research Council of Canada and the U.S.S.R. Academy of Sciences. In Moscow visits were made to the Vernadslay Institute of Geochemistry and Analytical Chemistry, the Institute of Geology of Rare Elements, the Institute of Geology Ore Deposits, Petrology, Mineralogy, and Geochemistry, Institute of Mineralogy, Geochemistry, and Crystal Chemistry of Rare Elements, and Moscow State University. Five lectures were given in the various institutes in Moscow.

These were titled:

Geochemistry in the Geological Survey of Canada.
Geochemistry of the Yellowknife Gold Belt.
Geology and Geochemistry of some Rare Elements in Canada.
Isotope Geochemistry - Some Problems.
Diffusion in Ore genesis.

In Leningrad the following Institutes were visited:

All Union Geological Research Institute.
Laboratory of Precambrian Geology.
Leningrad Institute of Mining.
Leningrad State University.
Geological Museum of the All Union Geological Research Institute.

While in Europe R.W. Boyle visited several Universities and Geochemical and Geological Institutes. These included:

The Geological Survey of Finland - Helsinki.
Univeristy of Helsinki.
Geological Survey of Sweden.
University of Oslo.
Geochemical Prospecting Institute at Royal School of Mines, London.
Camborne School of Mines.
Bureau Recherche Geologique Miniere, Paris.
Section de Geochemie, Centre d'Etudes Nucleaires Fontenay-aux-Roses, France.
University of Manchester.
Oxford University.

In England R.W. Boyle visited several classical mineral areas. These included:

Leadhills and Wanlockhead lead-zinc belt in Scotland.
Newton Stewart lead-zinc belt in Scotland.
Alderley Edge sandstone copper deposits in England.
Cornwall tin-tungsten belt in southwestern England.

R.W. Boyle also delivered a series of lectures on geochemical topics at the University of Toronto and University of Western Ontario in March.

Membership on Committees

K.L. Currie and R.W. Boyle served on the stable isotope committee of the Survey during 1962.

R.W. Boyle served on the council of the Royal Society of Canada during 1962.

Outside Publications

Boyle, R.W.

1962: Keno Hill-Galena Hill area, Yukon; Commonwealth Liaison Symposium on Regional Geochemistry, London.

1962: Geology and Geochemistry of the Magnet Cove Barium-Lead-Zinc-Silver Deposit, Walton, Nova Scotia; Can. Min. Journal, vol. 83, No. 4, pp. 104-110.

1962: Walton-Cheverie Area, Nova Scotia; Commonwealth Liaison Symposium on Regional Geochemistry, London.

1962: Southwestern Nova Scotia; Commonwealth Liaison Symposium on Regional Geochemistry, London.

1962: Yellowknife Gold Belt Northwest Territories; Commonwealth Liaison Symposium on Regional Geochemistry, London.

Holman, R.H.C.

1962: A Regional Geochemical Reconnaissance of Stream Sediments in the Northern Mainland of Nova Scotia, Canada; Liaison Symposium on Regional Geochemistry in the British Commonwealth, London, pp. 6-21, 1962.

1962: A Regional Geochemical Reconnaissance of Bedrock in the Red Lake-Lansdowne House Area of Ontario, Canada; Liaison Symposium on Regional Geochemistry in the British Commonwealth, pp. 27-36, London, 1962.

Jambor, J.L., and Boyle, R.W.

1962: Gunningite, a new Zinc Sulphate from the Keno Hill-Galena Hill Area, Yukon; Canadian Mineralogist, vol. 7, part 2, pp. 209-218.

Smith, A.Y.

1962: Southeastern New Brunswick; Commonwealth Liaison Symposium on Regional Geochemistry, London.

Summary of Work Completed in

Geochemical Preparation Laboratory, 1962

P. Lavergne

	Crushing	Grinding	Sizing	Superpanning	Frantz separations	Weighing of Fraction	Ball Mill Grinding
G. Archibald				200			74
R.W. Boyle	360	360	360	183	172		90
E.M. Cameron	10	10	10				
K.L. Currie	20	20	20	20	20		
J.L. Davies	152	152	152				150
C.F. Gleeson			80			400	
G.A. Gross	24	24	24	24			
J.J. Lynch							18
C.R. McLeod			30	300		150	312
W.H. Poole	873	873					873
S.M. Roscoe	62	62	62	30			
A.Y. Smith		221	221	221			12
J. Vollrath			90		90		396
D.R.E. Whitmore	57	57	57	57	57	57	
Total	1,558	1,779	1,106	1,035	339	607	1,925

Summary of Analyses Completed, 1962

J. Lynch

(1) For Geochemistry Section

Field Geologist	Type of Sample	Metals Analysed	No. of Samples	No. of Analyses
R.W. Boyle	Pyrites	Zn, Cu, Pb, As, Sb.	9	118
R.W. Boyle	Gabbro	Zn, Cu, Pb, As, Sb, Ni, Co.	1	25
R.W. Boyle	Pyrite Diabase	Zn, Cu, Pb, As, Sb.	1	9
R.W. Boyle	Chromite	Zn, Cu, Pb.	2	6
R.W. Boyle	Sediments Precipitates	Zn, Cu, Pb, As, Sb.	19	251
R.W. Boyle	Rocks	Zn, Cu, Pb, As, Sb, Ni, Co.	4	52
R.W. Boyle	Shale	Zn, Cu, Pb, As, Sb, Ni, Co.	1	16
R.W. Boyle	Tuffs	Co	11	22
R.W. Boyle	Rocks Pyrites	Zn, Cu, Pb, As, Sb.	177	1,845
R.W. Boyle	Soils, Sediments Coal, Vegetation	Zn, Cu, Pb, As, Sb, Ni, Co.	34	254
R.W. Boyle	Rocks	Zn, Cu, Pb, As, Sb.	207	1,418
R.W. Boyle	Rocks	Zn, Cu, Pb, As, Sb, Ni, Co.	27	428
R.W. Boyle	Rocks	Zn, Cu, Pb, As, Sb.	819	4,321

Summary of Analyses (continued)

Field Geologist	Type of Sample	Metals Analysed	No. of Samples	No. of Analyses
J.L. Davies	Rocks Pyrites	Zn, Cu, Pb, As, Sb.	187	1,172
A.H. Debnam	Soils	Zn, Cu, Pb.	482	1,446
R. Holman	Rocks	Pb, Ni, Co, As, Sb, Mo, W.	120	1,104
R. Holman	Minerals	Zn, Cu, Pb, As, Sb, Ni, Co.	92	677
R. Holman	Minerals	Zn, Cu, Pb, Ni, Co.	132	924
R. Holman	Rocks	An, Cu, Pb.	450	1,410
		Totals	2,775	15,498

(2) Outside Geochemistry Section

Sampler	Type of Sample	Metals Analysed	No. of Samples	No. of Analyses
R. Beschel	Soils, Sediments Precipitates	Zn, Cu, Pb, As, Sb.	17	83
C. Gleeson	Sulphides	Zn, Cu, Pb, As, Sb.	25	248
C. Gleeson	Sulphides	Zn, Cu, Pb, Ni, As.	77	513
C. Gleeson	Minerals	Zn, Cu, Pb, As.	278	1,305
J.C. Medcof	Ashed Scallops Oysters, Quahaugs	Zn, Cu, Pb, As, Sb, Ni, Co.	54	454
C. Smith	Rocks	Zn, Cu, Pb.	143	1,010
D. Whitmore	Rocks	Zn, Cu, Ni.	10	180
Totals			604	3,793
Grand Total			3,379	19,291

PLEISTOCENE SECTION

V.K. Prest

Activities

Two members of the Pleistocene section remained in the office over the 1962 field season; E.P. Henderson was engaged in the task of completing a memoir on the Avalon Peninsula, Nfld., while J.G. Fyles served as acting divisional chief for Dr. Y.O. Fortier for the period March 6th to October 1st. E.C. Halstead continued his Pleistocene studies on Vancouver Island, as a seconded member of the Groundwater section. Professor George H. Crowl continued Pleistocene investigations on Prince Edward Island for Dr. V.K. Prest, giving special attention to till fabrics in an effort to dilineate the sphere of action of New Brunswick and Cape Breton-derived glaciers. Professor Alexis Dreimanis assisted Dr. A.M. Stalker in special till fabric studies in southern Alberta. E. Mirynech located the sites for seismic profile lines across the Oak Ridges moraine, north of Lake Ontario, and collaborated with the party in the field to assist in the interpretation of the results. He also obtained his 'doctorate' from the University of Toronto at the year end. R.J. Fulton completed a thesis assignment in southern British Columbia, and at the end of the year obtained his doctorate degree from Northwestern University, thereby qualifying for the permanent C.S. position he had been occupying while completing his academic work. Mr. R. Klassen completed a second year of thesis work in the Riding Mountain area of Manitoba and a preliminary map of the work to date was submitted before the year's end. In addition he submitted short notes on puzzling linear features on the east side of Lake Manitoba (brought to our attention by Topographic Survey), concluding that they represent both glacial fluting and grooves left by lake ice-floes.

J. Terasmae spent the better part of the summer in the office and laboratory compiling the results of work at hand submitted for study by Pleistocene geologists and others from all parts of Canada. But he also found time to make short field excursions necessary toward completion of his palynological study on deglaciation of the Lake Erie to James Bay part of Ontario and other relevant areas. Sampling of bog and lake sediments was carried out in the following areas: Riviere du Loup and Dorion-Rigaud, Quebec; Picton-Belleville, Perth-Kingston, Ontario; and in Lake Erie (on board C.M.S. Porte Dauphine).

Both the annual mid-western and eastern Pleistocene field conferences were attended by five members of the section and one attended the Rocky Mountain conference. The glacial features, stratigraphy and chronology observed and discussed at the conferences were

of great interest to the delegates, as were the personal contacts with fellow Pleistocene geologists from diverse parts of Canada and the United States.

J.G. Fyles was a delegate to the annual meeting of the Geological Society of America, held in Houston, Texas, in November, where he served as chairman of the very active Geomorphology Group.

Samples for radiocarbon dating in the C-14 laboratory of the Geological Survey of Canada continue to be selected by a committee chaired by Dr. J.G. Fyles. During the year C-14 analyses were completed for about 65 samples that passed through the hands of the committee. Four of these samples were chosen by the Archaeology section of the National Museum and 2 more Archaeological dates are pending. Although most of the dates bear directly upon geological problems 6 analyses were made to provide information on the C-14 activity of modern and pre-atom bomb marine molluscan shells to aid in evaluating the dates of old shells. About one-quarter of the geological dates relate to early post-glacial marine submergence in Eastern Canada and another quarter to interstadial chronology in the Strait of Georgia region of British Columbia. The balance bear upon a wide range of problems including the chronology of the glacial Great Lakes; the age of the Klondike muck deposits and other materials from the Yukon, marine submergence in Hudson Bay, the Arctic mainland coast, and southwestern British Columbia; and the significance of anomalously high marine shells on Ellesmere Island. Most of these dates are listed in Geological Survey of Canada Radiocarbon Dates II, to be published in Radiocarbon, of the American Journal of Science, vol. V, 1963.

In addition to their regular field and office assignments members of the section were active as follows: -

Blake, W. attended by invitation a Glaciology conference, panel of Glaciology of the National Academy of Sciences (U.S.A.) held at Columbus, Ohio, March 22-24.

Craig, B.G. prepared a display of outstanding photographs to illustrate "Geomorphological Features in Permafrost" for the first Canadian Permafrost Conference, held in Ottawa. He also attended three organizational meetings for a proposed Air-photo Interpretation group, possibly as a subcommittee of the Photogrammetric Committee of the Canadian Institute of Surveying; he has agreed to act as chairman of a Geology Group within this subcommittee.

Fyles, J.G. acted for J.O. Wheeler at the meeting of the Glaciology Subcommittee, Association Comm. Geodesy and Geophysics, N.R.C.

Gadd, N.R. reported to the Director on the results of two days in the field on a problem involving the interpretation of natural phenomena for A.E.C.L., Chalk River.

Hughes, O.L. represented the Pleistocene Section of the Geological Survey at the conference on the Geologic, Hydrologic and Engineering Properties of Tills, held in Edmonton in September, under the auspices of the Pleistocene Subcommittee of the Nat. Advis. Comm. on Research in the Geol. Sciences.

Lee, H.A. acted as one of several leaders of a two-day tour in the Kirkland Lake-Larder Lake gold belt for geologists from Russia and Chile, and delivered a paper at the November G.S.A. meeting in Houston, Texas, on "Pleistocene Glacial-Marine Relations at Trois Pistoles, Quebec".

Terasmae, J. as an aid in the coordination of research efforts, attended the Great Lakes Research Conference in Toronto (April) and the conference on Climate Change, held in Aspen, Colorado (June); he also attended the Muskeg Vehicle Research Conference, held at Parry Sound, Ontario, specifically to study the interrelation of vehicular design and muskeg classification. He made a short colour movie for the Survey on performance of the vehicles demonstrated over different terrain types. In April he delivered a paper on "Palynology in the Canadian Arctic" at the International Conference on Palynology held in Tucson, Arizona and participated in the field trips connected with this conference.

Membership on Committees

Fyles, J.G.	- Commissioner, American Commission for Stratigraphic Nomenclature to November 1962. - Member, Committee on Stratigraphic Names, Geological Survey of Canada. - Chairman (1962), Geomorphology Group, Geological Society of America.
Gadd, N.R.	- Consultant to A.E.C.L. on waste disposal problems.
Lee, H.A.	- Member, Comm. on Sample Collections and Numbering; Geological Survey of Canada.

Stalker, A.M. - Member, Subcommittee on Pleistocene Geology, National Advisory Comm. on Research in Geological Sciences.

Terasmae, J. - Member, Advisory Comm. on Geology, Toronto Rapid Transit Subway Extension.
- Member, subcommittee on Muskeg, Assoc. Comm. Soil and Snow Mechanics.

Outside Publications

Bassett, I.J. and Terasmae, J.: Ragweeds, Ambrosia ssp. in Canada, and their History in Postglacial Time; Can. J. Bot., vol. 40, pp. 141-150 (1962).

Dyck, Willy and Fyles, J.G.: Geological Survey of Canada Radiocarbon Dates I; Radiocarbon, vol. 4, pp. 13-26, 1962.

Lee, Hulbert A.: Pleistocene Glacial-Marine Relations at Trois Pistoles, Quebec; (Abstract), Geol. Soc. Amer. Program for 1962 Ann. Meeting, p. 95A, 1962.

Olsson, I. and Blake, W., Jr.: Problems of Radiocarbon Dating of Raised Beaches based on experience in Spitsbergen; Norsk. Geogr. Tidsskr., V. 8, No. 1-2, 1961-62.

Prest, V.K. and Hode Keyser, J.: Surficial Geology and Soils, Montreal Area, Quebec; Dept. Public Works, City of Montreal, 1962.

Terasmae, J.: Geological Notes and Impressions; Sect. 2, in: Report on Botanical Excursion to the Boreal Forest Region in Northern Quebec and Ontario, by W.K.W. Baldwin, National Museum Canada, 1962.

Sedimentology Laboratory Report

H.A. Lee

Results from the Sedimentology Laboratory are being used as an aid to research carried out by geologists of the Geological Survey for improvement of classification and precision of nomenclature of clastic sediments, in correlation problems, and in basic research into the behaviour of sediments.

The accompanying summary of work chart for 1962 shows generally a moderate increase in output over 1961, and reflects the continuing emphasis maintained in this laboratory on providing services to fill increased demands. In addition to work shown on the accompanying chart, the laboratory staff has made 400 weighings and calculations in aid of a study by Hydrographic Services on silting in Moosonee harbour.

A new rapid-analyzer installed in the Sedimentology Laboratory in 1961 has undergone considerable development work so as to make this instrument capable of measuring not only sand sizes but also clay size particles.

A subsieve sizer was installed in the laboratory in 1962 to complement sieve analyses. This instrument measures the average particle size of the 'fines' of a sediment. A controlled hot plate was also newly installed. It is designed specifically for use in making heavy mineral mounts of detrital grains.

The laboratory staff has provided advice, trained a technician (George Duncan), and otherwise assisted in instrumentation towards establishment of a sedimentology laboratory in Bedford Institute of Oceanography.

Research by the laboratory staff began during the latter part of the year into determining the specific gravity of fines in tills of Canada and its relationship to sedimentation. Twelve measurements on till representative of Eastern Canada have been completed on this research.

Summary of Analyses of Work Completed, 1962

(1) For Pleistocene Section

Field Geologist	Project	Type of Sample	Sieving	Sieve and Pipette Analysis	Heavy Mineral Separation	Heavy Mineral Slides
V.K. Prest			13	19	23	46
W. Blake	Operation Bathurst	Tills, sediments	4	32		
R.J. Fulton	British Columbia	Tills		21		
O.L. Hughes	Operation Porcupine	Tills		10		
H.A. Lee	New Brunswick	Gravels	11	3	1	2
R. Mott	Ontario	Sand	1			
	Rerun on standards	Clay		8	8	
Total			29	93	32	48

(2) Outside Pleistocene Section

J.E. Charron	Manitoba	Sands	19			
C.F. Gleeson	Project Klondike	Sands			40	
Hydrographic Service	Moosonee Harbour	Sands, clays	8	9		
D.J. Kelley	Nova Scotia	Sandstone		2		
K. Kranck	Polar Shelf	Sands	60		34	68
C.R. McLeod	Project Klondike	Sands				705
J.S. Scott	Saskatchewan	Clays		5		
J.J. Tremblay	Quebec	Sands, clays	14	2		
B.R. Pelletier	Polar Shelf	Clays, sands Gravels	15	158	164	328
J. Wyder	Saskatchewan	Clays		8		
Total			116	184	238	1101
Grand Total 1962			145	277	270	1149
Grand Total 1961			112	181	290	637

Palynology Laboratory Report

J. Terasmae

Forty palynological reports have been prepared to date in 1962. Of these reports 24 have been to members of the Geological Survey. Other reports:

4	reports	to	Geographical Branch. M.T.S.
3	"	"	Ontario Department of Mines
2	"	"	McGill University (Montreal)
1	"	"	University of British Columbia
1	"	"	National Museum of Canada
1	"	"	Ontario Dept. Lands & Forests
1	"	"	Ontario Hydro-Electric Power Commission
1	"	"	Dept. Mines, Agr. & Res. Newfoundland
1	"	"	BP Exploration Company
1	"	"	Private Persons

In addition to these reports many inquiries have been answered on subjects of sampling, preparation, and examination of sediments for plant microfossils.

ENGINEERING AND GROUNDWATER GEOLOGY SECTION

I.C. Brown

This section is responsible for research in the field of hydrogeology. Groundwater is a part of the hydrologic cycle and consequently involves not only the study of the relation of groundwater to geology but also its relation to the associated fields of hydrology and meteorology. To cover this broad field we have a threefold program aimed at gaining more knowledge of and publishing information on:

1. The sciences of hydrogeology
2. The resources of groundwater
3. The techniques for developing groundwater

1. The science of hydrogeology requires the calculation of the water balance of a drainage basin. This requires a knowledge of the direction of movement of water from recharge to discharge areas, the quantity of water moving and in storage, and the chemistry of the water throughout the cycle. To this end studies are underway of 'type' drainage basins in different geologic and climatic environments.

At present the work is directed largely toward studies of groundwater flow system in these basins utilizing methods varying from the use of plants as groundwater indicators to the plotting of flow diagrams from pressure data obtained from piezometer sections and well inventory data.

2. The resources of groundwater are being studied by pump tests of selected aquifers, by baseflow studies, and by inventory studies. A vast reservoir of groundwater resource information is available in well inventories, geologic maps, soils maps, etc. To gather this information together and make it available a new series of "Water Probability Maps" has been started. These maps, on a scale of 1 inch to 4 miles, show by a combination of colours and symbols the probable quantity and quality of water that may be obtained by drilling into the various geologic formations. A series of cross-sections indicate the expected depth of the formations. Marginal notes explain the use of the map and call attention to conditions impossible to show on the map. These maps can be compiled rapidly and sufficient data are available to compile them for large areas of Canada.

3. The techniques for developing groundwater, location of an aquifer, quantitative and qualitative testing, and proper well construction are primarily the concern of provincial agencies and private industry. However, part of our concern is the development of techniques to study groundwater and many of these are applicable in its practical development. In cooperation with the Geophysics Division various geophysical techniques have been tested on known aquifers and potential aquifers. In regions of many well failures various techniques of well construction are being tested to see if supplies of potable water can be obtained for farm use.

Cooperation and exchange of information and ideas with other groundwater and hydrologic agencies is continuing to increase. The Third Canadian Hydrology Symposium held at Calgary in November provides a good example of the type of cooperation and interchange of information. At this meeting representatives of all fields of hydrology from the well driller to the research scientist took a very active part in discussion of the papers and these papers varied from description of new well development techniques to mathematical studies of theoretical flow directions.

Personnel

Mr. A. Treichel left the section in June to become a programmer for I.B.M. computers.

Dr. R.O. van Everdingen joined our staff in August. He had previously been working for the Libian government on groundwater and petroleum studies.

Three of our staff are at university on educational leave undertaking graduate studies in hydrogeology. Mr. P.A. Carr is attending the University of Illinois, Urbana. Mr. A.M. Toth is attending the University of Saskatchewan, Saskatoon. Mr. R.A. Freeze is attending the University of California, Berkley.

Dr. P. Meyboom presented a paper at the C.I.M. Annual Meeting in Ottawa, entitled "The Need for a New Approach to Underground Water Studies" and gave a three-day series of lectures and seminars at the University of Illinois, Urbana, at the request of the University.

Possibly the outstanding event of the year was the Third Canadian Hydrology Symposium, sponsored by the National Research Council Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, held at the Calgary Campus of the University of Alberta, November 8th and 9th. The theme of this symposium was groundwater and Mr. L.V. Brandon was responsible for choosing the papers, organizing the meeting, and editing the papers and resultant discussion. This meeting was very successful and gave a clear indication that groundwater research in Canada is advancing at a rapid rate and is now on an equal footing with work in other countries in quality if not in quantity.

Field and Office Activities

Certain field and office activities are worthy of mention in addition to those reported on in Geol. Survey Papers 63-1 and 63-2.

Late in the year space was made available for a groundwater model laboratory and experimental studies were started on conductive paper analogue models.

An extensive drilling program was undertaken during the year with a total of 19,955 feet of drilling being done. Some 6,500 feet of this was drilling and electro-logging done under the 'Winter Works Program' in southeastern Saskatchewan in order to provide accurate reference sections across the buried Missouri Valley against which various geophysical studies could be checked. In December piezometers were installed in the Riverhurst area as a start of the study of the effect on bedrock of flooding of the reservoir behind the South Saskatchewan Dam. Some of the drilling was done to obtain stratigraphic information and some for aquifer test purposes, but a large proportion of it was done in installation of piezometer sections across stream valleys.

Requests received for groundwater information from individuals, industries, drilling companies, and other government departments are referred in large measure to the increasingly active provincial agencies, but where we have specialized knowledge are answered directly.

For the second year the Geological Survey provided engineering geology service to the Department of Public Works, while their engineering geologist is taking graduate training. Advice was given on a variety of projects varying from foundation investigations to sources of aggregate and water supply. Many of the Department of Public Works requests were relayed from other government departments, but in addition to these, direct assistance or advice on engineering geology or groundwater problems was given to the following organizations:

Dept. of National Defence

Dept. of Citizenship and Immigration, Indian Affairs Branch

Dept. of Northern Affairs and National Resources

Dept. of Justice, Penitentiaries Branch

Dept. of Agriculture

P.F.R.A.

Canadian National Railways

Dept. of Forestry

Prince Edward Island, Dept. of Industry and Natural Resources

Nova Scotia Dept. of Mines

Ontario Dept. of Mines

Manitoba Dept. of Agriculture and Conservation

Saskatchewan Dept. of Agriculture

British Columbia Dept. of Lands and Forests

City of Regina

J.S. Scott, in addition to his regular field work, has provided advice and assistance on the groundwater aspects of the Winnipeg Floodway. In cooperation with other members of the staff Scott continued development of the rapid sediment analyzer; test runs of this apparatus were started before the end of the year.

E.B. Owen gave engineering geology advice to the St. Lawrence Seaway Authority in the Welland Canal area and to the Mines Branch in their possible experimental mine study. He continued working with Dr. Pelletier on the submarine drill and planning has reached the stage where funds must be spent; there progress has stopped.

R.G. Pearce revised the groundwater files into two parallel sets of files. One of these sets records data from the observation well program and is filed according to drainage basins. The other contains information from all other drilling programs and is filed according to the National Topographic System. These two systems are designed to fit in with the Central Technical Files. In addition Mr. Pearce keeps an inventory of, and maintains, a considerable amount of specialized equipment and instruments used in groundwater research.

The observation well program is expanding slowly and is being supplemented by a large number of piezometer sections. The number of these in operation in 1962 is as follows:

			Piezometers	
Province	Automatic	Tape	Points	Sections
N.S.	1	-	-	-
P.E.I.	1	2	-	-
N.B.	2	-	-	-
Que.	3	-	-	-
Man.	9	7	63	5
Sask.	6	5	79	13
B.C..	3	-	-	-
N.W.T.	1	-	-	-
Ont.	5	-	-	-
TOTAL	31	14	142	18

I.C. Brown visited Manitoba, Saskatchewan, Alberta, and British Columbia and discussed the observation well program and other groundwater problems, activities, and plans with the various provincial government agencies, research councils, and universities. Saskatchewan and Alberta have been active in groundwater work for some years and Manitoba and British Columbia are now starting active investigations.

Membership on Committees

I.C. Brown	-	Salaries and Classification Committee, Professional Institute.
	-	Subcommittee on Scholarship and Research Training, National Advisory Committee on Research in the Geological Sciences.
	-	Subcommittee on Pleistocene Geology, National Advisory Committee on Research in the Geological Sciences.
L.V. Brandon	-	Subcommittee on Hydrology, N.R.C. Committee on Geodesy and Geophysics.
E.B. Owen	-	Geological Survey E.M.O. Committee.
J.S. Scott	-	N.R.C. Associate Committee on Soil and Snow Mechanics.
	-	Chairman, Till Characterization Committee of the Subcommittee on Pleistocene Geology, National Advisory Committee on Research in the Geological Sciences.

Attendance at Meetings

I.C. Brown	-	Third Canadian Hydrology Symposium, Calgary.
	-	Annual Meeting C.I.M., Ottawa,
	-	Permafrost Symposium, sponsored by N.R.C. Ottawa.
L.V. Brandon	-	Third Canadian Hydrology Symposium, Calgary.
	-	National Water Well Exposition, Cincinnati.
E.C. Halstead	-	Third Canadian Hydrology Symposium, Calgary.
	-	Pleistocene Geology Field Trip Whatcom, Washington, and Fraser Valley.
	-	Symposium on Irrigation, Vancouver.
P. Meyboom	-	Third Canadian Hydrology Symposium, Calgary.
J.S. Scott	-	Conference on the Geologic Hydrologic and Engineering Properties of Till, Edmonton.

Outside Publications

I.C. Brown - A Discussion of Chemical Methods as an Aid to Hydrogeology; presented at the 3rd Canadian Hydrology Symposium. (In press.)

L.V. Brandon - (In cooperation with G.D. Hobson and J.E. Wyder) Aquifer Exploration in Canada by Geophysical Methods; Jour. Amer. Waterworks Assoc., vol. 54, no. 9, pp. 1073-1081, Sept. 1962.

- Hydrogeological Programme of the Geological Survey of Canada; presented at National Waterwell Exposition, Cincinnati. (In press.)

P. Meyboom - Patterns of Groundwater Flow in the Prairie Profile; presented at 3rd Canadian Hydrology Symposium. (In press.)

GEOPHYSICS DIVISION

L.W. Morley, Chief

INTRODUCTION

The function of the geophysics division is firstly to conduct and interpret geophysical surveys that will aid in the understanding of the geology of Canada. Secondly, it is to carry out research into the development of new geophysical methods and instruments that may be applied to help geological investigations and prospecting.

While the organizational chart of the Geological Survey indicates that the geophysics division has 6 sections, in actual fact the divisions between the sections is not as sharp as is indicated. Table I illustrates more fully the spectrum of activity covered by the division.

The following are the highlights of the 1962 work of the division (not in order of priority):

1. The successful completion of the first year of supervising and inspecting the Federal-Provincial Aeromagnetic Survey Plan.

2. The completion of the spinner and astatic-remanent magnetometer for palaeomagnetic work.

TABLE I

PRESENT ACTIVITIES OF THE GEOPHYSICS DIVISION; GEOLOGICAL SURVEY OF CANADA

Type of Work / Method	Geophysical Surveys and Interpretation	Research in Field Methods	Continental Shelf Surveys	LABORATORY RESEARCH			
				Theoretical	Experimental	Instrument Development	Rock Properties
MAGNETIC	Supervision, federal/provincial aeromagnetic surveys. Aeromagnetic interpretation at 1" = 4 miles. Investigations into methods of interpretation	Techniques for flying aeromagnetic surveys in mountains	Aeromagnetic and ship magnetometer surveys	Magnetic field analysis		Airborne and ship magnetometers	Magnetic susceptibility, remanence
SEISMIC	Delineation of buried valleys. Reflection and refraction surveys in stratified rocks. Velocity determinations in PC rocks	Application to Precambrian. Hammer seismic applied to Pleistocene and groundwater	Polar Shelf refraction and reflection surveys				
SONIC		Application to Pleistocene mapping	Sparker and Exploder surveys				
E.M.		Case history studies; application to groundwater		Electromagnetic field analysis applied to various earth models	E.M. model studies using water tank	Airborne devices, instruments for model studies	Conductivity, permittivity, "I.P. effect" of rock and soil samples
RESISTIVITY	D.C. resistivity for delineation of aquifers	Application to groundwater studies				Multi frequency V.L.F. equipment	Conductivity, "I.P. effect"
PALAEO-MAGNETIC		Application to geologic structure		Mapping of polar wandering curves		Curie Point meter; Spinner magnetometer; astatic magnetometer; demagnetizing equipment	Direction of polarization
RADIO-METRIC		Application to geological mapping		Absorption calculations	Gamma-ray absorption by air and rock	Portable gamma-ray spectrometer for field use	Gamma-ray spectra of rocks, soils and emanation

3. The development up to the field testing stage of low frequency induced polarization equipment for groundwater exploration.

4. The successful development of the telemetering proton magnetometer and field evaluation in Nova Scotia and Vancouver Island.

5. The delineation of a large aquifer near Winkler, Manitoba by a D.C. resistivity survey (in cooperation with the Groundwater Section).

6. The indication of a 10,000-foot thickness of sedimentary rocks in Hudson Bay using the ship magnetometer results of the 1961 "Theta" cruise.

7. The demonstration (in cooperation with the Fuels and Stratigraphy Division) of the usefulness of the palaeomagnetic method as a means of solving gross structural problems in the case of the Lewis Thrust Sheet in southern Alberta.

8. The interpretation of the "Roads to Resources" aeromagnetic data in northwestern Ontario (in cooperation with the Regional Geology Division), in which large tracts of hitherto unknown greenstone belts were delineated.

9. The suggestion and supervision of a reconnaissance aeromagnetic survey of Nigeria in cooperation with the Foreign Aid Office together with an interpretation and detailed report recommending further work.

10. The collection of about 600 oriented rock specimens of diabase dykes from widely separated locations in the Canadian Shield, in cooperation with the Regional Geology Division, as part of the Canadian Upper Mantle Project.

11. The interpretation of the 1961 seismic survey near Isaachsen in the Sverdrup Basin of the Arctic, indicating a probable sedimentary thickness of more than 60,000 feet.

12. The successful development of a portable 3-channel gamma-ray spectrometer for field use in cooperation with McGill University.

13. Two well-executed hammer seismic surveys, one resulting in a bedrock topographic contour map of the Moncton Sheet showing the location of the old buried channel of the Petitcodiac River. The other detailed the depth to bedrock and the Pleistocene stratigraphy in the new Winnipeg Floodway.

14. The preparation and submission for publication of four important theoretical papers on electromagnetic prospecting and on the theory of induced polarization.

15. The discovery of an abrupt increase in depth to the Precambrian at Point Traverse in Prince Edward County during a seismic refraction survey of the Oak Ridge Moraine north of Lake Ontario.

PERSONNEL

Additions to staff

Dr. E. Gaucher joined the Palaeomagnetic Section in May. He is a geologist whose thesis work was concerned with rock magnetism and aeromagnetic interpretation.

Dr. D.T. Anderson joined the Geophysics Division in July and has been working on aeromagnetic interpretation and investigating methods of photogeologic interpretation for the Precambrian Shield. His thesis work with the University of Manitoba was concerned with the occurrence of metallic sulphides in igneous rocks.

Dr. W.A. Robertson, an N.R.C. post-doctorate fellow from the University of Canberra, joined the Division on November 6 to do research in palaeomagnetism.

A. Brown and E. Roy were employed as winter seasonals to work on aeromagnetic interpretation.

Attendance at conventions

L.W. Morley, G.D. Hobson, and P.J. Hood - 32nd Annual Convention of the Society of Exploration Geophysicists, Calgary, Alberta in September.

A. Larochelle attended a 2-day symposium on palaeomagnetism in Pittsburgh, Pa., in February.

Visits to other institutions

A.F. Gregory visited the Nigerian Geological Survey, Kaduna, Nigeria; the Overseas Geological Survey, London, England; and the Commonwealth Geological Liaison Office, London, England.

L.S. Collett and B.K. Bhattacharyya visited the laboratories of Newmont Explorations Limited, Danbury, Connecticut; and the Department of Geophysics and Geochemistry, University of Pennsylvania, State College, Penna.

Special talks

A.F. Gregory
- Geophysics Discussion Group, Ottawa
- Logan Club - G.S.C.
- Officers of Nigerian Geological Survey, Kaduna

L.S. Collett coordinated the evening course in Exploration Geophysics at Carleton University. Other members of the Geophysics Division aiding in the lecture series were: A.F. Gregory, G.D. Hobson, P.J. Hood.

L.W. Morley addressed the Canadian Exploration Geophysicists in Toronto on "Geophysics in Japan".

Other activities

A.F. Gregory was assigned to work on a Colombo Plan project to act as an adviser to the Nigerian Government in the matter of aeromagnetic surveys. He spent 3 months at the beginning of the year in Nigeria consulting with officers of the Geological Survey of Nigeria, supervising and interpreting a reconnaissance aeromagnetic survey and spot-checking geological conditions in the field. After returning to Canada he wrote a detailed report of his recommendations for the Nigerian Government, which resulted in aeromagnetic surveys being conducted.

In addition to the above work, he also investigated and reported on possible Canadian assistance in the development of groundwater in Nigeria.

Courses taken by staff members

A. Larochelle and A.F. Gregory took computer programming courses in October and November.

REPORTS ON SECTIONS

MAGNETIC SURVEYS AND INTERPRETATION SECTION

A.S. MacLaren

Aeromagnetic Compilation

A total of 83-map sheets were compiled and 36 were published during the year as follows:

Nova Scotia	2	B.C.	22
Quebec	29	N.W.T.	26
Ontario	5		

Federal-Provincial Aeromagnetic Surveys

The plan went into full swing in 1962. Six 4-year contracts were let in each of Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and the Northwest Territories, totalling more than a million line-miles of survey, of which 404,700 line miles were completed in 1962. This amounts to approximately 500 one-mile map sheets, most of which will be published before the 1963 field season.

A contract for aeromagnetic surveying was awarded the Hunting Survey Corporation for flying an aeromagnetic survey of about 30,000 line miles over the Polar Continental Shelf in the Arctic.

During 1962, 278 federal-provincial aeromagnetic maps submitted by contractors were checked to contract specifications by the aeromagnetic compilation section. Of those checked, 200 were published during the year. Mr. E.E. Ready made three inspection trips to Toronto in connection with this work.

Interpretation

A. Brown carried out a preliminary aeromagnetic-geologic interpretation of the northern Saskatchewan area between 59° N. Lat. and 60° N. Lat. Interpretation on the thickness of the Athabasca sandstones was also done.

E. Roy has carried out aeromagnetic interpretation in northwestern Ontario extending from 90° W. Long., west to the Manitoba border, south of latitude 50°30' N.

SEISMIC AND RESISTIVITY SURVEYS SECTION

G.D. Hobson

The work of this section is largely reported in Geol. Survey Paper 63-1.

In addition to the projects so reported, a hammer seismic survey over the site of the proposed headquarters building for the Department of Agriculture was carried out in order to supply data on depth to, and configuration of, the bedrock surface to the Public Works engineers.

A similar project was carried out for the Mines Branch over the proposed site for the 'experimental mine' at Bells Corners, Ontario.

PALAEOMAGNETISM SECTION

A. Larochelle

The work in this laboratory consisted primarily of the measurement of remanent magnetism of oriented rock specimens and in the design and construction of a spinner and an astatic magnetometer. This work is reported in Geol. Survey Papers 62-30, 63-1, and 63-2.

ELECTRONIC INSTRUMENTATION AND RESEARCH SECTION

L.S. Collett

Introduction

Instruments not available commercially (as, for example, the direct-reading nuclear precession magnetometer for ship and airborne use, the electronic panels for spinner type remanent magnetometer and the very low frequency induced polarization equipment) are designed and constructed in these laboratories. Modifications and maintenance to existing equipment is also done here.

The section consults on instrumentation problems with officers of the Geological Survey outside of the Geophysics Division. Radio communications are supervised by the section head. Some members of the section serve on survey parties during the summer months. An electronic store room is stocked and maintained in the section. Supplies can be drawn by members of other divisions in the Geological Survey.

Ship magnetometer project

W.J. Stauffer installed a direct reading nuclear precession magnetometer, Model GSC60-2, on C.H.S. "Baffin". He operated this magnetometer during May and June, during which approximately 5,000 line-miles were done in an area over the continental shelf off Halifax, N.S. This unit was then transferred to the "Sackville" under the direction of Dr. M.J. Keen, Dalhousie University.

A.Dicaire and J.E. Lee (student) installed Model GSC 60-1 on C.H.S. "Kapuskasing". Lee was in charge of the operation from May 15th to the end of August. Stauffer took charge for September and October. About 11,000 line-miles were done in the area bounded by 61°00 W to 65°00 W Long. and 42°00 N to 44°00 N Lat., which is off the coast south of Halifax.

A.Dicaire and J.E. Lee set up the Varian ground station Model V4930 in Sackville, N.S. This station was inoperative during the month of August for lack of an input transformer in the preamplifier.

P. Sawatzky put the third unit GSC 60-3 on board the "Porte Dauphine" at Windsor. This magnetometer was operated by officers of the Great Lakes Institute on Lake Huron during the summer. The whole lake was done on a 5 mile line spacing, the lines being in an east-west direction.

Air-turbine spinner remanent magnetometer

After the completion and installation of the electronic apparatus for the air-turbine spinner, faults which appeared made the instrument unusuable. R. Ahrens and C. Gauvreau went over the instrument very carefully and corrected the intermittent signals. The sensitivity of the signal channel was increased from 0.39 microvolts to 0.129 microvolts peak-to-peak. The band-pass response is absolutely flat from 251 cps to 259 cps. The signal-to-noise ratio was improved from 10:1 to 22:1. The phase shaft through the amplifiers for $\pm$ 2 cps around the centre frequency of 255 cps is $\pm$ 1.5°. The spinner remanent magnetometer now has a sensitivity of the order of 10^{-7} cgs u/cc. Measurements can be made on weakly polarized red sandstones with the air-turbine spinner.

Radio communications

J.L. Blanchard is responsible for the repair and maintenance of 149 transceivers and 65 receivers used by officers of the G.S.C., Polar Continental Shelf Project, Geographic Branch, Topographic Survey, Legal Surveys, and the Dominion Observatory. He is also responsible for scintillation counters, geiger counters, and mineral lights.

He advises on the choice of equipment and frequency procurement. During the summer months, there have been so many requests from the field parties for help on their communication problems that it has been found expedient to have Mr. Blanchard remain in Ottawa. Electrical engineering students, who are radio amateurs, are hired to act as radio operators on the larger field parties.

Radio-supported winter party operations are on the increase. Two parties were in the field during 1961-62 season and five parties are in the field for 1962-63 winter season. Each party receives from 1 to 3 transceiver sets. This increases the maintenance work load since it entails checking the sets and installation of new crystals and alignment twice each year instead of once.

Consultation on projects outside the division

Two projects outside of the Geophysics Division on which the section has been consulted are: (1) sediment analyser, (O.P. 238) for Dr. J.S. Scott, and (2) field plotting equipment for model studies applied to groundwater investigations, (O.P. 326) for Dr. R.O. van Everdingen.

The electronics for the sediment analyser as used by the Woods Hole group was a Schaevitz Model 033S-L linear differential transformer with a Sanborn Model 150-1160 carrier-carried preamplifier. In order to get around the problem of phasing and matching the differential transformer to the preamplifier at an excitation frequency of 2400 cps, it was decided to use the Sanborn DC Differential Transformer Model 7 DCDT-050 with a stabilized DC preamplifier Sanborn Model 150-1800. This DC differential transformer has the excitation frequency and demodulated output encapsulated within the unit. The input is 6 volts DC at 20 ma and the output is linear to ± 1.40 volts DC for ± .050 inches displacement of 3.6 microinches is equivalent to 1 mm on the recorder chart. The recorder is a single channel Sanborn Model 150-5460 with paper speeds of 0.5, 1.0, 2.5, 5 and 10 mm per second.

Some time was spent on the electronic equipment for plotting static electric fields for simulating groundwater hydrostatic potentials. Instead of building up the electronic circuits, it was decided to purchase a field plotter made by Servomex Controls Limited Type FP92. This course of action proved to be cheaper and more expedient.

MEMBERSHIP ON COMMITTEES

Collett, L.S.
- Member, Instrument and Research Shop Committee
- Secretary-Treasurer, Physicists Group, Professional Institute
- Member, Superannuation and Insurance Committee Professional Institute
- Secretary, Ottawa Geophysical Discussion Group

Hobson, G.D.
- Member, Subcommittee on Seismology
- Thirty-second Annual SEG Convention Program Committee

Larochelle, A.
- Subcommittee on Isotope Studies and Geochronology of the Associate Committee on Geodesy and Geophysics of the N.R.C.
- Subcommittee on Geomagnetism of the Associate Committee on Geodesy and Geophysics of the N.R.C.
- ad hoc Committee to advise on Survey Rock Collections and Sample Numbering

MacLaren, A.S. - Member, Library Committee, G.S.C.
- Member, Exhibits Committee, G.S.C.
- Member, G.S.C. Committee on Absolute Age

Morley, L.W. - Member, N.R.C. Associate Committee on Geodesy and Geophysics
- Member, Subcommittee on the Upper Mantle
- Member, Subcommittee on Geomagnetism
- Member, D.R.B. Committee on M.A.D.
- Member, Mining Geophysics Committee, S.E.G.

OUTSIDE PUBLICATIONS

Hobson, George D.: Seismic Exploration in the Canadian Arctic Islands; Geophysics, Vol. 27, No. 2, April 1962.

Hobson, George D., Wyder, J.E., and Brandon, L.V.: Aquifer Exploration in Canada by Geophysical Methods; Jour. Amer. Water Works Ass., vol. 54, No. 9, September 1962.

Norris, D.K. and Black, R.F.: Application of Palaeomagnetism to Thrust Mechanics; Nature, vol. 192, No. 4806, pp. 933-935, December, 1961.

Palaeomagnetism and Differential Rotation in the Lewis Thrust Sheet; Jour. Alberta Soc. Petro. Geol., vol. 10, No. 1, pp. 13-21, 1962.

PETROLOGICAL SCIENCES DIVISION

S.C. Robinson, Chief

INTRODUCTION

Functions and organization of the Division reflect a coordinated approach to the study of a coherent group of geological units; isotopes, elements, minerals, and rocks:

the Isotope and Nuclear Geology Section is concerned with the distribution of isotopes and with measurement of geological time;

the Analytical Chemistry Section deals with the elemental composition of geological materials in all ranges of concentration;

the Mineralogy Section investigates all aspects of minerals - possibly the most critical of all geological units;

the Petrology Section studies rocks and meteorites in all phases from detailed descriptions to theories of origin.

As in past years, more of the work of the laboratories has been devoted to support of projects initiated by field staff of the Survey than to research initiated within this Division. It is, however, a matter of great satisfaction to the laboratory staff that there is an increasing sense of collaboration with, rather than service to, personnel of all units of the Survey and in consequence, greater pride in the achievements of the Branch as a whole.

It is therefore, particularly satisfactory to record a further substantial increase in productivity of the laboratories despite some restrictions due to austerity measures. This productivity has also made possible advances of real significance in research projects largely initiated within the Division. Possibly one of the most important achievements of the past few years, however, is the increasingly productive collaboration of such diverse disciplines as chemistry, crystallography, mathematics, mineralogy, petrology, and physics in the work of this division as applied to projects of the Survey as a whole.

Reports of the four sections reflect a year of increased productivity and expanded service. Of particular note are: the sharp increase in rapid method rock analyses to 401 in the year; a 65% increase in spectrographic determinations to 26,353; doubling of X-ray mineral identifications to 3,293; and a total of 2,504 minerals and mineral fractions separated. The mass spectrometer laboratory achieved a total of 736 isotope analyses. These increases are the fruit of patient improvements in technique and of more efficient programming and are due to a staff whose keeness comes largely from interest in the projects to which they contribute. During his visit to various institutions overseas, Dr. Maxwell did not find any laboratories whose output per man was equal to ours.

During the year, a third mass spectrometer was completed, an Elion electron micro-analyzer was installed (but is not yet in operation), a laboratory for extraction of lead from rock-forming minerals was put into operation, equipment for study of plug flow phenomena was successfully tested, a new 5-litre counter was installed in the radiocarbon laboratory and a precession camera was installed in the X-ray laboratory.

Study by Mr. Lachance of new methods of rock analysis developed by the U.S.G.S., using an A.R.L. X-ray multi-channel spectrometer, was followed by tests carried out through the courtesy of Falconbridge Nickel Mines Limited, on their instrument at Richvale, Ontario. Results of these tests were so convincing that an instrument was ordered for use in the rock analysis laboratories. Results of a similar study of Infra-red methods for quantitative analysis of the mineral content of rocks were not encouraging.

The first full year in which the mineral collections have had a full-time curator has seen a gratifying increase in the minerals represented and in minerals available for exchange. The trade commissioners of the Department of Trade and Commerce facilitated exchanges by notifying 125 foreign museums and other institutions of our desire to exchange minerals.

Preparation and distribution of mineral and rock collections also established a new record in 1962. Materials for these collections come in part from operating mines and quarries, and it is a pleasure to acknowledge the cooperation of the following companies in this respect:

Molybdenite Corporation of Canada Limited
Fundy Gypsum Company, Limited
Lachaine's Quarry
St. Lawrence Columbium and Metals Corporation
New Calumet Mines Limited
Falconbridge Nickel Mines Limited
Canada Talc and Ind. Limited
International Minerals and Chemical Corporation, (Canada) Limited
Indusmin Limited
Wallingford Mica Company
Manitou-Barvue Mines Limited
Hollinger Consolidated Gold Mines Limited
Aluminum Company of Canada
Steep Rock Iron Mines
Magnet Cove Barium Corporation Limited
Gaboriault and Nevers Quarries
Canadian Refractories Limited
Quartz Crystal Mines Limited
Quemont Mining Corporation
Actonvale Slate Quarry
Gypsum, Lime and Alabastine Limited
Iron Ore Company of Canada
Newfoundland Minerals Limited
Potash Company of America
United Keno Hill Mines Limited
American Smelting and Refining Company

The Consolidated Mining and Smelting Company of Canada Limited
Eldorado Mining and Refining Limited
Gillis Quarries Limited
Hudson Bay Mining and Smelting Company Limited
The Yukon Consolidated Gold Corporation
Bicroft Uranium Mines Limited
The International Nickel Company of Canada Limited
Malagash Salt Company Limited
Melrose Granite Company of Canada
Sherwin-Williams Company of Canada Limited
Silver-Miller Mines Limited
Stanstead Granite Quarries Company Limited
University of British Columbia

In the petrographic laboratories 4,300 specific gravity determinations were made and over 1,700 sections were stained. Over 140 specimens were examined as possible meteorites. Of these 2 proved to be genuine. Seven additional specimens of meteorites were obtained by exchange and purchase.

One field project of the major granite study was completed by a Ph.D. candidate, Mr. D.W. Hyndman and another started by Mr. P.B. Read. Work done on this project has resulted in new concepts of structural and petrologic significance that are incorporated in a bulletin now nearing completion.

The International Upper Mantle project studies made excellent progress during this first year of the official 3-year period. The first five contributions from this Division were published or are in press. In addition, a Ph.D. thesis on the Tulameen intrusion was completed, and an excellent report and map were submitted on completion of field work on the Jennings River intrusion. Detailed mapping, and gravity and magnetic studies on the Mount Albert intrusion led to selection of the best location for deep drilling, and sampling of the intrusion was completed at 1,000-foot centres. Detailed geological and magnetic surveys were completed on the Muskox intrusion to permit selection of sites for the two 5,000-foot drill holes that were approved late in the year.

PERSONNEL

Results of the government's austerity measures in this field materially affected work of the Division. Six new scientists were appointed prior to the imposition of the measures, but eight supporting technician positions were still not filled. Fortunately the resulting balance was partly rectified by use of seasonal personnel.

Mr. R.J.C. Fabry retired from the Service in March after 35 years as rock analyst and mineralogist.

Mr. A.M. Vaux resigned from the mineral preparation laboratory to enter private business.

Mr. R. Cormier won a competition in Submarine geology but we have been fortunate that he is to remain in the mineral separation laboratory until he leaves for Dartmouth in the Spring.

Dr. F.P. Agterberg joined the staff as petrological statistician and is presently devoting most of his time to Upper Mantle data.

Mr. R. Delabio has substantially increased the volume of mineral determinations completed since joining in the Spring.

Mr. D.C. Findlay was appointed field petrologist in the Upper Mantle project and is in charge of field work on the Muskox intrusion.

Mr. C.D. Bradshaw joined the mass spectrometer laboratory.

Messrs. P.J. Gauthier, W.A. Gibson, and B.D. Machin joined the mineral separation laboratories' staff.

Dr. T.N. Irvine left the staff of McMaster's Department of Geology to take over responsibility for coordination of petrological aspects of the Upper Mantle programme.

Miss A.V. Payne and Dr. J.G. Sen Gupta joined the staff in Analytical Chemistry to work on petrochemical aspects of the Upper Mantle studies.

At the year's end four Post-doctorate Fellows are working in the Division:

Dr. R.P. Hollingworth expects to complete his studies on methods of analysis of fluorine in rocks in April next year.

Dr. Th. C.J. Zwartkruis from the University of Amsterdam commenced a detailed study of the feeder dyke of the Muskox intrusion in June.

Dr. A. Sasaki of the Geological Survey of Japan joined the Isotope and Nuclear Geology Section as an N.R.C. Post-doctorate Fellow in September to work on the distribution of sulphur isotopes in the Muskox Intrusion.

Dr. S. Bhattacharji, on leave from the University of Chicago, arrived in October to make a study of plug flow as a possible process of magmatic intrusion.

The Division has been fortunate in having the services of six Ph.D. candidates on a seasonal basis during part of the year:

Mr. D.C. Findlay completed his thesis on the Tulameen intrusion at Queen's University.

Mr. Peter Fox assisted J.E. Reesor and completed field collections on the Adamant batholith for his thesis at Carleton University.

Mr. D.W. Hyndman completed field work on granites and rocks of differing metamorphic grade in the Nakusp area for a thesis at the University of California.

Mr. I.D. MacGregor assisted Dr. C.H. Smith and completed mapping and sampling of the Mount Albert intrusion for his thesis at Princeton University.

Mr. P.B. Read commenced field work on the eastern contacts of the Kuskanax batholith for a thesis at the University of California.

Mr. W.J. Wolfe, commenced and completed a field study of the Jennings River ultrabasic intrusion for a thesis at Yale University.

Work of the laboratories is heavily dependent on the contributions made by summer seasonal employees without which the large backlogs of service work developed through the year could not be reduced. In similar fashion winter seasonal employees have again been of great value in working through much of the laboratory work on samples from major projects collected in the summer.

Laboratories of the Division were visited by many different individuals and groups. We were particularly pleased to welcome over 50 delegates to the 12th annual Clay Minerals Congress in August. Staying with us for longer periods were: Mr. John Muysson of the Department of Geology, McMaster University, who spent 6 weeks studying new developments in the rock analysis laboratories; Mr. S.S. Rajah of the Federated States of Malaya studying X-ray fluorescence analysis; and Mr. Abdul Gabezi from Siene Leone.

Visitors to the Division* included:

Professor L.R. Wager from Oxford University
Dr. E. Jager of the University of Bern
Dr. J.V.P. Long of Cambridge University
Dr. W.C. Nixon, Cavendish Laboratories, Cambridge University
Principal H.G. Thode, McMaster University
Professor Roger Webber, McGill University
Professor W.F. Slawson, University of British Columbia
Dr. D. York, University of Toronto
Dr. Gote Ostlund, Geological Survey of Sweden
Dr. Stephen Moorbath, University of Oxford
Professor H.W. Fairbairn Mass. Institute of Tech.
Dr. B. Mason, Am. Museum of Nat. History, New York
Dr. R.L. Mitchell, Macaulay Institute for Soil Research, Aberdeen
Mr. J. Moatte, Bureau de Recherches Geologique et Minieres, Paris

*Visitors to the Survey as a whole are not listed.

ATTENDANCE AT MEETINGS

Dr. J.A. Maxwell spent two months in Great Britain and Scandinavia visiting laboratories concerned with analysis of rocks and minerals. In this period he attended a conference on analysis of meteorites and a course of lectures in methods of analysis at the College of Science and Technology in Manchester.

Mr. Sydney Abbey attended a course on Infrared Spectroscopy at the Massachusetts Institute of Technology and visited manufacturers of infrared equipment for the purpose of evaluating this method for determination qualitatively of the mineral content of rocks.

Dr. R.J. Traill visited laboratories using electron microanalyzers in a trip to attend a conference on applications of X-ray analysis at Denver and a symposium on X-ray optics and micro-analysis at Stanford.

Mr. H.R. Steacy visited universities across Canada as a member of the Civil Service recruiting team. He also visited Museum mineral collections in Washington, New York, and Boston.

Mr. G.R. Lachance visited the X-ray laboratories of the U.S.G.S. in Washington to learn about the new method of rock analysis using an X-ray multichannel spectrometer. Subsequently with Dr. Traill he successfully tested the method on an instrument in the laboratories of Falconbridge Nickel Company at Richvale, Ontario.

Dr. R.K. Wanless attended a conference on sulphur isotopes at Yale and later represented the Survey at a meeting on nuclear geophysics sponsored by the United States National Research Council at Wood's Hole, subsequently visiting laboratories at M.I.T.

Mr. W.H. Champ attended the Tenth Colloqium Spectroscopicum Internationale at Washington and subsequently visited manufacturers of direct-reading spectrographic equipment.

G.S.A. Meeting, Houston; Dr. J.E. Reesor, Mr. R.D. Stevens.

International Mineralogical Congress, Washington; Dr. R.J. Traill, Dr. J. Rimsaite, Mr. J.L. Jambor, Miss A.P. Sabina, Dr. C.H. Smith, and Dr. S.C. Robinson.

Royal Society of Canada, Hamilton; Dr. K.R. Dawson, Mr. D. Loveridge, Dr. S.C. Robinson.

American Geophysical Union, ann. meeting, Washington; J.A. Lowdon.

Mineralogical Association of Canada, Ottawa; Dr. R.J. Traill, Dr. C.H. Smith, Mr. H.R. Steacy, Dr. J. Rimsaite, Dr. K.R. Dawson, Mr. J.L. Jambor, Dr. S.C. Robinson.

Ninth Ottawa Symposium on Spectroscopy; Messrs. S. Abbey, W.H. Champ, S. Courville, R.P. Beaulne, and W.F. White.

Clay Minerals Conference, Ottawa; Dr. J. Rimsaite.

Visits to Mass Spectrometer Laboratories; Shell Development Co., Houston; Mr. R.D. Stevens, McMaster University; Mr. W.D. Loveridge, University of British Columbia, and U.S.G.S. in Washington, Mr. J.A. Lowdon.

Visits to Elion Instruments Inc., Burlington, N.J., in March and December; Dr. R.J. Traill.

X-Ray Diffraction course, Chicago; J.L. Jambor.

REPORTS ON SECTIONS

ANALYTICAL CHEMISTRY SECTION

J.A. Maxwell

Introduction

The Analytical Chemistry Section provides chemical and spectrographic data on all types of geological materials, at all levels of element concentration, with particular emphasis on silicate analysis; in this capacity it works closely with Survey mineralogists, petrologists, and geochemists. It also prepares special chemical compounds for use in other Survey laboratories, and advises when requested on chemical and spectrographic problems arising within the Survey. No basic research is done in the Section but new methods, instrumentation, and techniques are investigated for their application to the work of the Section, and existing methods are modified and improved.

Statistics

Samples Received and Completed, to December 18, 1962

	Complete Chemical	Partial Chemical	Special Chemical	Spectrographic All Types
Samples on hand, January 1, 1962	384	554	2	390
Samples received, 1962	315	95	42	2578
	699	649	44	2968
Samples completed, 1962	490	283	42	2093
	209	366	2	875
Samples withdrawn	1	331	0	1
Samples on hand, January 1, 1963	208	35	2	874

Summary

		1961	1962
Samples received		3694	3030
Samples completed			
	Chemical	1577	815
	Spectrographic	2433	2093
Backlog of samples, December 18			
	Chemical	1064	245
		390	874
Chemical analyses made			
	Precise rock and mineral	79	89
	Rapid	149	401
	Partial	1284	283
Spectrographic analyses made			
	Qualitative	85	258
	Semi-quantitative	397	370
	Quantitative	2250	1744
Total number of chemical determinations made		8772	10571
Total number os spectrographic determinations made		15000*	26353
Total number of quantitative spectrographic determinations made		9137	17572
Total number of spectrographic exposures made		4866	3961

*Includes estimation of number of qualitative and semiquantitative determinations made.

Fewer samples were submitted to the chemical and spectrographic laboratories than in 1961, and fewer samples were completed. More work was done, however, on this smaller number of samples. This is explained by the change that occurred in the nature of analysis required - the demand for the determination of a few elements declined sharply in favour of fuller analyses, both chemical and spectrographic.

The production of rapid rock analyses rose from 149 in 1961 to 401 in 1962 as a result of improved methods and reorganization of the laboratory operations. Further increase in the production of this type of analysis can be achieved only by an increase in staff or by the use of a new and very different technique. Precise chemical analyses were confined almost entirely to minerals and it is expected that the demand for precise whole rock analyses will continue to decline. Of the 245 samples in the backlog, 181 are for rapid rock analysis.

The total number of spectrographic determinations made in 1962 passed the 26,000 mark. It is particularly noteworthy that the number of quantitative determinations made (17,572) are almost double the number made in 1961*; 5,681 semiquantitative and 3,100 qualitative determinations were also made. The previous statement that more elements were done per sample is emphasized by the fact that, although more determinations were made in 1962, the number of spectrographic exposures made was considerably less than the number made in 1960. The general quantitative spectrographic method was extended to cover more elements than formerly and more time is now required for densitometry and calculations.

---

*In 1960, only 1,550 quantitative determinations were made.

Chemical

1. Although the demand for rapid rock analyses increased, that for precise rock analyses declined sharply and was replaced by an increasing demand for mineral analysis. The majority of these latter were common types such as biotite, garnet, amphiboles, plagioclase, and pyroxene, but a number of unusual ones were also analyzed. There is an increasing complexity in the nature of the samples now being submitted.

2. Continuing efforts are being made to use or develop methods needed to handle these more complex and/or difficult samples. Among the methods on which development work is complete are the following:

(a) the colorimetric determination of traces of thorium in rocks.

(b) the titrimetric and colorimetric determination of traces of sulphur in rocks, with emphasis on the basic and ultrabasic varieties.

(c) the adaptation of the Rigg and Wagenbauer method for the determination of titanium to our rapid methods of analysis.

(d) the adaptation of a method for the determination of small amounts of aluminium in the presence of large amounts of iron and titanium.

3. The laboratories completed a major project for Dr. Chamberlain in which several hundred rocks from the Great Bear Lake area were analyzed for ferrous and ferric iron, and for traces of uranium.

4. An investigation was made into the potential use of infrared spectroscopy in the mineralogical analysis of rocks.

5. Improvement in the production of rapid method analysis can be ascribed in part to the use and development of new equipment. Among these items are the mobile spectrophotometer, the dual carbon dioxide apparatus, and the automatic dispensers used in the aluminium, titanium, and manganese determinations.

6. A new flux-accelerator mixture, which insures complete decomposition of the silicate rock, is now in use in Dr. Hollingworth's fluorine project. Reference fluorine values have been obtained for a variety of rocks and minerals, using a modified Berzelius steam-distillation method, and further evaluation of accelerators and flux-accelerator mixtures, which do not decompose silicates, as well as of the one that does, is under way.

7. A successful separation of coesite from material from the Rieskessel crater was done.

8. Among the projects now under way in the chemical laboratories, in addition to the regular work, are the adaptation of a micro-combustion method for the determination of carbon dioxide and water, a flame photometric method for the determination of aluminium, the colorimetric determination of small amounts of phosphorous, an investigation into sampling errors, and the preparation of our precise methods of rock and mineral analysis for publication.

Spectrographic

1. Comments on the sample analysis work of the laboratory are given with the statistical portion of this report and the data speak for themselves.

2. In method development the year has been largely one of consolidation during which methods previously set up have been extended to the limits of their applicability. We are now prepared to do quantitatively some 40 elements in their normal ranges of concentration in alumino-silicates, basic and ultrabasic rocks, iron ores and limestones. There is also an increasing emphasis on the quantitative determination of trace elements in specific minerals (as opposed to rocks in previous years) at the lowest possible limits, and synthetic standards have been prepared for barite, gypsum, pyrite, galena, sphalerite, pyrolusite, magnetite, calcite, and Ti- and Zr-base materials. Because there is also an increase in the demand for semiquantitative analyses on small quantities of widely-varying samples for which quantitative determinations are not warranted, the semi-quantitative procedure has been improved and re-established to cover about 50 elements in almost any powdered material, in the 0.01% level only.

3. It is anticipated that some time will be unavoidably lost in the coming year because of the need to re-establish our procedures on a new photographic emulsion, a need due solely to the manufacturer's decision to discontinue our present type of photographic plate.

ISOTOPE AND NUCLEAR GEOLOGY SECTION

R.K. Wanless

Introduction

For some years the major emphasis in the field of isotopic age determinations has been concentrated on the application of the potassium-argon method, and with the completion of 198 age determinations during 1962, the total number of samples processed by the Section has now reached 654. During 1962, efforts were made to broaden the activity in this field to embrace the measurement of the ratios of rubidium and strontium in whole rocks and minerals, and the lead, uranium, and thorium concentrations in zircons. The experimental techniques required for the sample processing and isotope dilution determination of the elemental concentrations have been tested and developed to the point where they may be applied to a wide variety of geological problems. This experimental development has involved the preparation and calibration of enriched isotopic solutions and their use in the precise determination of the elemental concentrations, the processing of small amounts of sample and the separation of the various fractions using ion exchange columns, and the perfecting of mass spectrometric techniques for the analysis of microgram quantities of sample

in solid form. This capability has made practical the application of age determination techniques to problems in which the concentration of the elements is below the limit of detection of methods previously employed at the Geological Survey of Canada.

Sulphur isotope studies have continued to be of interest and several small groups of samples have been processed for officers of the Survey. The majority of these projects have been of a reconnaissance nature in specific localities or have been conceived to give data on similar types of mineralization from various localities. At the same time work has continued on a detailed study of the Keno Hill deposits (O.P. 144). In this study the sulphur isotope ratios are to be compared with the lead isotope abundance values determined on the same samples.

The original decision to proceed with the large scale potassium-argon age reconnaissance program outlined above, placed a very heavy load on the existing analytical facilities of the laboratory, and consequently stable isotope studies have not received as large a proportion of the available mass spectrometer time. In order to relieve this imbalance, plans were made to increase the mass spectrometric potential of the laboratory by building two new mass spectrometers, thereby bringing the total to four instruments. The first of the new mass spectrometers is now essentially complete and vacuum testing is underway. Some components of the second unit have been purchased and it is anticipated the fabrication will begin early in 1963. With the completion of these instruments the laboratory will be in a position to simultaneously carry forward a variety of projects involving both stable isotope studies and age measurements.

The radiocarbon dating laboratory has also been expanded to permit the incorporation of a second, larger, proportional counter, which is now in the testing stage. The original, two-litre, proportional counter has operated in a very satisfactory manner and a total of 85 samples have been processed during the year.

In order to efficiently employ the expanded facilities it is essential that the laboratories be adequately staffed. The austerity program introduced during the summer of 1962 has seriously affected the operation and progress. Specifically, the loss of three technician positions, two in the mass spectrometer laboratory and one in the radiocarbon laboratory, has been keenly felt and the output has only been maintained at its current level through the diligent efforts of the scientific officers concerned, who have assumed responsibility for all aspects of the work, including routine compilations. The output of the laboratories will only advance to the anticipated limits when the technical support staff required to take care of the day-to-day operational aspects of the work is available.

Age Determination Program

The high vacuum apparatus designed for the extraction and purification of radiogenic argon has been operated at near capacity and has been found to be easy to maintain. Due to the efficient manner in which the samples may be outgassed before fusion, the correction required for atmospheric argon contamination in the radiogenic sample has been reduced to negligible proportions. The majority of the age measurements have been based on argon extracted from mineral concentrates. However, during 1962, encouraging results were also obtained for a group of whole rock samples.

The age determination facilities have been extended to include determinations based on the Rb^{87}-Sr^{87} ratio in rocks and minerals. Experimental techniques required for the extraction, purification, and solid source mass spectrometric analysis of samples have been developed to the point where they may be applied to geological problems. All samples are processed in duplicate with different spike-to-sample ratios in order to maintain a constant check on possible contamination, which may be introduced during the complicated extractive procedure.

A preliminary study based on the rubidium and strontium concentration in whole rock and mineral concentrates from the various phases of the White Creek Batholith in B.C. is now nearing completion. The results of this investigation are to be compared with potassium-argon age determinations carried out on the same rocks, and it is hoped that this detailed investigation will yield the information needed to interpret the age relationship between the various phases of the Batholith.

In addition to the geological application, noted above, the precise values of the rubidium and strontium concentration determined by using isotope dilution techniques are to be used to provide calibration points for analyses carried out on the X-ray spectrometer.

When difficulties arise in the interpretation of age determination results based on a single parent-daughter decay relationship it is often desirable to obtain additional results based on one or more other methods. With this in mind, plans were made to provide the facilities required for the determination of age based on the uranium-lead and thorium-lead ratios in zircons. In order to proceed with this method it has been necessary to equip a special laboratory in which the level of lead contamination may be kept at a minimum, and to perfect methods for the mass spectrometric analysis and determination of the small quantities of lead, uranium and thorium.

The structural alterations required for the low level laboratory have been completed and an electrostatic air purification system has been installed. The laboratory walls have been painted with Tygon paint and plastic plumbing fixtures have been substituted for all fixtures containing lead. Samples of lead, uranium and thorium in the low microgram range (10-50 micrograms), have been prepared and successfully analysed using the solid source mass spectrometer. The enriched isotopes required for the isotope dilution determination of the concentration of lead are on hand, and it is anticipated that enriched uranium and thorium isotopes will be available early in 1963. The calibration of the isotope dilution solutions and the determination of the level of the lead contamination in the laboratory will complete the preparatory phase of the project.

Mass Spectrometer Development Program

The demand for isotopic analyses, of both gaseous and solid samples, continues to exceed the capabilities of the present compliment of two mass spectrometers. In order to relieve this problem, two smaller 6" radius instruments were designed and the fabrication of component parts undertaken. The first mass spectrometer, a gas source instrument, was essentially completed in December and will be in operation early in 1963. Considerable progress has been made on the assembly of the second smaller unit which is designed for solid sample analyses.

Since no suitable laboratory space was available to house the new instruments, the partition between two offices was removed and the area converted for laboratory use. Direct power lines have been installed and trenches have been cut in the floor to carry service lines to the new mass spectrometers.

Early in 1962, the mercury diffusion pumps in use on the original solid source mass spectrometer were replaced with new Vac-Ion electronic pumps, on an experimental basis. The new pumps have been found to operate quite satisfactorily, and since no liquid nitrogen refrigerant is required, a considerable saving has been realized. In addition, the Vac-Ion pumps are not subject to power and water supply failures, thereby ensuring more reliable operation. In view of our favourable experience, similar pumps have been purchased for installation on the new mass spectrometers.

Radiocarbon Dating Laboratory

The two-litre proportional counter, which became operative in January 1961, has continued to perform satisfactorily, and 85 samples have been counted during 1962. In order to increase the potential of the laboratory, and make efficient use of the shielding provided by the castle, a larger five-litre, copper, proportional counter, has been designed and assembled. Preliminary tests have been completed with the new counter and successful operation up to three atmospheres pressure has been realized. At this pressure a maximum sample age of 47,000 years may be measured. It is anticipated that this limit may be extended to 50,000 years as gas purification techniques are refined, thus permitting operation of the counter at the design pressure of five atmospheres. An all-metal high-vacuum, high-pressure, sample handling line, required for the operation of the new counter, has been constructed and tested.

All electronic units required for the operation of the second proportional counter have been assembled. In addition, a ten-pen operation-event recorder has been installed. This recorder provides a continuous, permanent, record of all counts registered on the various channels, thereby providing a means of checking the performance of the equipment during night-time and week-end operation. Consideration of the record permits one to make allowance for possible cosmic fluctuations and hence to increase the reliability of the C-14 measurements.

In order to prevent the possible accumulation of long-lived radioactive dust particles within the counter shield, an electrostatic air purification unit has been installed in the duct supplying air for the counting room.

Statistics

Argon Extractions (including 15 experimental)	198
Argon-38 Spike Calibrations	25
Argon Age Determinations Reported	162
Rubidium-Strontium Extractions (including 8 experimental)	58*
Rubidium-87 Spike Preparation and Calibration	1

*All sample extractions carried out in duplicate.

Mass Spectrometer Analyses

A) Samples in Gaseous Form

Extracted Argon Samples	171
Argon-38 Spike Calibrations	29
Sulphur Dioxide (Simultaneous Collection)	332
TOTAL	532

B) Samples in Solid Form

Rubidium	70
Strontium	88
Lead	36
Uranium & Thorium	7
Magnesium	3
TOTAL	204
TOTAL ANALYSES	736

Radiocarbon Determinations	85

MINERALOGY SECTION

R.J. Traill

Introduction

The Mineralogy Section includes the following units: sample preparation and mineral separating laboratories servicing all aspects of analytical work within the Division and a major part of the Branch requirements; X-ray diffraction, X-ray spectrography and electron microanalysis laboratories; the Systematic Reference Series of the National Mineral Collection; mineralogy of rock-forming minerals; preparation of collections of minerals and rocks for sale to the Public; and mineral identification and information service to the public.

The output of service work from the Section again showed an increase in 1962 to reach an all-time high. Comparative figures for 1961 and 1962 are given in the various laboratory reports. The increase in number of samples processed in the sample preparation and mineral separating laboratories reflects an over-all increase in the output of analytical work by the laboratories of the Branch. The demand by the Public for mineral and rock collections increased in the past year and has now reached the point where the unit can no longer prepare enough collections to meet the demand.

It is gratifying to note an increase in scientific research and development work in 1962. O.P. 309 (Studies of Rock-Forming Micas, Part I; Fresh Micas) is nearing completion and scientific reports are in preparation. The mineralogy of four new mineral species (O.P. 306) was investigated and reports describing two of these minerals are in preparation. A comprehensive study of feldspar mineralogy (O.P. 311) began in 1962 as part of the Upper Mantle Project. An X-ray diffraction study of the olivine series (O.P. 305) was completed and a professional paper submitted for publication. An accurate method for the determination of rubidium and strontium in rocks and micas by X-ray spectrography (O.P. 307) is being investigated. A study of methods and instrumentation for multi-channel X-ray spectrographic analysis of rocks was completed and purchase of an instrument recommended. Installation of an electron probe microanalyzer began in August. A succession of instrumental problems has delayed placing the instrument into operation and we have been unable to proceed with O.P. 308 - Electron Probe Microanalysis.

Activities

In the period May 22 - October 11, Mr. C.H.R. Gauthier visited about 40 localities in eastern Canada to collect bulk samples of minerals and rocks for the preparation of collections for sale to the Public. The distance covered by truck was about 8,000 miles, and about 16 tons of materials were delivered to Ottawa. From July 16 to August 8, Mr. Gauthier was attached to Mr. D.C. Findlay's field party in the Coppermine area. Drilling and blasting was conducted at 40 sites and some 1,500 lbs. of sulphide samples were collected.

In the period June 29 - July 21, Miss A.P. Sabina visited mineral occurrences of interest to tourists between West Hawk Lake, Manitoba, and Ottawa. The results of this field work will be used in replying to requests for information, and in preparation of a special publication on mineral collecting.

X-ray Diffraction (J.L. Jambor)

The assistance of a summer student, Mr. R. Trischuk, during the period June-September is in large measure responsible for the unparalleled increase in X-ray mineral identification made during the past year. It is evident that the demand for such services is unlimited and productivity would be greatly increased if the services of a technician were available on a permanent basis.

During the year the X-ray laboratory acquired a single crystal precession camera, and together with the Weissenberg unit the laboratory is now properly equipped to do detailed work on mineral species of special interest. Unfortunately, these cameras cannot be operated full time unless routine mineral identifications are sacrificed; this results wholly from the lack of space available on the basic X-ray units and it is hoped that the situation will be rectified by purchase of another unit.

The number of new X-ray patterns added to the files is approximately the same as was accumulated in 1961. However, a vast number of newly obtained species has been acquired through the National Mineral Collection system; little progress has been made in examining this material.

The following table gives comparative production figures for 1961 and 1962.

	1961	1962
Mineral identifications	1808	3293
Cell-edge determinations	394	156
Diffractometer analyses	549	441
Composition determinations	632	304
Standard patterns added	25	31
Single crystal exposures	--	562
Letters to public re: occurrences	101	104

X-ray Spectrography (G.R. Lachance)

The work done on X-ray spectrochemical analysis during 1962 may be divided into two general categories:

(a) investigations and development of methods
(b) analyses for officers of the Geological Survey

(a) Investigations: The development of an accurate method for the determination of rubidium and strontium in rocks and micas in the 0-1000 p.p.m. range is being investigated. Because of the low concentrations and the small size of some of the samples, a direct method using correction factors is being evaluated.

(b) Analyses: a total of 654 samples were received for X-ray spectrochemical analysis during 1962. These samples may be classified as follows:

Type	No. of Samples Received	No. of Samples Reported
Mica (%K for Age)	222	162
Mica (general)	84	84
Igneous rocks	115	115
Titaniferous magnetite	36	36
Minerals	28	28
Native metals	6	6
Separates	148	148
Miscellaneous	15	15

A total of 3,664 quantitative and 127 semiquantitative determinations were made and reported on the above samples during the year. A total of 196 ratios (of two elements) were determined on miscellaneous products and 30 scans were made on polished sections in order to establish the relative abundance of the elements detectable. A breakdown of the number of determinations for each of the 39 elements analyzed for is as follows:

Quantitative					
Arsenic	157	Iron	220	Thorium	16
Barium	194	Lanthanum	87	Tin	73
Bromine	73	Lead	180	Titanium	222
Calcium	186	Manganese	218	Uranium	16
Cerium	3	Neodymium	3	Vanadium	135
Cesium	84	Nickel	189	Yttrium	88
Chromium	218	Niobium	73	Ytterbium	3
Cobalt	32	Potassium	246	Zinc	162
Copper	162	Praseodymium	3	Zirconium	73
Dysprosium	3	Rubidium	145		
Erbium	3	Samarium	3		
Gadolinium	3	Scandium	84		
Gallium	84	Strontium	223		

Semi-Quantitative					
Antimony	6	Copper	6	Nickel	6
Arsenic	6	Iron	6	Silver	6
Bismuth	6	Manganese	6	Strontium	67
Cobalt	6	Mercury	6		

Mr. S.S. Rajah, a student under the Colombo Plan from the Federation of Malaya, spent the last three months of 1962 in the X-ray laboratory. Approximately two of those months were devoted to the theoretical and practical aspects of X-ray fluorescence analysis.

Sample Preparation and Mineral Separating (J.C. Paris)

For the fourth consecutive year the laboratory has shown an increase in production. The number of mineral concentrates produced increased by 28 per cent over the 1961 output, and the number of samples prepared for analyses decreased by 23 per cent. The staff situation improved considerably with the addition of three new assistant technicians on continuing staff. A backlog of several hundred samples are on hand. Total overtime amounted to 226 hours.

Comparative figures for 1961 and 1962 are as follows:

Type of Concentrates	1961	1962
Magnetic fractions	1,398	469
Heavy minerals	302	1,226
Micas	164	223
Magnetites	84	116
Zircon	26	140
Hornblende	20	58
Epidote	14	9
Pyroxene	4	6
Garnet	12	17
Sulphides	—	56
Quartz	1	9
Feldspars	84	125
Augite	—	17
Hypersthene	—	19
Orthopyroxene	—	5
Oxide	—	1
Molybdenite	—	2
Tourmaline	—	2
Lithium	—	1
Uraninite	—	2
Staurolite	—	1
TOTALS	1,948	2,504

Separate Operations Included:	1961	1962
Crushed, ground, and sized	1,494	1,633
Wilfley	21	71
Superpanned	406	465
Carpco separation	806	1,275
Frantz separation	2,651	3,344
Heavy liquids	2,635	5,042

Samples prepared for the various laboratories:

Rock analysis laboratory	328
Spectrographic laboratory	348
C. Gleeson	221
National Health and Welfare	46
Others	202

Preparation of Mineral and Rock Sets (C.H.R. Gauthier)

During the past year our output of mineral and rock collections has increased from 7,072 sets in 1961 to 8,580 sets in 1962.

Below is a comparative list showing our output of collections in 1961-1962 according to various provinces. Note: figures for the last two weeks of December 1962 were computed from the same in 1961.

Province	1961 Collections	1961 Specimens	1962 Collections	1962 Specimens
Ontario	2,665	94,165	3,029	108,033
British Columbia	1,707	60,658	2,002	70,831
Alberta	854	30,318	1,037	36,763
Quebec	282	10,184	284	10,092
Saskatchewan	232	8,239	595	21,220
Manitoba	230	8,184	289	10,230
N.W.T. and Y.T.	134	5,151	36	1,261
Nova Scotia	74	2,627	320	11,360
New Brunswick	23	817	36	1,276
Prince Edward Island	2	71	2	71
Newfoundland	0	0	8	284
Labrador	0	0	2	71
Office*	869	30,865	940	33,368
	7,072	251,279	8,580	304,860

*Mr. Touchette's Office

Minister's Office:

25 sets of mineral chips (900 specimens)
25 sets of rock chips (875 specimens)
1 collection of 6 mineral specimens
10 specimens of sylvite
2 economic collections (240 specimens)

Economic collections shipped during the year - 1961 - 64 (7,680 specimens)
1962 - 80 (9,600 specimens)

Special Collections:

During the year about 31 collections of rocks and minerals (approximately 408 specimens) were prepared and/or shipped for Mr. H.R. Steacy.

Identification service to the Public:

As of February 28th, 1962 when Mr. R.J.C. Fabry's work was taken over by this section, over 700 identifications of rocks and minerals have been made and the results sent to the persons interested (294 letters).

Examination of Mica Concentrates and Rocks (J. Rimsaite)

Examination of concentrates prepared for the age determination and for research studies has been continued. Miss C.M. Hunt assisted during the summer in X-ray diffraction analysis and in optical studies. The cleanest mica concentrates composed of least altered flakes were selected for dating. A brief description of each concentrate is included in G.S.C. reports on Isotopic Ages (Papers 60-17, 61-17, and 62-17). A total of 181 concentrates were forwarded to the Isotope Geology Section to December 19, 1962.

Number of Concentrates and Rocks examined:

Specimen	XRD-Analysis		Optical	Photomicrographs	
	Diffractometer	Laue	Examination	Black & White	Colour
Mica concentrates	28	125	375	100	34
Heated micas	10		25	2	
Mica standards	15		5		
Feldspars	10		14		
Miscellaneous (hornblende, uraninite,	7		10	20	
Rocks	10		95	124	32
TOTAL	337	125	524	246	66

National Mineral Collection (H.R. Steacy)

In 1962 much time was spent in expanding the Systematic Reference Series of the National Mineral Collection. This series is the responsibility of the Geological Survey of Canada and is being built up to provide as full a representation as possible of all known mineral species and varieties. It is maintained as an active working collection and its expansion proportionally increases its importance to research in the geological sciences. Officers of the Geological Survey are free to consult the Series at any time and, upon request to the Curator, may use the material it contains for approved office projects. Indeed, they are encouraged to do so and to assist in the development of the Series through the collection and donation of useful material; quantities of rare Canadian minerals that could be used for exchange would be particularly welcome contributions. The need for such material is demonstrated by the fact that 26 exchanges were arranged during the year with individuals and organizations in Canada and abroad and our activity in this field is likely to increase in the future. Most of the exchanges in 1962 resulted from a program initiated in June in cooperation with the Department of Trade and Commerce, whose officials abroad approached approximately 125 museums, government agencies, and other prime sources on our behalf. The program involved much correspondence but it was successful materially and

provided many excellent contacts, and we are grateful to the Department of Trade and Commerce for their assistance. In addition to acquiring material through these exchanges Mr. Steacy corresponded and placed orders with commercial dealers and collected specimens in the field. These various activities resulted in a large volume of fine and rare mineral specimens for the Series, which were augmented by gifts from Survey officers, mining companies, and individuals. In all, 184 specimens or groups of specimens were added to the Series by exchange, donation, purchase, or collection in the field. The acquisitions were more selective this year than last and represent 156 species and varieties, of which 95, listed on the attached sheet, were previously unrepresented in the Series. To these, however, should be added another 199 minerals on order, or forthcoming as a result of exchanges during the year, of which 163 are new to the Series. Activities have therefore effectively contributed 383 minerals in varying amounts to the Series and increased its representation by approximately one-third.

Attesting to the continuing importance of the Survey collections as a source of research material 13 special requests from Officers of the Geological Survey, government agencies, and universities were filled. Supplementary suites were also provided for the reference collections maintained by the Survey's Yellowknife and Whitehorse regional offices and a suite of ore minerals to the Economic Geology Division for their metallogenic reference collection. Mr. Gauthier and his staff assisted in the assembling, parcelling, and shipping of these collections and of the exchange suites. Specimens were also provided for illustrating Miss Sabina's publication on mineral collecting in Canada.

The exchange collection was improved by the addition of 20 or more hand specimen examples of each of the following minerals collected in the field: akermanite, britholite, hisingerite with fayalite, monticellite with niobium perovskite, niocalite and pyrochlore. Locks were installed on the cabinets in Room 750 that contain the Systematic Reference Series, and on 95 cabinets in Room G48.

During the year Mr. Steacy studied many of the large collections in Canada and the United States. In January, as a member of the University Recruiting team, he had an opportunity to examine collections at some of the large Canadian universities. In May he visited collections at the United States National Museum, the American Museum of Natural History, and Harvard University, and benefited from discussions with their curators, respectively, Dr. George Switzer, Dr. Brian Mason, and Dr. Clifford Frondel. In March and April Mr. Steacy collaborated with the Curator of the Display Series on an exhibit for the C.I.M. Annual Meeting held in Ottawa; this exhibit is currently on display at the National Museum of Canada.

PETROLOGY SECTION

K.R. Dawson

The microscopic and specimen preparation laboratories continued to supply services and facilities for the officers on field mapping, ultrabasic rocks, and granites of Canada projects. Laboratory use was originated mainly by the two major petrographic projects. New equipment includes the "vacuum picker" for hand beneficiation of mineral concentrates and new apparatus for staining feldspars in thin section. These have increased production in both activities. The type and volume of laboratory use are illustrated by the following statistical summary.

Laboratory Activities

Type of Activities	Quarterly Reports				
	1	2	3	4	Total
Specific gravity determinations - rock chips	1,120	581	2,642		4,343
- rock slabs					40
Mineral staining					
- microcline + coverglass		52)		273)	
- microcline + plagioclase	533	378)	407	40)	1,683
- pyroxene + K-spar		7	27		34
- calcite	4				4
Modes	119	105	236	73	533
Samples handpicked + centrifuge		105	99	250	454
Mineral identification					
- refractive index	14	46	161	317	538
- 2V (U-stage)	10	28	150	35	223
- Z C (U-stage)		195		11	206
- plagioclase fusion		19	34	10	63
- calcite etch				4	4
- others		3	5	14	22
Petrofrabric analysis - quartz Thin Sections			20		20
Petrographic descriptions	53	92	12	15	172

Type of Activities (cont'd.)	Quarterly Reports				
	1	2	3	4	Total
Calculations					
- norms 1,620 Calculation			373	17	390
- statistical		22	320	24	566
Collections catalogued					
- rocks					
- meteorites		5			5
- thin sections				20	20
Smear and balsam mounts			32	13	45
Rocks Split			80	400	480
Heavy Liquid beneficiation			40	9	55
Pseudo meteorite identifications		59	59	18	136
Plaster mould				1	1
Specimens unpacked				40	40
Figures drafted				53	53
Immermin oil inspection of concentrates				44	44

Three collections, - the Representative Rock Collection, the Thin Section Collection, and the Meteorite Collection - have been administered by the Petrological Section since 1958.

Representative Rock Collections

These collections which consist of 80 to 100 hand specimens and thin sections for each $\frac{1}{2}$ of a 4-mile map-area are not growing as rapidly as the rate of field mapping. In 1961 it was announced that 57 per cent of the country was illustrated by geological maps whereas only 5 per cent of that area is represented by specimen suites. The present rate of mapping is 5 per cent per year whereas the submission of collections is only 2 per cent. The suites received in 1962 include the following:

Cape Breton, N.S.	Dr. E.R.W. Neale
Bonavista, Nfld.	Dr. S.E. Jenness
File Lake, Manitoba	Dr. H. Williams
Caribou Lake, Ont.	Dr. H.H. Bostock
Ft. George-Great Whale River	Dr. K.E. Eade

Thin Section Collection

The Geological Survey Thin Section Collection, which represents 75 years of geological mapping in Canada, was rarely used in 1962. Two new suites were submitted and two loaned suites were returned.

The Canadian Meteorite Collection

Newspaper articles on meteorite recovery and the sighting of two spectacular fireballs over western Canada served to increase public interest in the subject. As a result a total of 140 pseudometeorites have been received for identification since the first of April and a 3-day trip was made to southwestern Ontario to examine specimens and to interview Mr. Orval Brown, former owner of the Dresden meteorite. The publicity also resulted in a marked increase in the volume of correspondence required to handle meteorite enquiries.

The interest shown by the public in the subject of meteorites has also resulted in the production of a non-technical brochure. This will be illustrated by a number of black and white photographs and non-technical captions. The brochure, which is in the final stages of production, should be available early in 1963.

The Meteorite Collection continued to grow by means of exchanges although at a slower rate than in 1961. Several exchanges and one new purchase are listed below.

Bonita Springs	79 gms	Dr. B.H. Mason
Concho	227 "	" "
Henbury	1374 "	" "
Lake Labryinth	77 "	" "
Ramsdorf	93 "	Dr. J. Zahringer
Canon Diablo	141 "	Dr. J.C. Cobb
Dresden	1800 "	Mr. Orval Brown

The descriptive paper dealing with the two Canadian falls - the Holman Island, and Benton, N.B. falls, is still in preparation.

REPORT ON THE UPPER MANTLE PROJECT

C.H. Smith

The International Upper Mantle Project, extending from 1962 to 1964, is a program of studies designed to obtain and interpret geophysical and geological data on the upper mantle of the earth. The broad program of studies in Canada, more especially that of the Department of Mines and Technical Surveys, has been outlined in a special publication titled "International Upper Mantle Project" distributed by the Department of Mines and Technical Surveys.

The part of the Upper Mantle Project carried out in the Petrological Sciences Division includes petrographic, mineralographic, chemical, and isotopic studies related to basic and ultrabasic intrusions. The intrusions, in particular, provide an indirect means of sampling and studying the chemical and physical conditions and processes existing in the mantle itself.

The planning for drilling several micro-Moholes has occupied much of the past year. During the spring of 1962, much attention was given to the drafting of specifications for deep drilling contract. The lack of experience in deep diamond drilling in Canada prevented a close evaluation of the proper methods and costs involved. Tenders were called to drill a 10,000 foot hole through the Muskox Intrusion, but later cancelled due to the apparently high cost, and to withdrawal of the available drilling funds during the austerity period. Detailed surveys were made over the proposed drilling areas in Muskox and at Mt. Albert, Gaspé. These combined detailed mapping and magnetometer surveys, and in places gravity surveys by the Dominion Observatory, to determine bedrock distribution, the location of shear zones or dykes, which might interfere with drilling, and to provide further data on the regional structures. The Seismic Section of the Geophysics Division carried out a seismic survey in the Mt. Albert area to determine the depths of overburden. The Muskox specifications were modified to consist of two 5,000-foot holes and resubmitted for tenders in the fall. The result of the tenders indicates a considerable saving in cost without greatly sacrificing the geological advantage of a single deep hole, and it is expected that a contract will be awarded for the program in January, 1963. The Mount Albert drilling plans, consisting of a single 10,000 foot hole, have been postponed until 1964 for financial reasons.

Laboratory studies, to provide quantitative data needed to fill gaps in our knowledge of 'mantle' material, have continued. Studies of techniques have been necessary, and papers on the determination of olivine composition by X-ray methods (Jambor and Smith) and the use of cell dimensions to interpret variations in chrome spinel compositions

(MacGregor and Smith) are in press, Studies by Pouliot on feldspars are reported elsewhere in this report. These studies, and others like them, are needed to sharpen the tools used in petrological studies of basic intrusions.

The Mount Albert study has continued, with decreased attention. Additional sampling was done this summer to allow a more precise positioning of the chemical variations in the intrusion; this data is being studied using trend surface analysis by F.P. Agterberg. This is one of the few ultrabasic intrusions from which a great deal of detailed systematic, mineralogical data has been obtained, which will be invaluable in comparative studies of cores from depth either at Mt. Albert or from mantle drilling elsewhere in the world. I.D. MacGregor is completing a study of the metamorphic aureole bordering this intrusion as a Ph.D. study at Princeton University.

The Muskox intrusion has received increased attention because of the unique opportunity it offers for quantitative study of the chemistry and differentiation of basaltic magma. The following studies are now underway -

Petrology of intrusion	T.N. Irvine
Mineralogy of feldspars	G. Pouliot
Mineralogy of sulphides	J. Chamberlain
Study of sulphur isotopes	A. Sasaki
Study of feeder-petrology	Th. Zwartkruis
Study of feeder-mode of intrusion	S. Bhattacharji

Geophysical surveys (aeromagnetic by Geological Survey of Canada and gravity by Dominion Observatory) have been completed and await interpretation. Palaeomagnetic studies are planned by W.A. Robertson. Outside studies have been completed by D. Smith on the alkali feldspars (University of Western Ontario) and A. Gabezi on contact metamorphism (Carleton University). Chemical data, from analyses provided by the Analytical Chemistry Section, allow a very complete interpretation of the evolution and concentration of elements in the rock and magma phases during the complete cycle of crystallization. The feeder studies are also providing new data on the effects of the flow properties of solid-fluid mixtures in causing differentiation in magma conduits.

The fundamental plan in ultrabasic studies in Canada has been to study in considerable detail selected intrusions representing diverse petrologic, chemical, and tectonic relations, and to use this information to interpret the many other Canadian occurrences which, because of poor exposures, incomplete mapping, or other features, do not provide on their own the necessary data for genetic interpretations. In this way the disadvantages inherent in individual 'two-dimensional' field studies can be overcome by studying masses eroded to different levels. D.C. Findlay completed a manuscript

dealing with the unique, zoned ultrabasic complex at Tulameen, B.C., and W.J. Wolfe mapped the Blue Mountain intrusion in northern B.C., which represents a peridotite mass cut and metamorphosed by the Cassiar granite. His study is continuing at Yale University. R.F.J. Scoates continued his work on the peridotites associated with the Gordon Lake nickel deposit, which will be completed at the University of Manitoba. These studies are contributions to the knowledge needed to understand the complex picture provided by the many diverse samples of mantle material now exposed across Canada. When completed they will improve the confidence with which random surface observations can be extrapolated through space and time toward their source in the parent mantle.

MEMBERSHIP ON COMMITTEES

Sydney Abbey:	Membership Committee, Professional Institute. Reserve Panel of Appeal Representatives, Professional Inst.
W.H. Champ:	Non-Metallic Standards Committee, Canadian Assoc. for Applied Spectroscopy.
K.R. Dawson:	Dept. Committee on Computer Systems (Chairman). N.R.C. Assoc., Comm. on Meteorites. Branch Committee on Collections and Sample Numbering.
G.R. Lachance:	Ottawa Comm., Ottawa Symposium on Applied Spectroscopy.
J.A. Maxwell:	Library Committee. Subcomm. on Min., Geochem., and Pet. of National Advisory Comm. Councillor, Chem. Inst. of Canada. Standards Comm., Geochemical Soc.
J.E. Reesor:	Branch Committee on Age.
S.C. Robinson:	N.R.C. Assoc. Committee on Meteorites (Chairman). Royal Society of Canada Exec. Comm. and Council (Hon. Secretary). Departmental Committee on Training. Branch Committee on Collections and Sample Numbering (Chairman). Branch Committee on Age. Queen's University, Advisory Council.

H.R. Steacy: Branch Exhibits Committee (Chairman).
Mineralogical Association of Canada (Honorary Treasurer).
Publicity Subcommittee, C.I.M. Meeting (Convenor).

C.H. Smith: Scientific Committee for the Upper Mantle Project.
Branch Stable Isotope Committee (Chairman).
Deep Hole Subcommittee of the Scientific Research Subcommittee of the Advisory Committee on Northern Development.

R.J. Traill: Branch Committee on Age (Secretary).
Branch Committee on Analyses.
Committee on New Minerals and Mineral Names, International Mineralogical Association.
Program Committee, Eleventh Clay Minerals Conference.

R.K. Wanless: Branch Committee on Stable Isotopes.
Branch Committee on Age.
Subcommittee on Isotope Studies and Geochronology of N.R.C.
Associate Committee on Geodesy and Geophysics (Secretary).

OUTSIDE PUBLICATIONS

Abbey, Sydney, and Maxwell, J.A.: Photometric determination of small amounts of magnesium in rocks; Anal. Chim. Acta, vol. 27, p. 233, 1962.

Agterberg, F.P.: Statistical analysis of X-ray data for olivine; Min. Mag. (London), in press.

_____: Rounding off in geochemistry; (letter to Editor), Can. Mineralogist, in press.

Champ, W.H.: An account of the development of the Stallwood jet; The Spex Speaker, vol. 7, No. 3, 1962.

Courville, Serge: Apparatus for total water determining by the Penfield method; Can. Mineralogist, vol. 7, p. 326, 1962.

Dyck, W. and Fyles, J.G.: Geological Survey of Canada radiocarbon dates, Report II; Radiocarbon, vol. 5, in press.

Jambor, J.L., and Boyle, R.W.: The geochemistry and geothermometry of sphalerite in the silver-lead-zinc lodes of the Keno Hill-Galena Hill area, Yukon; Can. Mineralogist, in press.

Jambor, J.L., and Smith C.H.: Olivine composition determination with small-diameter X-ray powder cameras; Min. Mag. (London), in press.

Jambor, J.L.: Elroquite and phosphochromite discredited; Can. Mineralogist, in press.

MacGregor, I.D. and Smith, C.H.: The use of chrome spinels in petrographic studies of ultramafic intrusions; Can. Mineralogist, in press.

Page, J.A., Maxwell, J.A., and Graham, R.P.: Analytical applications of the mercury electrodes. A review; The Analyst, vol. 87, p. 245, 1962.

Reesor, J.E.: Precambrian of southern Canadian cordillera; Precambrian of the World, ed. by K. Rankama, Interscience Publishers, in press.

Rimsaite, J.: Studies of rock-forming micas (abstract); Am. Mineralogist, vol. 47, p. 201, 1962.

Robinson, S.C.; Loveridge, W.D., Rimsaite, J., and Van Peteghem, J.: Factors involved in discordant ages of euxenite from a Grenville pegmatite; Can. Mineralogist, in press.

Smith, C.H. and Kapp, H.E.: The Muskox Intrusion, a newly discovered layered intrusion in the Coppermine River area, Northwest Territories; Am. Mineralogist, in press.

Traill, R.J.: A rhombohedral polytype of molybdenite; Can. Mineralogist, in press.

MARINE GEOLOGY

B.R. Pelletier

INTRODUCTION

For informational purposes a review of the Marine Geology Unit is given here outlining a few historical notes, projects, purpose of the unit's activities, and present plans.

Marine Geology in the Geological Survey was first organized in 1959 to operate within the framework of the Polar Continental Shelf Project. The first program was initiated by B.R. Pelletier, then of the Fuels and Stratigraphy Division, in April of 1960 and comprised a joint oceanographic - geological exploration of the Arctic continental shelf on the western boundary of the Queen Elizabeth Islands. Later that same year an inshore program commenced by D.R. Horn and B.R. Pelletier took place in Deer Bay, Ellef Ringnes Island, and included a broad sampling program of sediments from the headwaters of the drainage basins on land to the site of deposition at sea. A laboratory schedule was drawn up in the form of a flow sheet to assist in expediting samples to the various laboratories of the Geological Survey in Ottawa. These laboratories carried out analyses in sedimentology, palaeontology, X-ray diffraction on clay minerals, optical spectrograph on certain elements, and geochemistry for certain chemical factors.

In the spring and summer of 1961 work on the Polar Continental Shelf Project was continued with Pelletier working offshore over the Arctic continental shelf and Horn working over Peary Channel in both inshore and offshore areas as well as certain drainage basins of adjacent land areas.

Two office-laboratory studies in conjunction with work undertaken by the geology department of Carleton University, Ottawa, were supported by the Geological Survey during the summer of 1961. H.F. Sproule worked on material from the Gaspé region of the Gulf of St. Lawrence, and G.A. Bartlett collected and studied material from the Scotian Shelf. Both projects involved a study of the relationship of marine bottom fauna to the associated sediments. From mid-July to late September a marine geology project was undertaken in Hudson Bay with the cooperation of the Division of Oceanographic Research. R.J. Leslie was the geologist on the cruise and was joined in the latter part of the project by B.R. Pelletier.

In October of 1961 it was decided to make Marine Geology directly responsible to the Director's Office, which brought about the separation of the unit from the Fuels and Stratigraphy Division, transferring it to the Administration Division. A complete program, including qualifications of personnel, proposals for various field and laboratory projects, and a projected strength to 1,972, was submitted to the Director and Chief Geologist and later placed in the Branch Files.

In 1962 marine geology projects were carried out over Arctic waters, the Atlantic Ocean, and Hudson Bay. These projects are summarized in the section on field activities. Also during 1962 plans were made to move the group in Marine Geology to the new Bedford Institute of Oceanography in Dartmouth, Nova Scotia. From this centre field programs will be organized and laboratory analyses carried out. At present equipment is being installed in the marine geological laboratories at Dartmouth, and will include apparatus for studies in sedimentology, geochemistry of sediments, palaeontology, clay mineralogy, and certain metallic elements, thereby duplicating present laboratory establishments and services of the Geological Survey in Ottawa.

The chief aims of Marine Geology include the following: to establish the total sedimentary environment and the alteration of detritus undergoing sedimentary transport; to study formative sedimentary processes and interpret the distribution of sediments on the present sea floor as well as that which occurs in sub-bottom cores; to outline submarine topography and elucidate physiographic histories of the various study areas; to interpret climatic and physical settings of ancient environments by means of analyses of foraminifera and related fauna as well as by the analyses of certain chemical sedimentological, and mineralogical constituents. Long range projects will include production of a marine geological atlas of Canadian waters extending over the adjacent continental shelves. The atlas will depict the distribution of fauna and sediments, submarine topography, and other items of scientific and economic interest. A basic system of stratigraphic units will be set up in order to establish chronology in the layered sediments below the depositional interface. To support such activities and proposals a laboratory program has been initiated, which at present follows three major lines of research and services: 1) mechanical analyses of sediments - mineralogy and textural studies; 2) chemical analyses of sediments - X-ray diffraction, spectrography, and wet chemistry; 3) palaeontological studies - identification, morphology, population, zoning, ecology, and speciation. Later it is hoped to include studies with radio-active materials chiefly for the purpose of dating stratigraphic units and determining rates of sedimentation.

ACTIVITIES

Although field activities of Survey officers are given in Geological Survey Paper 63-1, a brief reference to this work is included here due to the continuity of field and laboratory studies.

D.R. Horn completed a manuscript to be published as a preliminary paper on his work in Peary Channel, District of Franklin. He is presently on educational leave at the University of Texas in Austin, Texas.

J.I. Marlowe joined the Geological Survey in May, 1962. He is engaged in a study of sediments and pertinent oceanographic data obtained on a marine geological survey in the eastern part of Prince Gustaf Adolf Sea, District of Franklin. Present research deals with the textural and mineralogical constitution of bottom sediments obtained from the study area. A manuscript dealing with this work has been prepared and will be submitted for publication as a preliminary paper early in 1963. This will be co-authored by G. Vilks.

B.R. Pelletier continued his sampling program over the Arctic continental shelf adjacent to the western Queen Elizabeth Islands, District of Franklin. Topical Report 47 by Pelletier covers the overall contribution of the Marine Geology Group to the Polar C.S.P. for the years 1960-61, and another similar report to cover the year 1962 will be submitted early in 1963. A manuscript is in preparation for publication on submarine topography and bottom material on the Arctic continental shelf. This paper will be co-authored by F.J.E. Wagner.

G. Vilks joined the Geological Survey in May, 1962, and commenced a study of inshore sediments and microfauna from Deer Bay, Ellef Ringnes Island, and adjacent parts of the floor of Prince Gustaf Adolf Sea. Vilks is presently making routine identifications of the fauna, as well as undertaking a population study on fauna from bottom sediments and the sub-bottom layers. A manuscript will be submitted to the Geological Survey for publication as a Paper early in 1963. It will be co-authored by J.I. Marlowe.

F.J.E. Wagner was transferred from the Palaeontology Section to Marine Geology in late 1962. She is responsible for the identification of bottom fauna obtained on certain marine geology projects in the Arctic, as well as service work for the Pleistocene Geology Section on material submitted to the Palaeontology Section. Other work includes the following two office projects: 1) O.P. 190 - Identification of organic remains from offshore dredged samples in Exeter Bay on the east coast of Baffin Island, District of Franklin; and 2) O.P. 256 - Micropalaeontology of marine sediments.

In addition to the activities of the regular staff, an office project and two doctoral theses involving field projects were supported by the Geological Survey. K.M. Kranck began O.P. 301 on recent marine sediments of Exeter Bay in the east coast of Baffin Island, District of Franklin. R.J. Leslie, beginning his doctoral research, commenced a detailed study of bottom topography, sediments, and fauna of Hudson Bay in the vicinity of the Churchill estuary. G.A. Bartlett commenced his doctoral research on a detailed study of bottom-dwelling foraminifera in various oceanic and inshore environments on the Scotian shelf in the vicinity of St. Margaret's and Mahone Bays.

Other activities of Marine Geology include the laboratory assistance of two technicians: 1) G. Duncan in the sedimentology laboratory, and 2) R. Cormier in the mineral separation laboratory. Cormier was transferred to Marine Geology in April 1962.

ATTENDANCE AT CONVENTIONS

J.I. Marlowe - Clay Mineral Conference, Ottawa

G. Vilks - Clay Mineral Conference, Ottawa

VISITS TO OTHER INSTITUTIONS AND SPECIAL TALKS

J.I. Marlowe and B.R. Pelletier made a trip to the Bedford Institute of Oceanography at Dartmouth, Nova Scotia. A display of marine geology projects undertaken by the Geological Survey was set up and demonstrated to the public at the official 3-day opening period in October.

B.R. Pelletier in March made an official visit to the Dalhousie Institute of Oceanography, and the Atlantic Oceanographic Group of the Fisheries Research Board, both located in Halifax. In April Pelletier attended the annual meetings of the Canadian Committee on Oceanography held in Ottawa and reviewed the marine geological work currently undertaken in the Arctic by the Geological Survey. Also in April he talked to the Carleton University Geology Club on marine geology on the Polar Continental Shelf Project. In November he spoke on marine geology projects to the Ottawa University Geology Club and in December gave the same talk in Hamilton, Ontario, for the McMaster University Geology Club.

Membership on Committees

B.R. Pelletier - geological advisor for the Polar Shelf Project
- liaison officer on marine geology programs for the Department of M. & T.S.

OUTSIDE REPORTS

Bartlett, G.A. 1962: Foraminifera and their Relations to Bottom Sediments on the Scotian Shelf. Unpublished M.Sc. thesis, Dept. of Geology, Carleton Univ., Ottawa, Ontario.

Leslie, R.J. 1961: A compilation of Published Information on Hudson Bay, Canada. Unpublished report for the Geological Survey of Canada.

Pelletier, B.R. 1962: Marine Geology Projects of the Geological Survey; prepared for the Division of Oceanographic Research, Marine Sciences Branch, Ottawa, Ontario.

Sproule, H.F. 1962: A Regional Study of the Distribution of Benthonic Foraminifera in the Gulf of St. Lawrence, Canada. Unpublished B.Sc. thesis, Dept. of Geology, Carleton Univ. Ottawa, Ontario.

SPECIAL PROJECTS

REPORT ON ACTIVITIES

C.H. Stockwell

TECTONIC MAP OF CANADA (O.P. 154)

The purpose is to prepare a Tectonic Map of Canada for publication by the Geological Survey of Canada on the scale of 1:5,000,000. The map is being prepared jointly by the Geological Survey of Canada, the Geological Association of Canada, and the Alberta Society of Petroleum Geologists, under the overall chairmanship of C.H. Stockwell. Various committees and subcommittees have been formed and, altogether, at least 25 geologists are actively engaged

in the project. Up to the end of 1962 most basic information has been compiled by the various people involved and it is expected that this will be assembled, correlated, and ready for submission to the editor by late 1963.

By the end of 1962 a large number of potassium-argon age determinations had been completed in the laboratories of the Petrological Sciences Division, many of which were done specifically for the Tectonic Map Project, mainly in the Canadian Shield where the object has been to determine the age and extent of various orogenic belts.

A punch card file of all age determinations in Canada (about 1,300 to date) was prepared, chiefly for use in the compilation of the Tectonic Map.

The Tectonic Map of Canada will also serve as Canada's contribution toward the preparation of a world tectonic map to be compiled and published by the International Geological Congress. Our contribution will be submitted to the Congress through the Vice President for the North American Subcommission for the Tectonic Map of the World, a position held by Dr. George V. Cohee of the United States Geological Survey.

MEMBERSHIP ON COMMITTEES

Canadian representative on the International Geological Congress, Commission on the Tectonic Map of the World.

Chairman, Committee on the Tectonic Map of Canada.

Member, Geological Survey of Canada Committee on Isotopic Age Determinations.

Chairman, Programme Committee, Geological Division, Section III, Royal Society of Canada.

OUTSIDE PUBLICATIONS

C.H. Stockwell: A Tectonic Map of the Canadian Shield; In the Tectonics of the Canadian Shield, Roy. Soc. Can. Special Publication No. 4, pp. 6-15, 1962.

REPORT ON ACTIVITIES

A.H. Lang

The year was devoted to compilation of geological maps on the 1 to 1,000,000 scale. These are for separate publication, but will also aid in preparation of a new geological map of Canada on the 1 to 5,000,000 scale. C.R. McLeod was assigned to assist with these compilations, half-time on November 1 and full-time on December 1.

At the end of 1962 the following nine maps had been completed (including those done in 1961); Hay River (N.T.S. 84); Clearwater River (N.T.S. 74); Cochrane River (N.T.S. 64); Churchill River (N.T.S. 54); North Saskatchewan River (N.T.S. 73); Carrott River (N.T.S. 63); Ekwan River (N.T.S. 43); South Saskatchewan River (N.T.S. 72); Assiniboine River (N.T.S. 62). The following six maps, which can be compiled most efficiently as a group, had been begun: Sachigo River (N.T.S. 53); Fort George River (N.T.S. 33); Kaniapiskau River (N.T.S. 23); Hamilton River (N.T.S. 13); North River (N.T.S. 14); Gatineau River (N.T.S. 31).

In December Lang was delegate to the annual meeting of the International Commission for the Geological Map of the World held in Paris to further the preparation of geological, tectonic, and metallogenic maps of the world.

MEMBERSHIP ON COMMITTEES

Member, Geological Map of the World Committee, International Geological Congress.

OUTSIDE PUBLICATION

Lang, A.H.: On the Relation of Metal Occurrences to Tectonic Divisions of the Canadian Shield; in The Tectonics of the Canadian Shield, Roy. Soc. Canada, Special Publications No. 4, pp. 16-21, 1962.

BRITISH COLUMBIA OFFICE REPORT

J.E. Armstrong

GENERAL

The British Columbia office at Vancouver is under charge of J.E. Armstrong. S. Leaming and a clerical staff of two complete the personnel. Seven other geologists, six in Regional Geology and one in Economic Geology are attached to this office; during the summer Sylvia Jones, a Colombo Plan student at U.B.C. was attached to this office. Also one student assistant spent the summer in the office.

A complete stock of Geological Survey publications and topographic maps relating to Western Canada is maintained for sale and reference. The British Columbia Department of Mines and the Federal Mines Branch publications are also stocked for sale and reference. In addition a library and reading room are maintained for use of the public.

1962 was the busiest year ever recorded in the B.C. Office. 9,650 visitors registered and 24,724 publications of various kinds were distributed. 1,382 collections of rocks and minerals were sold. The total cash sales amounted to $8,450.58* exclusive of British Columbia Department of Mines publications. Armstrong interviewed 1,150 people and Leaming 2,215 and they identified about 555 rocks and minerals. Approximately 2,600 letters were answered by the staff. 1,175 pages of geological manuscript were also typed.

A number of short term field projects are carried out each year by the geologists in the office, mainly at the request of other Government Departments. These consist largely of engineering and groundwater investigations.

The B.C. Office of the Geological Survey provides space, telephone service and secretarial services for the Federal Explosives Inspector for Western Canada, and three surveyors of the Legal Surveys. The office also works in close cooperation with the B.C. Department of Mines, who maintain an office adjoining our own staffed by a personnel of nine.

---

* This does not include money collected for B.C. Dept. of Mines and turned over to them directly, probably about $1,000.00 a year.

	Visitors	Publications Distributed	Rocks and Mineral Distributed	Sales
Dec. 1961	575	1,516	83	563.35
Jan. 1962	800	1,657	57	623.40
Feb.	925	2,321	91	747.15
Mar.	900	2,303	163	792.55
Apr.	920	2,438	104	769.95
May	880	2,538	75	880.65
June	700	2,207	57	663.35
July	750	1,711	61	590.13
Aug.	810	2,053	61	649.70
Sept.	760	1,927	192	739.65
Oct.	880	2,285	240	817.40
Nov.	750	1,768	198	613.30
	9,650	24,724	1,382	$ 8,450.58

ACTIVITIES

J.E. Armstrong did 77 days field work and supervising of field work. The time was spent as follows: (1) 21 days examining surficial geology in the Fraser Lowland area, B.C. in order to gain additional information for preparation of a final manuscript, (Field Project 54-10); (2) 22 days supervising and aiding S. Leaming in his investigation of gravel deposits in the Strait of Georgia area, B.C., (Field Project 61-17); (3) 7 days supervising R.J. Fulton's mapping of Pleistocene geology of the Nicola map-area, B.C. (Thesis area project 60-12); (4) 7 days supervising D.F. Sangster's investigation of magnetite deposits of B.C. (Thesis project 57-29); (5) 7 days cooperating with the Federal and Provincial Soils Surveys and the Federal and Provincial Forestry Departments in the southern interior of B.C.; (6) 4 days cooperating with E.C. Halstead on the southeast coast of Vancouver Island, (Field Project 61-15); (7) 7 days on organized field trips in the State of Washington and the southwestern corner of the B.C. Mainland; and (8) 2 days showing I.C. Brown the Pleistocene and groundwater geology in the Fraser Lowland.

J.E. Armstrong and S.F. Leaming participated in two field trips as follows:

(1) A Pleistocene field trip was undertaken in Whatcom County, Washington State, U.S.A. and the Fraser Lowland of B.C. (the areas adjoin on the International Boundary). D.J. Easterbrook was responsible for the U.S. part of the trip and J.E. Armstrong for the Canadian part. 18 geologists were on the 2-day trip; 14 from the U.S. and 4 from Canada.

(2) A two-day field trip was made to the San Juan Islands (between Vancouver Island and Washington State).

Armstrong arranged a one-day field trip up Howe Sound for some of the geologists in the B.C. Office in order to illustrate to them typical Coast Range geology. He also conducted four 1-day geological field trips (Saturdays) for the Vancouver Natural History Society and the Vancouver Lapidary Society.

Armstrong and Leaming attended the 50th anniversary meeting of the B.C. and Yukon Chamber of Mines and the annual Western meeting of the Canadian Institute of Mining and Metallurgy, both held in Vancouver.

At the anniversary meeting of the B.C. and Yukon Chamber of Mines a display of G.S.C. reports and maps was arranged and geologists from the B.C. office were present at this display for questioning. R. Barager of Yellowknife and R. Skinner of Whitehorse participated in this display.

Armstrong attended two meetings of the Publications Committee of the Geological Society of America in New York in January and September. He also attended the B.C. Resources Conference in Kelowna, B.C. in September and the Northwest Science Association in Bellingham, Washington, U.S.A. in December.

During the year Armstrong interviewed approximately 1,150 and Leaming 2,215 people. The average interview probably lasted 10 to 15 minutes, the total time involved probably equalling 80 working days. In addition they answered at least 500 letters and 2,000 phone calls seeking information.

During the year Armstrong gave the following public talks: (1) Geology of the Oslo Area to the Vancouver Natural History Society; (2) Geology of Howe Sound Area to the Vancouver Lapidary Society; (3) Geology of the Fraser Lowland to the New Westminster Lapidary Society; (4) A synopsis of the work done by the G.S.C. and B.C. Dept. of Mines in Southwestern B.C. to the Mining Exploration Group.

Armstrong took an active part on the following committees:

(1) He was a member of the Publications Committee of the Geological Society of America. - Elected Chairman in November 1962. He was also appointed an Associate Editor for the G.S.A. for a three-year term commencing in 1962. In addition to attending meetings as already outlined, he either read critically or found critical readers for eight papers for the G.S.A.

(2) He was Treasurer for the B.C. Section of the C.I.M.M. In the year 1962 his duties included the arranging of finances for the 1962 Annual Western Meeting.

(3) He was President of the Vancouver Natural History Society. This meant attending at least 25 evening meetings and 10 week-end field trips, all related to Natural History subjects.

(4) He was Chairman of the Vancouver Geological Discussion Club. This entailed the soliciting of 8 speakers and arranging evening meetings.

(5) He was a member of the Subcommittee on Forest Land Classification of The Soils Advisory Committee of the B.C. Department of Agriculture. He attended two meetings of this committee, one in Vancouver and one in Quilchena (Southern Interior of B.C.).

One other activity Armstrong believes worthy of note is his pre-submission critical reading of J.A. Roddick's 350 page manuscript on the geology of the Pitt Lake, Vancouver North, and Coquitlam map-areas. This memoir includes the Vancouver North map-area, which was mapped by Armstrong; consequently he felt he should read it.

The North Vancouver School Board requested the Geological Survey to give a night school course for Rockhounds. S.F. Leaming organized the course and gave the first 10 lectures (one a weak). At the Annual Western Meeting of the C.I.M.M. Leaming gave a talk on Geology and Engineering in the Sand and Gravel Industry.

WHITEHORSE OFFICE REPORT

L.H. Green

The function of the Whitehorse Office of the Geological Survey is to assist mining exploration in the Yukon and the part of the District of Mackenzie more readily accessible from points in the Yukon. The staff consists of a Resident Geologist, an Assistant Resident Geologist, and a Clerk.

The office has a reasonably well stocked library containing many of the out-of-print publications on the Yukon, northern British Columbia, and the District of Mackenzie. A large stock of current geological and topographical publications is maintained for sale, and the office statistics for the year are:

Visitors	Publications Distributed* Topographical	Geological
2,037	5,723	1,565

*(includes 1,017 Topographical and 184 Geological publications distributed free of charge to G.S.C. parties or other government departments.)

Other office services include supplying geological information and advice to prospectors, exploration geologists, other government departments, and the general public. The most common technical requests are for information on old showings and the regional geology of mineralized areas. During the summer months, the clerk handles a very large number of requests for topographical information from tourists and weekend prospectors. During the year, a large number of mineral and rock specimens were identified; in some cases these were forwarded to Ottawa for X-ray or spectrographic work. An annual prospectors course is given in the early spring in conjunction with the Yukon Chamber of Mines.

The Resident Geologist keeps in touch with mining and exploration developments within the Yukon and headquarters are kept informed through a monthly letter to the Chief Geologist. An annual report on the Mining Industry of the Yukon and Southwestern District of Mackenzie is prepared for publication in the Geol. Survey's Paper Series. During the field season, all of the operating lode mines and most of the more important lode prospects and placer operations were visited. In addition, a considerable amount of airborne reconnaissance was done in the unmapped area in the vicinity of the Yukon-Northwest Territories boundary. The technical staff were in the field approximately half the summer.

The Resident Geologist cooperates with and supplies technical information to the Department of Northern Affairs and National Resources and the Yukon Territorial Government on a number of matters. He is a member of both the Screening Board and the Review Board as set up under the Prospectors Assistance Program of the former department. He is a member of the Tote Trail Committee, which advises the Commissioner of the Yukon on tote trail assistance. He cooperates with the Resident Mining Inspector in reviewing and recommending to the Commissioner the value of geological, geophysical, and geochemical work submitted as representation work on mining claims.

Yukon mineral production in 1962 was about the same as 1961. United Keno Hill Mines Limited remained the only important lode producer mine with the value of their production for the year about

10 million dollars. In addition, Dominion Explorers Limited shipped hand-sorted ore from the Johobo property and an independent producer in the Mayo district made a small shipment. Yukon Consolidated Gold Corporation continued their placer operations in the Klondike area and the total value of their production will probably be about the same as last year. In addition, a large number of independent, small-scale placer operations were carried on in the Klondike, Sixtymile, Mayo, and Kluane Lake areas.

In exploration, the most significant event of the year was the staking of the Snake River iron deposit by Crest Exploration Limited, a wholly-owned subsidiary of The California Standard Company. The deposit was discovered in 1961 but remained a closely guarded secret until the staking was recorded in Mayo, Yukon, in late June 1962. The deposit consists of a sedimentary iron formation, composed essentially of jasper and hematite, which is up to 200 feet thick within the area staked. The deposit is of major rank and a rough estimate of the reserves is in excess of 50 billion tons of iron formation with an iron content of about 50 per cent. Late in the year, Crest Exploration retained Canadian Bechtel Limited to do a feasibility study of the deposit and preliminary results may be available early in 1963. Development of this deposit would have a major effect of the entire economy of the Yukon.

The discovery of high grade silver minerals at the Tintina Silver Mines property in late 1961 sparked a large increase in exploration in the Yukon during the 1962 season. The Tintina property itself turned out to be somewhat of a disappointment but a number of other interesting discoveries were made. Among the more interesting are: a potentially large lead-zinc deposit discovered by the Frances River Syndicate near Watson Lake in an area that was not previously known to be mineralized, a silver-gold showing discovered by the Mount Nansen Syndicate in the Carmacks area, and a molybdenite showing discovered by Conwest Exploration Company Limited prospectors near the Canol Road. In addition, underground development was carried out by Ormsby Mines Limited at their property near Carmacks and by Peso Silver Mines Limited at their property in the Mayo district.

In the District of Mackenzie, Canada Tungsten Mining Corporation Limited, have completed the mill and mined a year's supply of ore at their tungsten property in the Flat River area. They expect to start shipping concentrates early in 1963. The road between the property and Watson Lake was completed late in 1962. Also in the District of Mackenzie, Redstone Mines Limited worked on a number of mineral showings.

YELLOWKNIFE OFFICE REPORT

W.R.A. Baragar and E.H. Hornbrook

Introduction - The function of the Geological Survey Office in Yellowknife is to assist the mining public in furthering the exploration and development of mineral resources in the Northwest Territories.

Personnel - The office is staffed by a Resident Geologist, Scientific Officer, and a Clerk. The Scientific Officer was added to the staff in April of this year.

In February the Resident Geologist attended a Prospecting and Exploration Conference in Vancouver marking the 50th Anniversary of the British Columbia and Yukon Chamber of Mines, where he participated with personnel from Vancouver and Whitehorse offices in a "Discussion Room". This was meant to provide regional information to delegates anticipating exploration or prospecting ventures in either British Columbia, Yukon, or Northwest Territories.

The office cooperated with the Canadian Institute of Mining and Metallurgy in producing a prospectors course consisting of 4 lectures and 4 field trips during May.

Office Procedure - The office acts as a source of geological information and maintains a reasonably well-equipped library and reading room as well as a stock of Geological Survey publications available for sale. During the past year 438 publications were sold and an additional number were made available to Geological Survey and other government parties. Prospector rock-and-mineral kits are available and a number were sold. Frequent calls were made on library items.

The office also acts in an advisory capacity in its relationship to the public. Prospectors, engineers, and geologists made frequent calls at the office to obtain data, to exchange information, and to test ideas.

Mineral and rock specimens were commonly brought to the office for identification and where necessary they were forwarded to laboratories in Ottawa for X-ray or spectrographic analysis. Limited thin sections studies were carried out on rocks from a number of properties. The office was equipped with a spectrometric analyser early this summer to provide rapid qualitative or semi-quantitative spectroscopic data for the mining public. This service is meant to be a guide to assaying rather than a substitute for assaying. It may also

afford the means of detecting unsuspected commercially important elements in conventional mineral samples. To date it has had rather limited use but in future will probably be more in demand as the public learns of its availability and function.

The Resident Geologist cooperated with the Department of Northern Affairs and National Resources in reviewing and approving geological, geophysical, and geochemical work submitted as representation work on mining claims. The reports concerned are retained in the Geological Survey office where, following a confidential period of 3 years, they will be available for use by the general public. A number of such reports were added to the files during the year. The office was also called upon to assist the Department of Northern Affairs and National Resources with the Prospectors Assistance Program. The Resident Geologist served on the screening and reviewing boards which respectively selected the prospectors qualified for assistance and assessed the data they submitted at the end of the season. During the summer a number of parties working under the auspices of the program were visited in the field.

Geological Survey Headquarters were kept informed on prospecting and mining activity in the Northwest Territories, particularly the Mackenzie District through monthly and bi-monthly reports issued by the Yellowknife office. In the course of the year the 3 producing mines, Con, Giant, and Discovery were visited periodically and 19 properties were examined and reported on. A report on mining and prospecting activities in the Mackenzie District was compiled at the end of the year and submitted for publication as a preliminary paper.

GEOLOGICAL MANUSCRIPTS UNIT

H.M.A. Rice

All manuscripts submitted for publication by the Geological Survey of Canada, whether maps or reports, are processed by the Geological Manuscripts Unit. It is the responsibility of the unit to ensure that all publications conform to Geological Survey standards and to help the author to produce an accurate, logical, unambiguous report and map. Duties of the unit include the transmission of reports to the Departmental Editorial Division and maps to the Cartography Unit.

During the year an author index was prepared to accompany Johnston's index of Geological Survey publications. This should be available shortly.

This year also marks the inclusion of the annual "Information Circular" on field projects in the Preliminary Series Papers and a change in emphasis from a report written primarily by the compiler to short individual reports written by the officer concerned. A comparable series covering progress on office projects was initiated.

It is interesting to note that over the last few years there has been a steady increase in the number of P.S. Papers processed with respect to P.S. Maps. At the same time Papers on the average are longer and more complex. In effect the original purpose of the P.S. Series, to provide speedy publication of the first provisional but important conclusions of research is in danger of being overlooked.

STATUS OF GEOLOGICAL MANUSCRIPTS ON DEC. 27, 1962
WITH COMPARABLE FIGURES FOR 1960 and 1961

Type of Report	Being Processed						Published during			Total Active during year		
	At G.S.C.			After G.S.C.								
	1962	1961	1960	1962	1961	1960	1962	1961	1960	1962	1961	1960
Memoirs	14	11	14	18	15	15	2	6	7	34	32	36
Bulletins	26	20	13	26	26	20	14	9	10	66	55	43
Econ. Geol. Reports	4	1	1	2	2	2	1	0	1	7	3	4
Misc. Repts. etc.	4	4	0	2	3	2	4	0	1	10	7	3
Multicolour Maps[1]	2	4	4	37	40	36	8	6	9	47	50	49
P.S. Papers	11	7	6	20	17	18	38	31	27	69	55	51
P.S. Maps	5	11	5	8	7	13	27	38	34	40	56	52
Topical Reports							28	18	10			

[1] This does not include multicolour maps to illustrate Memoirs and Bulletins.

AREA OF CANADA MAPPED

The following is an estimate of the area of Canada covered by geological maps published by the Geological Survey of Canada to December 31, 1962.

Province of Territory	Total area in sq. m.	Area in sq. m. Published	Per cent
Newfoundland (Island)	43,359	24,551	56.6
Newfoundland (Labrador)	112,826	68,772	60.9
Nova Scotia	21,425	21,425	100
New Brunswick	28,354	28,354	100
Prince Edward Island	2,184	2,184	100
Quebec	594,860	278,914	46.9
Ontario	398,524	189,172	47.3
Manitoba	248,125	179,893	72.4
Saskatchewan	251,396	218,294	87.1
Alberta	255,285	130,276	51.1
British Columbia	366,255	238,173	65.2
Yukon Territory	207,076	116,391	56.2
District of Mackenzie	520,933	364,877	67.1
District of Keewatin	228,160	178,471	63.5
District of Franklin	549,253	285,667	52.0
TOTAL	3,831,016	2,325,417	60.7

SEASONAL EMPLOYEES

E. Hall

STUDENT PROGRAM

This year's recruiting program was marked by a larger than usual number of eligible applicants but the increase was confined to first and second year students. As usual there were some three hundred to four hundred unqualified applicants.

Technical Officers

Compared to last year our establishment of technical officers (T.O.) 1 - 11 was increased by eight to a total of 122. This total includes five T.O. 11 positions. The small decrease in the number of eligible technical officers was mainly due to a change in Civil Service regulations. This year the T.O. 1 level was restricted to persons with more than one summer of relevant experience rather than being open to any pass graduates. As sufficient technical officers were available from the T.O. 2 and 3 lists most T.O. 1's were offered as student assistant 4's.

There was a sharp jump in the long term trend to use more technical officers on office projects. Because of this and to provide assistants to new permanent staff members an increase in the technical officer establishment should be sought for next year.

Student Assistants

There was an increase of over 150 student applications this year, mainly because of the increase of first and second year students. An additional factor was the creation of a new group - S.A. 4's -, who are pass graduates with one summer or less of relevant experience.

However, the most significant factor is the decrease by almost one-third in the applications and acceptances by third year students. This parallels a decrease in university students in geology at this level and indicates that we are going to have considerable difficulty in recruiting sufficient experienced technical officers during the next two or three years.

Recruiting

In January Dr. W.H. Poole visited universities in the Maritime Provinces and Newfoundland speaking on the Tectonic Map of the Appalachians and summer employment opportunities with the Geological Survey. At the same time Mr. E. Hall visited Prairie universities and gave a talk on the Geological Survey in an attempt to interest students in employment with us. Members of the staff of our Vancouver office carried out similar duties at the University of British Columbia.

Refusals

A total of 34 recruits sent in refusals after accepting employment. Almost all of these came after April 1st when it becomes difficult to obtain replacements. Of this total only two were at the technical officer level.

Special Cases

A total of ten special cases were put forward to the Civil Service Commission this year. Seven of these were university professors, one was a non-Canadian student, and two were students hired because of special skills. Our establishment of 5 T.O. 11 positions used for professors is being exceeded each year and an increase should be requested.

Prevailing Rate

The prevailing rate establishment has proved to be adequate. As last year a list of positions and suggested names had to be submitted to the Minister's office for approval.

Salaries

Technical officer's salaries ranged from $325 to $515 per month and averaged $439. For student assistants the range was $245 to $305 per month and averaged $276.

Salaries paid to technical officers were competative. At the student level the minimum salary of $245 is adequate but an effort should be made to increase the increments paid for field and university experience. The large number of refusals indicate that student salaries should range up to at least $350 per month in order to make us competative with industry.

Colombo Plan

Six Colombo Plan students attending Canadian universities were attached to laboratories or field parties for the summer. A seventh man is to obtain training in our laboratories for about three months in the fall.

The following tables summarize the status of student applicants for the field seasons of 1955 to 1962 inclusive.

Table 1

Recruiting of Geology Students

		1962	1961	1960	1959	1958	1957	1956	1955
T.O. 3	Applications	72	66	50					
	Offered	71	64	50					
	Accepted	54	39	33					
	% "	76	61	66					
T.O. 2	Applications	68	67	82	Note:-	4 offers were made by			
	Offered	58	63	64		other Branches to bring total			
	Accepted	33	42	36		offers to 62			
	% "	57	67	56					
T.O. 1	Applications	17	44	34	Note:-	1 offer made by Oceanography			
	Offered	3	10	5		and 13 offered as Student Assistants			
	Accepted	2	7	4		4 of which 5 accepted			
	% "	66	70	73					
Total T.O.	Applications	157	177	166	172	85	81	69	94
	Offered	132	137	119	155	71	66	69	86
	Accepted	89	88	73	80	56	47	41	37
	% "	67	64	61	52	79	71	60	43

Note:- Table 1 includes only students recruited in the 1962 geology competition and does not include T.O.'s extended from winter employment, special cases, and non-geologist students. Details of previous years are in previous reports.

Table 1A

Recruiting of Geology Students

		1962	1961	1960	1959	1958	1957	1956	1955
S.A. 4th year	Applications	19							
	Offered	31					Note:- 13 T.O.1's offered as S.A. 4's		
	Accepted	16							
	% "	52							
S.A. 3rd year	Applications	96	128	144	171	169			
	Offered	94	123	135	133	144	Note:- 2 offers made by other Branches		
	Accepted	49	75	75	89	96			
	% "	53	61	56	67	67			
S.A. 2nd year	Applications	213	139	170	210	178			
	Offered	192	132	120	67	82	Note:- 4 offers made by other Branches		
	Accepted	77	84	67	28	39			
	% "	40	64	56	44	48			
S.A. 1st year	Applications	230	144						
	Offered	40	13						
	Accepted	24	4						
	% "	58	31						
Total S.A.	Applications	558	411	314	381	347	394	392	316
	Offered	357	268	255	200	226	191	273	212
	Accepted	165	163	142	117	135	110	112	108
	% "	47	61	56	59	60	58	41	51

Table 2

Resignations after assignment to party 1954-62

	1962	1961	1960	1959	1958	1957	1956	1955
T.O.	2	3	2	1	1	1	1	4
4th year	1	-	-	-	-	-	-	-
3rd year	4	5	2	3	2	1	3	3
2nd year	8	4	7	2	0	1	5	9
1st year	1	0	-	-	-	0	1	2
Total	15	12	11	6	3	3	10	18

Table 3

Actual Employment 1962

	Office	Field	Total	Establishment	Req'd Office	Req'd Field
T.O. 3-11	12	54	66			
T.O. 2	16	32	48			
T.O. 1	2	0	2			
Total T.O.	30	86	116	122	31	88
4th year	5	11	16			
3rd year	9	43	52			
2nd year	22	58	80			
1st year	10	14	24			
Total	46	126	172	190	46	126

NOTE: This table includes the following personnel not included in Table 1:

5 T.O. from chemistry competition
12 T.O.'s extended from last winter
10 T.O.'s - professors and special cases
5 S/A from chemistry competition
1 S/A Electrical Engineer

The column marked Req'd shows the numbers required to fully staff the field and office if positions and personnel had been available.

Table 4

Students employed in offices 1955-62

	1962	1961	1960	1959	1958	1957	1956	1955
T.O.	30*(20)	23-20	20-21	16-24	14-15	4-7	3-3	4-4
S.A.	46	34	24	15	23	19-6	17-5	10-1
Total	76	57	44-21	31-24	37-15	23-13	20-8	14-5

Note: *1st figure is summer employment and 2nd is establishment authorized for following winter.

Table 5

Students per field party 1955-62

Year	No. of Parties	No. of T.O.'s	T.O.'s per Party	No. of S.A.'s	S.A.'s per Party
1962	97	86	.90	126	1.30
1961	102	95	.93	136	1.33
1960	88	81	.92	127	1.44
1959	77	69	.90	107	1.39
1958	70	59	.84	95	1.36
1957	72	43	.60	91	1.26
1956	73	38	.52	95	1.30
1955	70	33	.47	98	1.40

Table 6

Distribution of Geology Students 1961-62

	T.O.		S.A.	
	62	61	62	61
Memorial	2	-	-	-
St. Dunstans	-	-	1	-
Dalhousie	2	2	3	5
St. Francis Xavier	-	1	3	4
Acadia	1	1	1	5
U.N.B.	1	3	2	2
Mt. Allison	1	-	3	-
Sherbrooke Coll.	-	-	1	-
Laval	-	-	3	1
U. of Montreal (e.P.)	-	1	3	2
McGill	4	7	1	3
Ottawa (inc. St. Pats.)	1	-	14	7
Carleton	12	12	25	29
Queen's	7	15	18	19
Toronto	8	6	13	10
McMaster	6	2	7	8
Western Ont.	4	4	1	8
Waterloo Univ. Coll.	-	-	1	1
Assumption	-	-	1	1
Manitoba	5	4	6	4
Brandon	-	1	3	2
Saskatchewan	7	2	21	20
Alberta	2	6	8	2
B.C. (inc. Victoria)	10	6	25	28
U.S.	15	13	2	2
Others	1	2	-	-

GEOLOGICAL CARTOGRAPHY

G.S. Daughtry

GENERAL

During 1962, the Cartography Unit's facilities for production of multicoloured maps and illustrations were increased by the installation of a whirler for the preparation of colour proofs, and a dot-etch table for use in the colour negative process. The advantages of this equipment are not yet reflected in production figures, but of the 25 multicoloured maps listed as in progress at the end of 1962, 19 are in the colour negative stage. An attempt to relieve this bottleneck by overtime work in the negative section was interrupted by the austerity restrictions. Other draftsmen will be diverted to negative work until the normal flow is resumed.

A number of figure illustrations and aeromagnetic maps were contracted out during the year with satisfactory results. This type of work seems better suited to contract work than the multicoloured maps, which appear to be beyond the capabilities of most mapping firms.

Displays were prepared for the Prospectors and Developers Association, the C.I.M.M., and the Groundwater Symposium at Calgary. C.E. McNeil has replaced L.A. Williams as a member of the Exhibits Committee.

PERSONNEL

During 1962 additions to the staff included J.S. Yelle and J.S. Lockie (student draftsmen), and W.M. Snyder (photo learner). R. Gottinger, a draftsman 3, accepted a position in the Hydrographic Service, and L. MacLachlan was transferred to the Calgary office.

At the end of 1962 the staff of the Cartography Unit numbered sixty-four, including six vacant positions.

PRODUCTION DATA

Maps and figure illustrations prepared by the Cartography Unit and printed during 1962 comprised the following:

Multicoloured geological maps ..... 14 (including 1 reprint)

Preliminary geological maps	51
Preliminary geological maps reprinted	27
Aeromagnetic maps	56
Aeromagnetic maps reprinted	52
Figure illustrations (lithographed)	76
Figure illustrations (zinc cut)	255
Water Supply Paper maps reprinted	36
Geological Index Maps	43

Miscellaneous drafting consisted of 87 items comprising 509 pieces, including drafting illustrations for scientific papers, colouring lantern slides, map mounting, preparing displays, and other general drafting services.

Maps etc. at Survey and Mapping Branch for printing at Dec. 31

Multicoloured geological maps	4
Preliminary geological maps	6
Figure illustrations	9

Work in progress at December 31

Multicoloured geological maps	25
Preliminary geological maps	12
Figure illustrations	219
Aeromagnetic maps	13

The following work was completed in the photo-mechanical section:

Mapping camera

Film negatives	4,491

Contact processes

Films	2,812
Ferro-prussiate blue-line	982
Vandyke prints	8,625
Copyflex prints	7,911
Blue-line map prints	30,460
Photostat prints	6,537
Mimeograph impressions	69,390

Typesetting

Map names, titles, etc. were set up and printed for all maps and figure illustrations being drafted. Postcards, envelopes, covers, etc. printed totalled 2,874 impressions of 83 items. Typesetting and printing for the Mineral Resources Division involved 37 hours work.

Manuscripts received

Multicoloured geological maps	13
Preliminary geological maps	52
Aeromagnetic maps	49
Figure illustrations	296

Backlog of maps and illustrations in Cartography Unit

	Dec. 31, 1962	Dec. 31, 1961
Multicoloured geological maps	32	31
Preliminary geological maps	1	7
Aeromagnetic maps	0	0
Figure illustrations	140	149

MAPS PRINTED FROM JANUARY 1, 1962 TO DECEMBER 31, 1962

Geological ("A") Series (Multicolour)
Preliminary Geological Series (P.S.)
Aeromagnetic ("G") Series; scale 1 inch to 1 mile unless otherwise indicated

CANADA

900A Principal Mineral Areas of Canada; (12th edition; in cooperation with the Mineral Resources Division; 1 inch to 120 miles ..... For separate distribution

900A (French edition)	Principal Mineral Areas of Canada; (12th edition); in cooperation with the Mineral Resources Division; 1 inch to 120 miles	For separate distribution
34-1962 (P.S.)	Geological Survey of Canada Field Parties, 1962	For separate distribution
34-1962 (P.S.) (French edition)	Geological Survey of Canada Field Parties, 1962	For separate distribution

DISTRICT OF FRANKLIN

5-1962 (P.S.)	Andrew-Gordon Bay - Cory Bay (36 B, G); Baffin Island; 1 inch to 4 miles	For separate distribution
9-1962 (P.S.)	Alexandra Fiord (Parts of 39 and 49); Ellesmere Island; 1 inch to 4 miles	For separate distribution
12-1962 (P.S.)	Southeast Ellesmere Island (39 B, 49 A, and parts of 38 G, 39 C, 49 B, 49 D); 1 inch to 4 miles	For separate distribution
20-1962 (P.S.)	Northeastern Ellesmere Island (340 and 120); 1 inch to 8 miles	Paper 62-10
28-1962 (P.S.)	Northernmost Axel Heiberg Island (Part of 560 D/SW); 1 inch to 1 mile	Paper 62-18

DISTRICT OF MACKENZIE

1126A	Wholdaiz Lake West (75A); (Aeromagnetic); 1 inch to 4 miles	For separate distribution
1127A	Beaverhill Lake (75I); (Aeromagnetic); 1 inch to 4 miles	For separate distribution
36-1961 (P.S.)	Muskox Intrusion (Part of 86 O); Coppermine River Area; (5 sheets); 1 inch to 1/2 mile	Paper 61-25
18-1962 (P.S.)	Basler Lake (85 O/13); 1 inch to 1 mile	For separate distribution

DISTRICT OF KEEWATIN

28-1961 (P.S.)	Northern District of Keewatin (Parts of 56, 57, 66, and 67); 1 inch to 8 miles	Paper 61-18

YUKON TERRITORY

1105A	Keno Hill (105 M/14); 1 inch to 1 mile	For separate distribution
13-1962 (P.S.)	Dawson (116B, 116C, E. 1/2); 1 inch to 4 miles	Paper 62-7
14-1962 (P.S.)	Larsen Creek (116A); 1 inch to 4 miles	Paper 62-7
15-1962 (P.S.)	Nash Creek (106D); 1 inch to 4 miles	Paper 62-7

BRITISH COLUMBIA

932A	Geological Map of British Columbia (revised); 1 inch to 20 miles	For separate distribution
37-1961 (P.S.)	Halfway River (94B); 1 inch to 4 miles	For separate distribution
42-1961 (P.S.)	Quesnel Lake, East Half (93A, E. 1/2); 1 inch to 4 miles	For separate distribution
2-1962 (P.S.)	McLeod Lake (93 J); 1 inch to 4 miles	For separate distribution
7-1962 (P.S.)	Trail (82 F/4, E. 1/2); 1 inch to 1 mile	Paper 62-5
8-1962 (P.S.)	Merritt (92 I/SE); (Surficial Geology) 1 inch to 2 miles	For separate distribution
21-1962 (P.S.)	Dease Lake (104 J); 1 inch to 4 miles	For separate distribution
29-1962 (P.S.)	Cry Lake (104 I); 1 inch to 4 miles	For separate distribution
1553G	Hydraulic (93 A/12);	

BRITISH COLUMBIA-ALBERTA

1039A	Alberta and Northeastern British Columbia; Oil and Gas Fields (8th edition); 1 inch to 20 miles	For separate distribution
31-1961 (P.S.)	Fernie, East Half (82 G, E. 1/2); (Surficial geology) 1 inch to 4 miles	For separate distribution

35-1961 (P.S.)	Fernie, East Half (82 G, E. 1/2); 1 inch to 2 miles	Paper 61-24
41-1961 (P.S.)	Mount Robson (82 E/SE); 1 inch to 2 miles	Paper 61-31

ALBERTA

41-1962 (P.S.)	Lethbridge, East Half (82 H, E. 1/2); (Surficial geology); 1 inch to 4 miles	For separate distribution

SASKATCHEWAN

25-1961 (P.S.)	Elbow (72 O); (Surficial geology); 1 inch to 4 miles	Paper 61-15
33-1961 (P.S.)	Milliken Lake, Sheet 2 (Part of 74 N/7); 1 inch to 800 feet	For separate distribution
10-1962 (P.S.)	Milliken Lake, Sheet 3 (Part of 74 N/7); 1 inch to 800 feet	For separate distribution

MANITOBA

1137A	Virden, East Half (62 F, E. 1/2); (Groundwater Probability) 1 inch to 4 miles	For separate distribution
32-1961 (P.S.)	Cross Lake (63 I); 1 inch to 4 miles	Paper 61-22
17-1962 (P.S.)	Gods River (53 N); 1 inch to 4 miles	Paper 62-8
30-1962 (P.S.)	Tadoule Lake (64 J); 1 inch to 4 miles	For separate distribution

31-1962 (P.S.)	Kasmere Lake (64 N); 1 inch to 4 miles.....	For separate distribution

ONTARIO

1062A (Reprint)	Southwestern Ontario; (Oil and Gas); 1 inch to 6 miles	For separate distribution
1-1962 (P.S.)	Wunnummin Lake (53 A); 1 inch to 4 miles	For separate distribution
4-1962 (P.S.)	Lansdowne House (43 D); 1 inch to 4 miles	For separate distribution
6-1962 (P.S.)	Fort Hope (42 M); 1 inch to 4 miles	For separate distribution
33-1962 (P.S.)	Lake George (41 K/8); 1 inch to 1 mile.....	For separate distribution
1445G	Round Lake (31 F/12)	
1446G	Achray (31 F/13)	

ONTARIO-QUEBEC

1436G	Pembroke (31 F/14)	
1437G	Chalk River (31 K/3)	
1447G	Des Joachims (31 K/4)	

QUEBEC

1106A	Southeast Beauchastel Township (Part of 32 D/3); 1 inch to 1,500 feet	Memoir 315 and separate distribution

1107A	Southwest Rouyn Township (Part of 32 D/2 and 3); 1 inch to 1,500 feet ..... Memoir 315 and separate distribution
1108A	Southeast Rouyn Township (Part of 32 D/2); 1 inch to 1,500 feet ..... Memoir 315 and separate distribution
30-1961 (P.S.)	Vaudreuil (31 G/8); (Bedrock topography); 1 inch to 1 mile ..... Paper 61-20
43-1961 (P.S.)	Rivière-du-Loup - Trois-Pistoles (22 C/3, 21 N/13, 14); (Surficial geology); 1 inch to 1 mile ..... Paper 61-32
1416G	Montcerf (31 K/9)
1417G	Kellog Lake (31 K/16)
1418G	Bark Lake (31 N/1)
1419G	Lac St. Amour (31 N/8)
1420G	Lac Landron (31 N/9)
1421G	Camachigama Lake (31 N/16)
1422G	Forsythe (32 C/1)
1423G	Lac Valmy (32 C/8)
1424G	Lac Maricourt (32 C/9)
1428G	Doolittle Lake (31 K/10)
1429G	Delahey Lake (31 K/15)
1430G	Lac Jean Péré (31 N/2)
1431G	Cabonga Reservoir (31 N/7)
1432G	Lac Bouchette (31 N/10)
1433G	Lac Yser (31 N/15)

1448G	Rowanton (31 K/5)	
1449G	Russell Lake (31 K/12)	

NEW BRUNSWICK

1109A	Point Wolfe (21 H/11, E. 1/2, parts of 21 H/10, W. 1/2, and 21 H/6, E. 1/2); 1 inch to 1 mile	For separate distribution
24-1961 (P.S.)	Moncton, East Half (21 1/2, E. 1/2) (Groundwater); 1 inch to 1 mile	For separate distribution
23-1962 (P.S.)	Canterbury (21 G/14); (Surficial geology); 1 inch to 1 mile	Paper 62-12
24-1962 (P.S.)	Woodstock (21 J/4); (Surficial geology); 1 inch to 1 mile	Paper 62-12
25-1962 (P.S.)	Florenceville (21 J/5); (Surficial geology); 1 inch to 1 mile	Paper 62-12
26-1962 (P.S.)	Andover (21 J/12); (Surficial geology); 1 inch to 1 mile	Paper 62-12

NOVA SCOTIA

40-1961 (P.S.)	Annapolis (21 A); 1 inch to 4 miles	For separate distribution
3-1962 (P.S.)	Hopewell (11 E/7); 1 inch to 1 mile	For separate distribution

PRINCE EDWARD ISLAND

38-1961 (P.S.)	Tignish (21 I/16); (Surficial geology); 1 inch to 1 mile	Paper 61-28

NEWFOUNDLAND

1117A	Stephenville (12 B); 1 inch to 4 miles	Memoir 323 and separate distribution
19-1962 (P.S.)	Botwood, West Half (2E, W. 1/2); 1 inch to 4 miles	Paper 62-9
22-1962 (P.S.)	Battle Harbour - Cartwright (13 SE); 1 inch to 8 miles	For separate distribution

ADMINISTRATIVE SERVICES

LIBRARY

Mrs. N.I. Kummermann

During the year the library lost Mrs. Laura Francis, who left us to attend library school. Temporary help was fortunately forthcoming and we are to have a permanent replacement after New Years. The library is very pleased that it was possible to release this position from the "freeze".

The lengthy illness of the head librarian made the smallness of our staff acutely felt, since no replacement was obtainable. However, the library was fortunate in obtaining temporary assistance during the hospitalization of Mr. Fisher.

During the summer the presence of four university students made it possible to reorganize our correspondence file according to a scheme devised by the head librarian during her hospitalization. This has proven to be of great benefit. A book wheel was also set up to give stack locations for current and recent books. One, however, has proven insufficient and another is being prepared for us.

In the summer we were also able to complete the organization of a reference collection of the Ontario Department of Mines reports and make large inroads on the back log of maps requiring cataloguing.

The growth of the library was reflected in the acquisition of a new 72-drawer addition to the catalogue, which, during the summer, was completely shifted to make use of this added space.

Library statistics for the year are as follows:

Acquisitions:

Books and pamphlets acquired by purchase	948*
Canadian government publications	4,804
Canadian periodicals	1,944
Proceedings, transactions and bulletins of societies	9,044
British and foreign government publications	7,274
British and foreign periodicals	2,882
Total	26,896

*of which 184 were for our outside offices.

Other data:

Recorded loans, books, pamphlets and periodicals	47,499
Interlibrary and occasional loans	6,591
Publications borrowed from other libraries	547
Maps and charts loaned	947
Maps and charts received before sorting for disposal	2,645
Cards added to general catalogue	17,998
Items catalogued, including books, pamphlets, microfilms, monographs and analytical entries	6,171
Volumes bound	1,000
Scientific books purchased for personal use of staff members at their expense	74

PUBLICATION DISTRIBUTION OFFICE

L. Touchette

Distribution of geological publications in 1962 exceeded last year's distribution by some 75,000 items. This increase is, to a certain extent, attributable to the greater number of aeromagnetic maps being issued, to new indices to geological maps, and to a heavy demand for the 11th edition of "Canada - Mineral Areas Map" in early 1962.

Response from the general public for the new indices (total of 45 issued in 1962) was greater than anticipated. However, despite wide publicity through the Editorial & Information Division, there has been to date little public response to the 12th edition of "Canada Mineral Areas Map", issued in October.

As of recent date the Publications Unit has taken over the "revenue" (previously with Mrs. S.W. McNabb, room 107). Therefore, officers who may receive remittances accompanied by requests for publications and/or rock and mineral collections are asked to send these direct to the Publications Unit, room 113.

Distribution statistics are as follows:

During the year the following publications were received and made available for distribution.

Economic Geology Series (revised)	1
Economic Geology Series (French E.G.7)	1
Memoirs	2
Bulletins (14 English, 1 French)	15
Preliminary Papers (35 English, 3 French)	38
Preliminary Papers (reprinted)	27
Water Supply Papers (reprinted)	36
Reprint Series	19
Topical Reports	28
Departmental Annual Reports	2
Misc. Reports (14 English, 1 French)	15
Index to Pubs., Reports, Cat. Fossils	3
Final Geological Maps - A Series	10
Preliminary Geological Maps (25 English, 1 French)	26
Preliminary & Final Geological Maps (reprinted)	2
Aeromagnetic maps (new)	272
Aeromagnetic maps (reprinted)	52
Mineral Map of Canada (English and French)	2
Oil and Gas Map (Revision of 1039A)	1

Indices to Geological Maps	45
Indices to Aeromagnetic Maps (new and revised)	3
Notice lists 42: Total pubs. *advertised	*412

DISTRIBUTION DATA:

Maps	139,401
Reports	82,413
Indices, listings, misc. items	56,550
TOTAL DISTRIBUTION	278,364

OTHER DATA:

Requests for publications and information....	24,212
Acknowledgements (letters, memo, quotations)	3,445
Visitors (cash sales 973 - information only 1,661)	2,634

PHOTOGRAPHIC SECTION

E.C. Elliott

The year 1962 was not a very productive one for the production of black and white photographs. In previous years we have been able to report advances and assistance to other branches in the department; this past year these requests were not forthcoming. The reason for this situation cannot be explained.

We are still without our negative filing cabinets, also we have been unable to have a position established for a photographic negative librarian. This is still a very critical situation as the negative collection cannot be brought up to date without a qualified person to look after it.

The photomicrographic camera is still badly needed if we are to undertake colour photomicrography as well as black and white for illustrations.

The photo competition held each year of outstanding field photos has also become a problem. In the past we have been compelled to ask for a postponement to a later date. It seems that

to complete this type of assignment all field work should be completed and prints in the hands of field officers, so that selections can be made and judging completed; at present this is not so. I see no reason why the opening date cannot be set just before the field officers leave for their summer operations. This would enable us to clear all field photographs without interrupting the normal flow of work through the photographic section and this would not seriously affect the showing of the selected pictures because they are on exhibition all year.

PRODUCTION REPORT

Logan Club

1 Projectionist in attendance at 10 meetings.

Emergencies Measures Organization

1 Projectionist in attendance at 23 meetings.

Geological Survey

Contact prints	19,869
Bromide enlargements	25,543
Photo negatives made	3,507
Photo negatives opaqued	170
Photo negatives retouched	51
Photomicrographs made	223
Photomacrographs made	82
Autoradiographs	13
Film positives made	9
Lantern slides made	503
Lantern slides bound	677
Positive prints made	188
Photos dry mounted	573
Exposures processed (Field work)	5,943
Magnetometer film processed	7,300
Colour transparencies made	435
Colour transparencies mounted	224
Colour transparencies processed	523
Colour negatives made	141
Colour negatives processed	46
Total	66,020

Continental Polar Shelf

Contact prints	190
Bromide enlargements	16
Photo negatives made	41
Exposures processed	54
Total	301

Oceanographic

Contact prints	74
Bromide enlargements	122
Photo negatives made	34
Total	230

Information and Editorial

Contact prints	66
Bromide enlargements	558
Photo negatives	79
Total	703

Army Surveys

Lantern slides	18
Colour transparencies	45
Total	63

Mines Branch

Bromide enlargements	62
Photo negatives made	29
Lantern slides made	29
Colour transparencies	1
Colour film processed	20
Total	141
Grand Total	67,458

STENOGRAPHIC POOL

Mrs. M. Shanks

Summary of work executed in the Stenographic Pool during 1962 is as follows:

Letters from dictaphone and stenorette	1,200
Letters from manuscript	2,384
Pages of reports from dictaphone and stenorette ...	484
Pages of reports from manuscript	9,331
Pages of Preliminary reports (1,485 s.s.)	2,970
Multilith masters	2,524
Tabulated pages	1,064
Long carriage tables	304
Cards	6,002
Forms	3,992
Total of carbon copies produced	26,813
Secretarial relief supplied - days	455
Daily average number of operators in pool	8
Daily time factor for assembling and elucidation of difficult manuscripts	15% approx.

Approximate assessment of work:

Letters = 30 to 40 lines single spacing, 1½" margin, including address and salutation.

Reports = 6" line, double spacing, 30/32 lines 6" x 10" approx.)

Multilith masters = include large variety of work, i.e. double and single spacing work, tables, charts, etc.

Tabulated pages = numerical statistics, correlation tables, etc.

Cards = IBM type cards, geological records, technical indices, etc.

Secretarial relief = 1.8 of personnel per day.

Changes of personnel have taken place over the year, which have meant admission to the pool of operators unfamiliar with the scientific terms and special needs of the work. This called for close supervision and regular instruction by the supervisor and assistant supervisor.

The Record of Work is maintained by the supervisor and augmented by a monthly return of work from each operator, which can be checked against this record.

Requisitioning of all multilith work and office supplies is carried out by the assistant supervisor.

Extensive checking of typed material is carried out by the supervisor and assistant supervisor.

LAPIDARY SECTION

H.W. Hay

Report of work done in Lapidary section from December 18, 1961 to December 28, 1962.

Thin Sections	6,623
Large Polished	82
Mounted Polished	327
Cut and Levelled	152
Cutting Jade Saw	158 hours
Frosted Slides	5,000
Cubes 2" inch	18

Two weeks in cooperation with Dr. Traill in the development of new techniques and instruments in the making of polished thin sections.

RESEARCH AND DEVELOPMENT SHOP

A.G. Meilleur

During 1962, a total of 176 requisitions involving fabrication, modification, and repairs to scientific apparatus such as X-ray and optical spectrographic equipment, astatic, air, and sea magnetometers, recorders, photographic equipment, microscopes, rock conductivity measuring apparatus, sediment samplers, etc., were completed in the Research and Development Shop. The majority of this work has required a significant contribution to the research and development of the engineering aspects of the projects being undertaken.

In addition to the above, fabrication of a new 6" radius gas source mass spectrometer has been completed and some components of a second, solid source, mass spectrometer have been fabricated.

The facilities have been expanded to include a second lathe and a surface grinder. In addition, in order to better serve the requirements of the G.S.C. a stock of raw materials in common demand has been maintained and made available to members of the staff for experimental work.

As in previous years, the demand for services has exceeded the capabilities of the present staff of two machinists augmented by the temporary summer help of one assistant. In order to keep abreast of the requirements of scientists of the Survey, arrangements have been made to have certain items of scientific equipment fabricated by local firms.

RESEARCH GRANTS TO CANADIAN UNIVERSITIES

J.F. Henderson

Grants by the Geological Survey of Canada to Canadian universities were initiated in 1951 at the instigation of the National Advisory Committee on research in the Geological Sciences to stimulate and support geological research in Canadian universities. Applications are received from members of university staffs and are submitted to the Director, Geological Survey of Canada. The applications are reviewed by the Projects Subcommittee of the National Advisory Committee and the grants are awarded by the Geological Survey on the basis of the Committee's recommendations.

For 1962-63, 59 applications were received (compared with 53 in 1961-62), and the total of the grants applied for was $142,945.00 (compared with $127,910.00 in 1961-62). Of the 59 applications, seventeen amounting in the aggregate to $55,490.00 were for support of projects supported previously. The remaining 42 applications, aggregating $87,455.00, were for the support of new projects. Grants totalling $75,000.00 were awarded sixteen universities in support of 28 new projects and 15 continuing studies. Amounts of the grants and summary descriptions of the projects are given in Appendix 1 of the 1961-62 Annual Report of the National Advisory Committee.

The National Research Council of Canada also awards grants in aid of research of the Geological Sciences on a substantial scale. This support, including geophysical research on geological

problems, has increased from $25,000.00 in 1955, through $75,000.00 in 1958, $150,000.00 in 1959, $180,000.00 in 1960 to approximately $250,000.00 in 1961-62. In 1962, in addition to regular grants for research in the earth sciences, the National Research Council is providing substantial support to the universities for participation in the Upper Mantle Project; many of these projects are geological.

Research grants in the geological sciences by the National Research Council and the Geological Survey are fully coordinated. Applications for National Research Council grants in aid are received up to January 15th of each year and successful applicants are notified in March or early April. Applications for Geological Survey of Canada grants are received up to May 1st of each year, are reviewed by the Projects Subcommittee of the National Advisory Committee in June, and applicants are notified immediately whether or not they have recommended for grants.

The Projects Subcommittee of the National Advisory Committee has full knowledge of grants awarded the preceding March by the National Research Council when it reviews applications for Geological Survey grants in June. In addition, one or more members of each reviewing committee is common to both. In this way grants in aid of research in the geological sciences by both organizations are fully coordinated.

COMPREHENSIVE STUDY OF A CANADIAN ORE DEPOSIT

J.F. Henderson

The end of the first stage of the comprehensive, cooperative study of the Coronation copper deposit a few miles southeast of Flin Flon, Manitoba, has been reached. Geologists, geochemists, geophysicists, and mineralogists from several organizations are participating, with the full cooperation of the Hudson Bay Mining and Smelting Company Ltd., the owners and operators of the mine. This project was initiated by the National Advisory Committee on Research in the Geological Sciences in 1960 and the Geological Survey of Canada was given overall responsibility for coordinating the project and assuring it is carried to completion. Most of the actual work has been done by individuals and groups associated with institutions outside the Survey (including several universities), as was intended in the original concept of the project. Funds for research have come from the usual sources and have been sought by and granted to individuals on the merits of their individual projects. The project as such has no overall budget.

Dr. D.R.E. Whitmore, coordinator of the project, reports that the 26 studies undertaken to date fall naturally into three groups. These include detailed studies of the mineralogy, geology, geochemistry, and geophysics of the orebody; studies concerned with the geological setting of the deposit including the geochemistry, petrology, and structure of the intrusive and metamorphic rocks of the area, and the relation of the Coronation orebody and similar nearby sulphide deposits to major tectonic features of the region, such as the Churchill Front; and studies of considerable practical interest, although perhaps not contributing directly to an understanding of the ore forming processes, which include standard or experimental geophysical, geochemical, and specialized geological surveys of the mine area in the hope that the detailed underground information that is available will assist in refining the interpretation of such surveys. More detailed information about the project may be found in the annual report of the National Advisory Committee for 1961-62.

ANNUAL REPORT, NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES

J.F. Henderson

On behalf of the National Advisory Committee on Research in the Geological Sciences the Geological Survey continues to publish the Annual Report of the Committee; this report includes a survey of current research in the geological sciences in Canada. The Annual Report for 1960-61 was published and distributed in January 1962. Some 750 copies were prepared and all but a few of them have been distributed. The report for 1961-62 will be ready for distribution early in 1963.

POST-DOCTORATE FELLOWS

In 1956 the first National Research Council post-doctorate fellowship tenable with the Geological Survey of Canada was awarded. Since then a total of fourteen post-doctorate fellows have held fellowships with the Survey, and the number allowed the Survey each year has been increased from one to five. Most of the post-doctorate fellows have been men with experience in research and the ability and desire to carry it out. The fellowships have allowed these men to undertake basic research of their own choosing at the peak of their interest and enthusiasm. The post-doctorate fellows have proved stimulating to our staff and many of them have produced results of real interest and value.

In 1962, 43 applications for post-doctorate fellowships were received by the Geological Survey. From these applicants the following four men were offered and accepted fellowships with the Survey:

T.C.J. Zwartkruis, Ph.D., Amsterdam	- Petrology and Structure (with Dr. C.H. Smith)
S. Bhattacharji, Ph.D., Chicago	- Petrology and Structure (with Dr. C.H. Smith)
A. Sasaki, Ph.D., Tokyo	- Isotope Geology and Mineral Deposits
W.A. Robertson, Ph.D., Australian, National	- Paleomagnetism (with Dr. A. Larochelle)

Dr. Adrian Debnam and Dr. Geoffry Playford completed their fellowships with the Survey in 1962.

APPENDIX I

STAFF LIST

Geological Survey of Canada

Director's Office

1 Director
Harrison, J.M.

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

1 Chief Geologist
Lord, C.S.

1 Secretary to Executive
Derry, Miss G.E.

Marine Geology

2 Geologist 3
Pelletier, B.R.
Wagner, Miss F.J.E.

1 Geologist 2
Marlowe, J.I.

2 Sc. Off. 1
Horn, D.R.
Vilks, G.

2 Technician 1
Cormier, R.
Duncan, G.A.

Special Projects

2 Chief of Division
Lang, A.H.
Stockwell, C.H.

1 Clerk 3
Wragg, Miss C.E.

Secretary Nat. Adv. Comm.

1 Sr. Geologist
Henderson, J.F.

Geological Manuscripts

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

1 Geologist 4
Harker, P.

1 Geologist 3
Jenness, S.E.

1 Sr. Sc. Off. 1
Hall, E.

1 Clerk 3
Mahoney, Mrs. L.R.

Equipment Office

1 Clerk 3
Rozon, R.

Instrument Shop

1 Technician 4
Meilleur, A.G.

1 Technician 2
Fournier, J.P.

British Columbia Office

1 Sr. Geologist
Armstrong, J.E.

British Columbia Office (cont'd)

1 Sc. Off. 1
Leaming, S.F.

1 Clerk 4
Marble, Mrs. A.

1 Stenographer 3
Lee, Mrs. E.K.

Whitehorse Office

1 Geologist 4
Green, L.H.

1 Sc. Off. 1
Godwin, C.I.

1 Clerk 2
Cromwell, Mrs. C.V.

Yellowknife Office

1 Geologist 3
Baragar, W.R.A.

1 Sc. Off. 1
Hornbrook, E.H.W.

1 Clerk 2
Pearson, Mrs. J.A.

Administrative Services

1 Admin. Off. 6
Pollitt, K.

1 Stenographer 3
Baker, Mrs. R.D.

Attendance

1 Typist 3
Shields, Mrs. L.

Accounts

1 Admin. Off. 2
Besserer, L.E.

1 Principal Clerk
Raymond, J.E.

1 Clerk 2
McNaught, Mrs. M.E.L.

Files and Messenger Service

1 Clerk 3
Moreau, V.

3 Clerical Assistants
Bissonnette, Miss M.C.
Jean, Miss R.
Nault, Miss D.

Geological Information

1 Supervising Clerk
Touchette, L.J.

1 Clerk 4
Letang, E.G.

1 Storeman 2
Coutu, F.V.

1 Clerk 3
Lortie, L.H.

3 Clerk 2
Clarke, C.R.
Higgs, Mrs. M.M.
McNabb, Mrs. S.W.A.

1 Typist 2
Drapeau, Mrs. G.M.

Stationery & Office Supplies

1 Clerk 4
Smith, D.D.

Stationery & Office Supplies (cont'd)

1 Clerk 3
Henderson, Mrs. M.V.

1 Storeman 2
Charlebois, G.J.

1 Typist 1
Rouleau, A.

1 Truck Driver
Cayer, H.H.

Photographic

1 Technician 4
Elliott, E.C.

3 Photographer 3
Cooke, F.J.
Emslie, J.B.
Thorpe, E.

1 Photographer 1
Skuce, C.A.

2 Technician 1
Kempt, J.W.
Stafford, W.G.

1 Asst. Tech. 3
White, Miss J.I.

Library

1 Librarian 5
Kummermann, Mrs. N.I.

1 Librarian 3
Whitney, Mrs. L.E.

1 Librarian 2
Hudak, L.

1 Tech. Off. 2
Lindsay, Miss L.E.

Library (cont'd)

1 Tech. Off. 1
Williams, Miss M.E.

1 Clerk 3
Stewart, Miss T.G.

1 Asst. Tech. 3
Fisher, A.

2 Clerk 2
Monette, Miss P.M.
Patterson, Miss E.L.

Stenographic Pool

1 Clerk 4
Shanks, Mrs. M.A.

2 Clerk 3
Britt, Mrs. M.G.
Partington, Mrs. G.

3 Typist 3
Butler, Mrs. J.D.
Casey, Mrs. M.
Millar, Miss M.

3 Typist 2
Gougeon, Mrs. C.L.
Hillert, Mrs. S.M.
Lessard, Miss J.

3 Typist 1
Macrillo, Miss M.A.
Morency, Miss L.S.
Murphy, Mrs. F.M.

Technical Services

1 Technical Officer 4
Jones, F.W.

Lapidary

1 Technician 3
Hay, H.W.

Lapidary (cont'd)

1 Technician 1
Whitehead, A.E.

1 Asst. Tech. 3
McEwan, W.O.

1 Asst. Tech. 1
Demers, A.Y.

Carpenter Shop

1 Carpenter
Carey, E.L.

Geological Cartography

1 Tech. Off. 7
Daughtry, G.S.

1 Clerk 3
Nakamoto, Mrs. S.

1 Technician 1
McCracken, J.N.

Map Editing and Work Planning

3 Technical Officer 5
McNeil, C.E.
Nunn, E.P.
Williams, L.A.

Draughting

1 Supervising Drafts. 3
Gardham, F.J.

1 Supervising Drafts. 2
Finn, H.J.

6 Draftsman 3
Daugherty, R.F.
Hayne, M.
Heyendal, H.A.
Hill, R.
King, J.A.
Kovachic, Mrs. H.

Draughting (cont'd)

1 Supervising Drafts. 2
Debain, P.

4 Draftsman 3
Barbary, G.J.
Gagnon, J.G.E.
Guibord, J.L.
Mainville, B.

1 Draftsman 2
St. Pierre, M.

1 Draftsman 1
Auger, M.

1 Supervising Drafts. 2
Dumbrell, E.A.

5 Draftsman 3
Edwards, B.
Howe, K.G.
MacLachlan, L. (Calg.)
Raddatz, Miss M.A.
Romhild, R.C.

2 Draftsman 2
Saffin, R.E.
Vermette, W.P. (Calg.)

1 Supervising Drafts. 3
Babcock, L.W.

1 Supervising Drafts. 2
Leader, R.E.

3 Draftsman 3
Cooke, Miss B.J.
Rockburne, K.G.
Walter, D.J.

3 Draftsman 2
Heney, F.J.
Nichol, H.S.
Whitman, G.S.

1 Draftsman 1
Sutcliffe, W.J.

Draughting (cont'd)

1 Supervising Drafts. 1
Bernard, M.

3 Draftsman 3
Bencik, K.
Lavigne, G.H.
Thomson, J.W.

1 Draftsman 1
Corriveau, J.P.

Negative Engraving, Colour Negatives

1 Supervising Drafts. 1
Williams, J.B.F.

1 Draftsman 1
Papps, T.L.

1 Asst. (L. or P.) 1
Daley, L.A.

3 Student Draftsman
Thomson, H.A.
Tintinalli, G.C.
Yelle, J.S.

Map Photography

1 Process Camera Operator
Buck, N.E.

1 Asst. Tech. 3
Sidock, K.S.

1 Learner (L. or P.)
Snyder, W.M.

Printing

1 Technician 2
Connell, C.

Photostat

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

Blueprint, Mimeograph

1 Dup. Eq. Operator 2
Mackenzie, R.J.G.

Typesetting

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

1 Asst. (Litho. or Photo.) 1
Fairfield, R.D.J.

REGIONAL GEOLOGY DIVISION

1 Chief of Division
Weeks, L.J.

1 Clerk 3
Paquette, Mrs. A.M.

Appalachian

1 Sr. Geologist
Neale, E.R.W.

4 Geologist 3
Anderson, F.D.
Benson, D.G.
Kelley, D.G.
Poole, W.H.

1 Geologist 2
Williams, H.

1 Tech. Off. 3
Gillis, J.W.

Eastern Shield

1 Sr. Geologist
Duffel, S.

5 Geologist 4
Blackadar, R.G.
Eade, K.E.
Fahrig, W.F.
Frarey, M.J.
Stevenson, I.M.

4 Geologist 2
Bostock, H.H.
Donaldson, J.A.
Emslie, R.F.
Jackson, G.D.

Western Shield

1 Sr. Geologist
Wright, G.M.

3 Geologist 4
Fraser, J.A.
McGlynn, J.C.
Tremblay, L.P.

3 Geologist 3
Bell, C.K.
Heywood, W.W.
Taylor, F.C.

1 Sc. Off. 3
Davison, W.L.

Cordilleran

2 Sr. Geologist
Bostock, H.S.
Little, H.W. (B.C.)

6 Geologist 4
Gabrielse, H.
Leech, G.B.
Muller, J.E. (B.C.)
Tipper, H.W.
Souther, J.G. (B.C.)
Wheeler, J.O. (B.C.)

Cordilleran (cont'd)

3 Geologist 3
Campbell, R.B. (B.C.)
Roddick, J.A. (B.C.)
Skinner, R.

2 Geologist 2
Baer, A.J.
Hutchison, W.W.

FUELS AND STRATIGRAPHY DIVISION

1 Chief of Division
Caley, J.F.

1 Clerk 3
Riddell, Mrs. N.H.

1 Sc. Off. 2
Howie, R.D.

1 Tech. Off. 3
Martin, H.L.

1 Clerk 3
McGuire, Mrs. V.M.

Petroleum Geology

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

2 Geologist 4
Irish, E.J.W. (Calg.)
Norris, D.K.

3 Geologist 3
Liberty, B.A.
Price, R.A.
Stott, D.F. (Calg.)

Petroleum Geology (cont'd)

3 Geologist 2
Mountjoy, E.W.
Ollerenshaw, N.C.
Taylor, G.C.

2 Sr. Sc. Off. 1
Latour, B.A.
Sanford, B.V.

1 Sc. Off. 3
MacLean, B.

1 Sc. Off. 2
Herr, R.L.

1 Technician 2,
Ter Haar Romeny, W.U.

2 Asst. Tech. 3
Bova, P.
Seguin, R.J.G.

1 Asst. Tech. 2
Larose, J.M.

1 Asst. Tech. 1
Remillard, G.

Arctic Islands

1 Sr. Geologist
Thorsteinsson, R.

1 Geologist 3
Christie, R.L.

2 Geologist 2
Kerr, J.W. (Calg.)
Trettin, H.P. (Calg.)

Stratigraphic Palaeontology

1 Sr. Geologist
McLaren, D.J.

Stratigraphic Palaeontology (cont'd)

6 Geologist 4
Bolton, T.E.
Copeland, M.J.
Jeletzky, J.A.
Norris, A.W.
Sinclair, G.W.
Tozer, E.T.

3 Geologist 3
Cumming, L.M.
McGregor, D.C.
Norford, B.S.

1 Geologist 2
Bamber, E.W.

1 Sc. Off. 1
Uyeno, T.T.

1 Technician 3
Botte, B.J.

1 Technician 2
Callahan, J.J.

1 Asst. Tech. 3
Matte, J.E.A.

1 Asst. Tech. 2
Shea, R.

1 Clerk 3
Lemoine, Mrs. A.M.

Senior Research Palaeontologist

1 Sr. Geologist
Frebold, H.W.

Coal Research

1 Sr. Geologist
Hacquebard, P.A.

1 Geologist 2
Cameron, A.R.

Coal Research (cont'd)

2 Sc. Off. 2
Birmingham, T.F.
Donaldson, J.R.

1 Tech. Off. 3
Barss, M.S.

Western Plains Office

2 Sr. Geologist
Wickenden, R.T.D.
Belyea, Miss H.R.

1 Geologist 4
Aitken, J.D.

3 Geologist 2
Burk, C.F.
Procter, R.M.
Pugh, D.C.

2 Sr. Sc. Off. 1
Chamney, T.P.
Price, L.L.

2 Sc. Off. 2
Cox, R.L.
Tassonyi, E.J.

1 Technician 1
Banning, W.J.

1 Asst. Tech. 3
Herron, D.L.

1 Asst. Tech. 1
Miller, R.B.

1 Typist 2
George, Mrs. M.E.

ECONOMIC GEOLOGY DIVISION

1 Chief of Division
Fortier, Y.O.

Economic Geology Division (cont'd)

1 Clerk 3
Burns, Miss E.M.

Central Technical Geological Files

1 Tech. Off. 3
Johnston, A.G.

1 Typist 3
Shurben, Mrs. P.A.

Geology of Mineral Deposits

1 Sr. Geologist
Kindle, E.D.

4 Geologist 4
Gross, G.A.
Mulligan, R.
Roscoe, S.M.
Whitmore, D.R.E.

3 Geologist 3
Chamberlain, J.A.
McCartney, W.D.
Rose, E.R.

1 Geologist 2
Gleeson, C.F.

1 Sc. Off. 2
McLeod, C.R.

Geochemistry

1 Sr. Geologist
Boyle, R.W.

3 Geologist 3
Cameron, E.M.
Currie, K.L.
Holman, R.H.C.

1 Geologist 2
Fortescue, J.A.C.

2 Sc. Off. 3
Lynch, J.J.
Washington, R.A.

1 Sc. Off. 1
Dawes, Mrs. T.D.

1 Technician 2
Lavergne, P.J.

1 Technician 1
Mihailov, G.

1 Asst. Tech. 2
Durham, C.C.

Pleistocene Geology

1 Sr. Geologist
Prest, V.K.

5 Geologist 4
Fyles, J.G.
Henderson, E.P.
Lee, H.A.
Stalker, A.M.
Terasmae, J.

3 Geologist 3
Craig, B.G.
Gadd, N.R.
Hughes, O.L.

3 Geologist 2
Blake, W.
Fulton, R.J.
Mirynech, E.

1 Tech. Off. 3
Mott, R.J.

1 Technician 2
Field, D.E.

Pleistocene Geology (cont'd)

1 Technician 1
Kelley, R.G.

Engineering and Groundwater Geology

1 Geologist 4
Brown, I.C.

1 Sr. Sc. Off. 2
Owens, E.B.

2 Sr. Sc. Off. 1
Halstead, E.C. (Vanc.)
Brandon, L.V.

3 Geologist 2
Meyboom, P.
Scott, J.S.
Van Everdingen, R.O.

4 Sc. Off. 2
Carr, P.A.
Charron, J.E.
Toth, A.M.
Tremblay, J.J.L.

1 Sc. Off. 1
Freeze, R.A.

1 Technician 1
Pearce, R.G.

PETROLOGICAL SCIENCES DIVISION

1 Chief of Division
Robinson, S.C.

1 Typist 3
Jackson, Miss F.

Analytical Chemistry

1 Sr. Sc. Off. 3
Maxwell, J.A.

2 Sr. Sc. Off. 1
Abbey, S.
Champ, W.H.

1 Sc. Off. 3
Sen Gupta, J.G.

2 Sc. Off. 2
Beaulne, R.P.
Courville, S.

2 Sc. Off. 1
Payne, Miss A.V.
Van Peteghem, J.K.

1 Tech. Off. 4
White, W.F.

3 Technician 1
Bender, G.
Hoops, K.G.
Malone, J.P.

1 Asst. Tech. 3
Bouvier, J.L.

1 Asst. Tech. 2
Letang, Miss F.J.

1 Asst. Tech. 1
Gauthier, P.J.

Isotope and Nuclear Research

1 Sr. Sc. Off. 3
Wanless, R.K.

2 Sc. Off. 3
Dyck, W.
Lowdon, J.A.

2 Sc. Off. 2
Loveridge, W.D.
Stevens, R.D.

Isotope and Nuclear Research (cont'd)

1 Technician 3
Smith, W.A.

1 Technician 2
Hurley, J.G.

1 Asst. Tech. 2
Bradshaw, D.C.

Mineralogy

1 Geologist 4
Traill, R.J.

1 Sr. Sc. Off. 1
Steacy, H.R.

1 Geologist 2
Pouliot, G.

2 Sc. Off. 3
Lachance, G.R.
Rimsaite, Miss J.

2 Sc. Off. 2
Jambor, J.L.
Sabina, Miss A.P.

1 Tech. Off. 3
Gauthier, C.H.R.

1 Tech. Off. 1
Delabio, R.N.

1 Technician 2
Paris, J.C.

1 Technician 1
Lacroix, A.

2 Asst. Tech. 2
Machin, D.B.
Turpin, J.

1 Asst. Tech. 1
Gibson, W.A.

Petrology

3 Geologist 4
Dawson, K.R.
Reesor, J.E.
Smith, C.H.

1 Geologist 3
Irvine, T.N.

1 Sc. Off. 2
Agterberg, F.P.

1 Tech. Off. 3
Findlay, D.C.

GEOPHYSICS DIVISION

1 Chief of Division
Morley, L.W.

1 Clerk 4
Thomas, Mrs. B.F.

Magnetic Surveys and Interpretation

1 Geologist 4
MacLaren, A.S.

1 Geologist 3
Gregory, A.F.

2 Tech. Off. 4
Owens, K.H.
Ready, E.E.

1 Tech. Off. 3
Anderson, D.T.

2 Technician 2
Essex, F.
Stauffer, W.J.

1 Technician 1
Reveler, D.A.

Magnetic Surveys and Interpretation (cont'd)

1 M.C. & C. Super. 1
Langlois, R.J.

2 M.C. & C. 4
Chretien, Miss M.B.
Derouin, E.J.

4 M. C. & C. 3
Dods, S.D.
Dregas, Miss T.C.M.
Leblanc, Mrs. M.K.
Zieman, F.W.

2 M. C. & C. 2
Haley, E.L.
Zebarth, A.L.

Palaeomagnetism

1 Geologist 3
Larochelle, A.

1 Geologist 2
Gaucher, E.H.

1 Sc. Off. 2
Black, R.F.

1 Asst. Tech. 2
Freda, G.N.

Seismic & Resistivity Surveys

1 Sr. Sc. Off. 1
Hobson, G.D.

1 Sc. Off. 1
Wyder, J.E.

1 Technician 4
MacAulay, H.A.

1 Technician 2
Hodge, R.A.

Electronic Instrumentation & Research

1 Sr. Sc. Off. 1
Collett, L.S.

1 Sc. Off. 3
Ahrens, R.H.

1 Sc. Off. 2
Sawatzky, P.

1 Tech. Off. 5
Washkurak, S.

1 Technician 3
Knapp, H.W.C.

2 Technician 2
Dicaire, A. (On Loan)
Gauvreau, C.

1 Technician 1
Houlihan, J.P.

Special Investigations

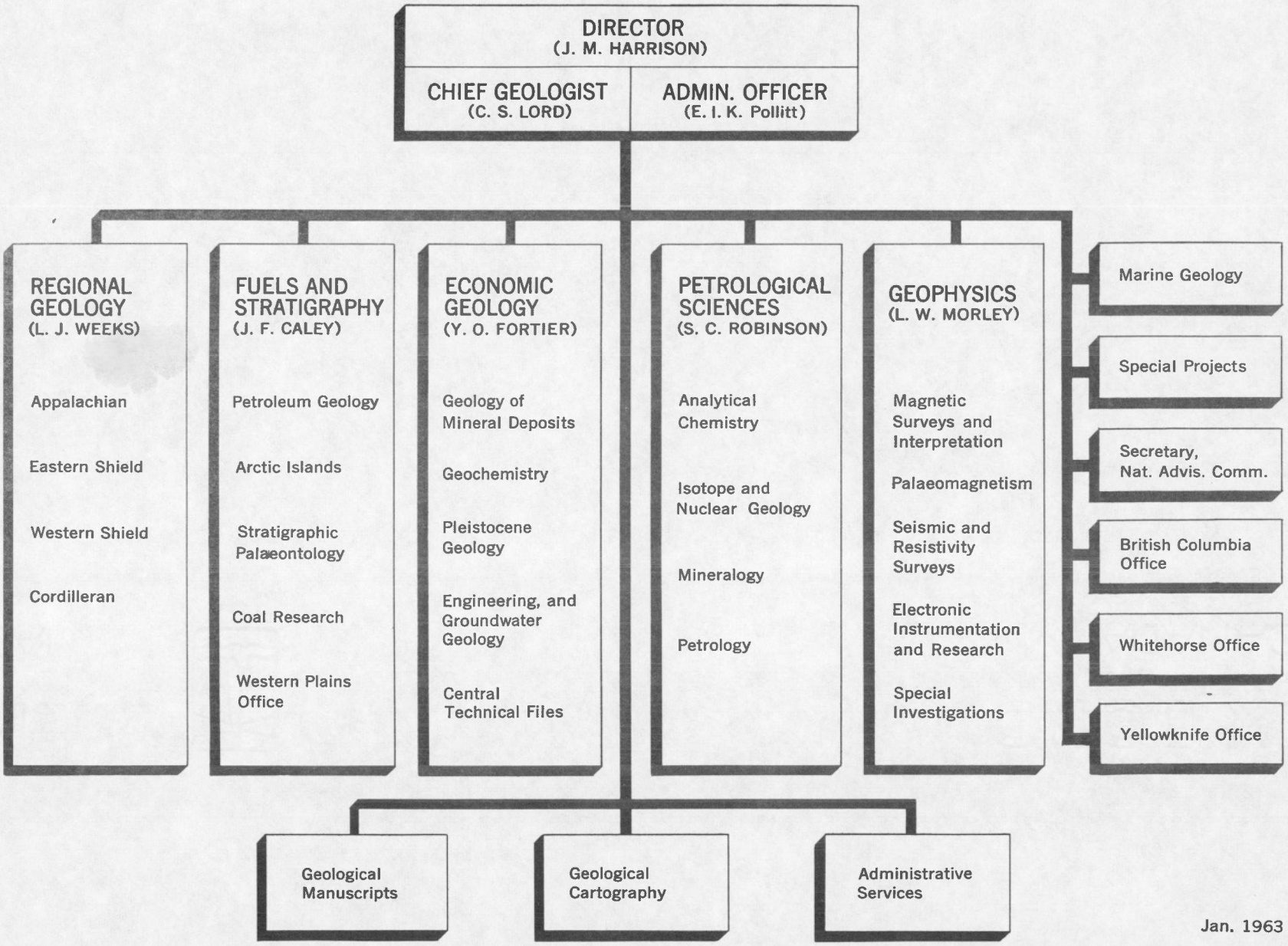
1 Sr. Sc. Off. 1
Bhattacharyya, B.K.

2 Sc. Off. 3
Bower Miss M.E.
Hood, P.J.

On Loan to Geophysics

1 Technician 2
Blanchard, J.

GEOLOGICAL SURVEY OF CANADA



Jan. 1963